Technology and Language

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Instructions

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Editorial Introduction

Instructing Technology, Technological Instruction: Editorial Introduction

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Abstract
The term *instruction* is multi-layered and used in completely different contexts – from printed user manuals, over explicitly uttered verbal directives to the implicit teaching of forms of conduct by exemplifying them. This issue collects contributions that explore instructions from a philosophical perspective on the relationship between language and technology. The following editorial introduces these contributions and identifies connections between them. Although the contributions in this special issue explore the term *instruction* from different angles, these contributions are all connected by a common thread, namely the philosophical reflection on the relationship between knowledge and action. This relationship seems to be prevalent in both written and verbal, implicit and explicit forms of instruction: instructions convey knowledge about action. Instructing a person or a machine connects the digital with the analogue and the abstract with the concrete while situating both instructor and instructed in a larger socio-technical context.

Keywords: Instruction; Language; Technology; Knowledge; Action

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Редакторская заметка

Инструктаж по технологии, Технологическая инструкция: Введение от редакторов

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Аннотация
Термин “инструкция” многослоен и используется в совершенно разных контекстах — от печатных руководств пользователя, явно произносимых словесных указаний до имплицитного обучения формам поведения путем их демонстрации. В этом номере собраны материалы, в которых рассматриваются инструкции с философской точки зрения отношения языка и технологии. Данная редакционная статья представляет эти вклады и определяет связи между ними. Хотя статьи в этом специальном выпуске исследуют термин “инструкция” с разных точек зрения, все они связаны общей нитью, а именно философскими размышлениями о взаимосвязи между знанием и действием. Эта взаимосвязь, по-видимому, преобладает как в письменных, так и в устных, неявных и явных формах обучения: инструкции передают знания о действии. Инструктирование человека или машины связывает цифровое с аналоговым, а абстрактное с конкретным, помещая как инструктора, так и обучаемого в более широкий социотехнический контекст.

Ключевые слова: Инструкция; Язык; Технология; Знание; Действие

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This special issue is not only dedicated to a multi-layered term that is used in completely different contexts. The articles also provide a look at the numerous objects that we refer to as instructions. The range is wide: on an airplane, for example, we encounter safety instructions in the form of printed paper with text and images, as spoken words, as video, and as gestures by flight personnel. This example already shows the relevance for the journal: instructions use technology and technique and they also refer to them. Obviously, this is true for user instructions, but work instructions are also only understandable through a socio-technical context in which the work takes place. The technique materialized in the instructions themselves is also worth looking at: Does it make a difference whether instructions are conveyed via video or as text? How does the technique of writing instructions itself evolve? How explicit and how descriptive is the content of the instruction? Finally, digitalisation and robotics also modify the question of the user of instructions: While in the past the users were usually humans (although we may find counter-examples addressing animals, plants, spirits and gods), today the technology itself requires instruction.

A common thread running through the contributions to this special issue is the relationship between knowledge and action. This is rooted in the concept of instruction, since it is through instruction that knowledge about action is conveyed. User instructions convey knowledge about how to act with a technical object, work instructions describe behavior at the workplace, and safety instructions convey knowledge about how to avoid accidents through actions. An important component of action here is physicality: actions take place in the physical world in most cases and the transfer of knowledge into physical action is not trivial.

In her contribution **Instructing To and Instructing In: Two Paradigms of Instruction**, Danka Radjenović (2022) makes a distinction between two ways in which the concept of instruction is used in the English language. The first paradigm – ‘instructing to’ – is predominantly found in the context of technology, especially human-machine interaction. This paradigm is best exemplified by a computer program that performs its functions by following a coded set of instructions. The second paradigm – ‘instruct in’ – can be exemplified in the process of teaching and learning a language. Although a language teacher also ‘instructs' their pupils 'to’ use certain words and phrases in certain contexts or to pronounce phonemes in a certain way, teaching a language ultimately represents a form of ‘instructing' pupils 'in’ using said language freely, creatively, and autonomously beyond the simple following a coded set of instructions.

Regina Wuzella (2022) shows us an exciting perspective on the corporeality of instructed actions in her contribution **Epistemologies of Formalized Sensuality - The Sensory as a Figure of Thought of AI-based Robotic Embodiment**. This paper is about the specific instructions for humanoid designed robots which enable these robots to react appropriately to the sensory input with their own behavior. It becomes clear that looking only at the explicit instructions in the algorithms is too narrow: intuitive sensor-motoric actions in particular require tacit knowledge and intelligence embedded in the body. The fact that a central control system alone cannot provide such tacit knowledge and intelligence points out that the translation of knowledge into action has many preconditions in the body itself.

An examination of the media through which instructions are conveyed can be found in the article **Do it Youself at Youtube** by Yegor Grom and Stepan Bytsan (2022). This paper is an empirical work that analyzes instructions for making tools uploaded on the video platform Youtube. These videos are contrasted with journal articles with a similar goal. Again, a key aspect is the translation of knowledge into action. The strengths and weaknesses of different media for conveying instruction are elaborated: While videos greatly simplify direct translation into actions, the textual form has strengths in conveying background knowledge and justifying specific steps.

In her article **Explicit and Implicit Components of Social and Technical Instruction**, Irina G. Belyaeva (2022) returns to instructions themselves and analyzes the concept itself and the forms in which instructions are socially applied. Here, there are several dimensions by which instructions can be classified: Their explicitness, the sign system in which they are written and their functional style. In addition, the user of the instructions is examined: besides human individuals, computer programs can also be considered, so it is proposed that users of instructions should be understood as subjects who modify an object on the basis of the instructions.

In Reiner Hähnle’s (2022) contribution **Program and Code**, the relation between knowledge and physical action is present in a special way. The article emphasizes the distinction between computer programs and code. Programs denote mathematical objects with unambiguous semantics. Code, on the other hand, refers to the physically executable objects that can run on a computer and that have physical effects - be it output on a screen or vehicle control. The distinction is important, for example, because formal verifications (mathematical proofs of correctness) always refer to the mathematical object. A relation between the two distinguished objects is only established by the application context of the program.

A completely different approach to the translation process of instructions into bodily action is shown by Danil Vyrypanov (2022) in his contribution **Staging Notations**. This article considers notations for recording ballet and theater performances: physical actions of people, e.g. dances, are to be recorded as instructions in order to reproduce these actions in the future. The history of notational forms is at the same time a history of the properties and limitations of the notational medium: three-dimensional temporal sequences are to be recorded, often on two-dimensional paper without the possibility of anchoring temporal sequences in the medium itself. However, the limitation can also open up possibilities: For example, a focus on the essentials in the instructions is necessary.

The previous contributions were primarily concerned with the translation of knowledge into actions. In the last paper **Visualizing the Composition: A Review of Latour's Science and Technology Studies and Visualization Practices** by Yingyu Zhu (2022), the question is asked conversely: How can we gain an understanding of processes from existing physical actions and compositions of people and things? For this purpose, the central concepts of Bruno Latour's science and technology studies are first taken up. A main focus of the article is on the visualization techniques through which the relations of different actants are made visible and thus knowledge is generated. Since the form and expressiveness of the medium play an important role here, the links to design and art are also examined.

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Research article

Instructing to and Instructing in: Two Paradigms of Instruction

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Abstract

In my contribution, I appropriate the distinction made in English between "instructing to" and "instructing in" in order to differentiate between the mode of instruction characteristic of technical processes – instructing to – which is more akin to order and command, and a mode of instruction closer to teaching – instructing in. Talk of instruction covers a spectrum of cases, with the technological paradigm of "instructing to" being on the one end of the spectrum, as opposed to the open-ended process of "instructing in" on the other end. More precisely, the former paradigm is that of an automaton, "a machine which performs a range of functions according to a predetermined set of coded instructions", whereas the latter can be imagined as an "open-ended" process of instruction, such as language instruction (following Cavell's take on Wittgensteinian scenes of instruction). While the model of instruction pertaining to technology is led by the goal of achieving automatisation, language instruction runs counter to the idea of language usage running in an automatic way – even though the process of instruction itself includes elements of drill and repetition. The goal of becoming a competent language user is in a way never achieved fully, since it is always possible to discover new ways of expressing the same things or even to discover new words and expressions. As the distinction elaborated in this contribution helps to show, it is thus not appropriate to talk of instructing a machine in singing, but it will be possible to instruct it to produce sounds that remind of singing. Taking the other direction, however, reveals that technological systems can instruct humans to behave in certain "automatic" ways, leaving it to education to instruct present and future generations in becoming competent users of different technologies.

Keywords: Instruct to; Instruct in; Automatisation; Teaching; Embeddedness; Wittgenstein; Cavell

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Научная статья

Инструкция к … и инструкция о … : Две парадигмы инструкции

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Аннотация
В своей статье я использую различие, проведенное в английском языке между “instructing to” (“инструкция к …”) и “instructing in”, (“инструкция о…”), чтобы различать способ обучения, характерный для технических процессов – instructing to – который больше похож на приказ и команду, и способ обучения ближе к обучению – “instructing in, инструктирование. Разговор об обучении охватывает спектр случаев, причем технологическая парадигма “instructing to” находится на одном конце спектра, в отличие от открытого процесса “instructing in” на другом конце. Точнее, первая парадигма – это парадигма автомата, “машины, которая выполняет ряд функций в соответствии с заранее определенным набором закодированных инструкций”, тогда как вторую можно представить как “открытый” процесс обучения, такой как языковое обучение (в соответствии с подходом Кавелла к витгенштейновским сценам обучения). В то время как модель обучения, относящаяся к технологии, направлена на достижение цели автоматизации, обучение языку противоречит идее автоматического использования языка, даже если сам процесс обучения включает элементы тренировки и повторения. Цель стать компетентным пользователем языка никогда не достигается полностью, поскольку всегда можно открыть новые способы выражения одних и тех же вещей или даже открыть новые слова и выражения. Как помогает показать различие, разработанное в этом вкладе, неуместно говорить об обучении машины пению, но можно научить ее производить звуки, напоминающие пение. Однако с другой стороны, мы обнаруживаем, что технологические системы могут научить людей вести себя определенным “автоматическим” образом, оставляя образованию обучать нынешнее и будущие поколения тому, как стать компетентными пользователями различных технологий.

Ключевые слова: Инструкция; Автоматизация; Обучение; Встроенность, Витгенштейн; Кавелл

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INTRODUCTION

We are all familiar with the composition of a cooking recipe, which contains a set of ingredients and instructions on how to prepare a meal, using the ingredients listed. And every now and then we read user manuals, following the instructions contained in them. In some other cases we can ourselves figure as “instructors” – when teaching another person how to cook or how to operate a machine or vehicle, to name only a few examples. Instructions can be either verbal (expressed in sentences of natural languages or in speech acts), formal (sets of symbols in programming languages) or non-verbal (hand signs, gestures).

Despite its familiarity within the everyday life and its special prominence in the context of using technology, the topic of instructing and instruction has not as yet been thoroughly explored in the area of philosophy of technology. In order to contribute to opening a discussion about instructions, I would like to present some preliminary ideas about the ways in which we can approach this topic. In this paper I introduce and elaborate on two distinct paradigms of instruction: *instructing to* and *instructing in*. They differ in several aspects: as regards their procedures, the context of application and overall goals/purposes.

Instructing to is most prominently found in the area of programming, in the cases where a machine, application, device, or an entire system is instructed to behave in a certain way, performing tasks or solving problems. The way the instruction works is rather straightforward: there is a clearly defined task and distinct steps that need to be completed in order for the task to be fulfilled. The regularity and routinized processes are at the core of this kind of instruction, since its success largely depends on the exact execution of instructions, that should be formulated in an unambiguous way. The possibility of variation or deviation has to be previously integrated into the instructions. In the first section of this paper I will introduce several cases of *instructing to*, in the area of human-machine interaction, but also in the interaction between human agents. The applicability of the paradigm in the case of molecular biology will also be presented.

Instructing in can be – most generally speaking – found in the field of teaching, where a skill is to be mastered or knowledge is being transmitted. This is a rather open-ended kind of instruction, where we cannot definitively say when the last stage has been reached. In my paper *instructing in* will be elaborated in the second section, where I will focus on the example of teaching and learning a language, by looking into this process from the perspective of both the person teaching and the person being taught. Furthermore, it will be assumed that even though there is a goal that is to be reached when we engage in this kind of instruction, this goal can never be fully attained, as the point is not simply to complete a task, but either to become *good at something* or to gain specific insight or expertise, which is accompanied by certain independence or autonomy in exercising it, that can only be the result of a long-term training process.

The goal of introducing the distinction between *instructing to* and *instructing in* is to capture two distinct processes and their specific features, as well as to clarify whether this distinction is well-founded.

THE PARADIGM OF *INSTRUCTING TO*

The first paradigm of instruction is mostly found in the context of technology, broadly speaking: both as a feature of human-machine interaction, as well as within the interaction between machines. In its purest form it is exemplified by an automaton – "a machine which performs the range of functions according to a predetermined set of coded instructions" (Rangra & Madhusudan, 2016). Automatic processes unfold in a predetermined way, where any variation or divergence is either also predetermined (hence part of the instructions) or otherwise indicates an interruption, error, or any kind of failure in the process. The underlying scheme of this kind of instruction is: command – execute – repeat. Typically, the goal of this first type of instruction is to enable the performance of different functions or a fulfilment of a task that a specific machine or device is designed to fulfil. The process of executing instructions, which are normally formulated as commands, is directed at fulfilling well-defined tasks. The success of the process depends both on the precision or exactness of instructions, as well as on well-defined tasks or functions that are supposed to be completed.

This is why *instructing to* is characteristic of computer programmes, or of programming generally. According to a common definition: "a computer program is a detailed plan or procedure for solving a problem with a computer; more specifically, an unambiguous, ordered sequence of computational instructions necessary to achieve such a solution." (Gregersen, 2021). What is important here is that the computer program gives orders to a computer processor, because it can be unambiguously translated into exact instructions in machine language. A group of such orders or commands for the central processing unit is called an *instruction set*. They enable the central processing unit to perform tasks. There are different kinds of instruction sets, some of which are more complex than others. One example of a single instruction can be a single *add* command: "A single instruction can initiate multiple actions by the computer, such as a single *add* command launching multiple memory access load and store instructions" (Kivan, 2022). Apart from that "instruction sets work with other important parts of a computer, such as compilers and interpreters. Those components translate high-level programming code into machine code that the processor can understand" (Kivan, 2022). What is apparent from the above definitions is that instruction sets have to be embedded into the entire makeup of the computer, in order to make possible the completion of certain tasks or functions. In order to be understood by the processor, programs have to be translated into instructions.

The importance of translation for *instructing to* becomes especially clear in the cases in which this paradigm had found its way into other fields, for example into molecular biology. When describing processes at the molecular level, it is common to say that DNA contains “instructions” for essential biological processes, such as protein synthesis. Analogous to the case of programming, the DNA code must be interpreted and translated, via mRNA and other intermediary steps, in order to be enacted in the cell. These features of *instructing to* show the process of translation to be its complementary process, at least in the two cases that were presented here: computer programmes and the DNA code.

The two mentioned cases of *instructing to* may suggest that this paradigm is only found in the context of programming – including the (metaphorical) application of programming to other fields. However, the case of *instructing to* is by no means limited to machine language or machine-to-machine communication. In the realm of interaction between human agents there are numerous cases where *instruction to* is instantiated. The example of partaking in traffic – either as a pedestrian, bicycle rider, car driver, or a user of any other means of transport – can serve to illustrate this case. In cases where the regulation by means of the system of traffic lights is not available, or for any other reason cannot be relied upon to regulate the traffic, there is a human agent – traffic policeman – regulating the flow of traffic at major busy crossroads, by using his arms and hands. The hand-signs that the traffic policeman is using are instructions – in the sense of *instructing to*. Such instructions are embedded into the broader context of traffic rules and driving tests, which makes it possible for participants in the traffic to understand the instructions given by the traffic policeman and to spontaneously act according to them in new situations. The act of translation, which was necessary in both previous cases, is here replaced by previous training – part of which consists in getting acquainted with the rules of the traffic system. We will see in the next section how this aspect of training features in the second paradigm of instruction, *instructing in*.

THE PARADIGM OF *INSTRUCTING IN*

The second paradigm can be best introduced by looking at the process of teaching and learning. I have chosen the example of a child learning a language, thus becoming in time a competent speaker and being introduced into the community of language speakers.

In explicating the paradigm with the help of this example, I follow Stanley Cavell’s reading of Wittgensteinian *scenes of instruction*, which are prominent in the *Philosophical Investigations*.

In these scenes we always see an instructor/teacher and a pupil/student focusing on a certain task or theme that the student is being instructed in. Normally the teacher will show the student the first steps of the task – for example how to continue a series of natural numbers according to a certain rule. After a while the student will be required to go on with the series without teacher's assistance, thus demonstrating the ability to continue the series on his or on her own and thereby of having mastered the application of the rule generating the series. Wittgenstein is especially interested in all the ways in which this instruction process can "go wrong". These are discussed under the general heading of "rule-following" and cover a much broader spectrum of questions than those pertaining to instruction. When it comes to the role of instruction in these examples, one can say that part of the instruction process does consist in *instructing to* – the student is instructed to write one number after another, or (to take the example of instruction in languages) demonstrate the ability to formulate a sentence according to grammatical rules. What makes the examples so interesting is the following: every time the teacher and the student reach a certain point at which the student needs to go on without teacher's assistance. At that moment the student might need to make a sort of a "leap" from already familiar cases to completely new ones. Cavell has described this as "anxiousness…upon which instruction may founder: an awareness of the point at which the path of our communication depends upon your taking the next step, unaided by anything more from me save my belief in your readiness to take it. It is the mark of a good teacher in certain domains to know when to stop prompting, domains in which further knowledge is earned not through further drilling but through proper waiting. It is a different form of exercise. People are not equally good at this, certainly teachers are not equally good; but one can learn to be better" (Cavell, 1999). The crucial thing about *instructing in* is that it requires this "leap" to happen in order for it to be successful. In most cases this is nothing extraordinary and perhaps one can even say that it happens naturally. Still, it marks one of the central differences between *instructing to* and *instructing in*. Perhaps we can say that *instructing in*, when successful, allows the instructed party to leave the instruction behind. If someone can continue on their own, without being told what the next step is or how to conduct it, then there is no need to be instructed. The goal is to attain mastery of a practice, whether that practice is dancing, playing an instrument, building houses, or speaking a language.

The second major difference between *instructing to* and *instructing in* concerns the kind of embedding that is present in both cases. We have seen that *instruction to* depends for its workings either on translation, or on its embedding in a system of rules. This gives rise to the question: What kind of embedding is required for *instructing in* to take place? In order to give an answer to this, I will one more time refer to Cavell's reading of the scenes of instruction, in the case in which a child is learning its mother tongue: "Instead, then, of saying either that we *tell* beginners what words mean, or that we *teach* them what objects are, I will say: We initiate them, into the relevant forms of life held in language and gathered around the objects and persons of our world. For that to be possible, we must make ourselves exemplary and take responsibility for that assumption of authority; and the initiate must be able to follow us, in however rudimentary a way, *naturally* (look where our finger points, laugh at what we laugh at, comfort what we comfort, notice what we notice, find alike or remarkable or ordinary what we find alike or remarkable or ordinary, feel pain at what we feel pain at, enjoy the weather or the notion we enjoy, make the sounds we make); and he must *want* to follow us (care about our approval, like a smile better than a frown, a croon better than a croak, a pat better than a slap). ‘Teaching’ here would mean something like ‘showing them what we say and do’, and ‘accepting what they say and do as what we say and do’, etc.; and this will be more than we know, or can say” (Cavell, 1999). The kind of embedding that is depicted here encompasses the entire way of living in which a certain practice takes place. Cavell describes the first steps of being instructed in a language (this language being one’s mother tongue) as being initiated “into the relevant forms of life held in language and gathered around the objects and persons of our world”. This kind of embedding provides both the instructor and the person being instructed with the possibility to reach the stage (be it one or several stages) at which the teacher can stop the instruction (stop prompting, requesting), so as to allow the other to take the next step on their own. Only then can the instructing process fulfil its purpose.

CONCLUSION

The two paradigms of instruction are indeed different paradigms. They cannot be “translated” into one another. If the goal of *instructing to* is to reach automatisation, the goal of *instructing in* is to become autonomous when engaging in a certain practice. These are very different goals. And even though *instructing in* includes *instructing to* at its various stages, it is still not possible to reduce *instructing in* to *instructing to*. At least for now, it is not possible to instruct a machine or a robot in singing; one can only instruct it to produce sounds similar to singing. It remains to be seen whether the developments in the field of machine learning and artificial intelligence in general can ever bring about the overcoming of this difference.

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Research article

Instructing Tacit Knowledge: Epistemologies of Sensory-Based Robotic Systems

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Abstract

The article tries to outline the supposed precarity of the body (or body-bound knowledge) in the context of AI-based environments by re-negotiating the borders of formalizing material-based, cognitive and tacit knowledge in regards to the (robotic) gesture (of grasping). In the following, it will be a matter of tracing the epistemes underlying this simulation that relies on specific instructions, which is understood in this context as a specific rule or command and hence by nature an explicit directive to execute a task on a behavioral level. How concepts of embodied knowledge are inscribed in the fabrication of the systems, how they can be recognized and how human corporeal involvement can be described on different levels of fabrication and use, is therefore part of the analysis: For the special case of humanoid designed robots the challenges are located in the anthropomimetic fabrication on a computational level, as well as in the production of anthropomorphic design and thus connects to a specific knowledge of the human movement and the human sensory apparatus.

Keywords: Robotic Manipulation; Instruction as Translation; Embodied/Distributed Embodiment; Machine Learning; Deep Learning; Human-Machine Interaction; Philosophy of Technology; Philosophy of Media

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Научная статья

Обучение неявным знаниям: Эпистемологии сенсорных робототехнических систем

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Аннотация
В статье делается попытка обрисовать предполагаемую ненадежность тела (или связанных с телом знаний) в контексте сред, основанных на ИИ, путем пересмотра границ формализации материальных, когнитивных и неявных знаний в отношении (роботизированных) жестов. (схватывания). В дальнейшем речь пойдет о том, чтобы проследить эпистемы, лежащие в основе этой симуляции, основанной на конкретных инструкциях, которые в данном контексте понимаются как конкретное правило или команда и, следовательно, по своей природе явная директива для выполнения задачи на поведенческом уровне. Таким образом, частью анализа является то, как концепции воплощенных знаний вписываются в создание систем, как их можно распознать и как можно описать человеческое телесное участие на разных уровнях изготовления и использования: проблемы находятся в антропомиметическом изготовлении на вычислительном уровне, а также в производстве антропоморфного дизайна и, таким образом, связаны с конкретным знанием человеческого движения и человеческого сенсорного аппарата.

Ключевые слова: Роботизированные манипуляции; Инструкция как перевод; Распределенное воплощение; Машинное обучение; Глубокое обучение; Взаимодействие человека и машины; Философия техники, Философия медиа

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INTRODUCTION: INSTRUCTING TACIT KNOWLEDGE

An instruction is a specific rule or command and hence by nature an explicit directive to execute a task on a behavioral level. In the following I want to discuss the notion of instruction in regard to machine learning-based robotic systems – amongst them soft robotic systems: I will outline the limits of explicit instructions in terms of the question of translatability of tacit/embodied knowledge (cf. Polyani, 1985; Collins et al., 2001) on a computational and morphological level in regards to specific outputs and controlled behaviour. To do so, I will take a close look at the processes of instruction in the context of robotic grasping devices and furthermore take the pivotal role of (tactile, soft) sensors into account. The (smart-)material used within soft robotics/morphological computing itself will be questioned as an quasi-agent of instruction. Since this paper is written from a media theoretical and STS-Studies perspective, I will understand the discussed robotic grasping devices as a media compound that are realized on the background of specific epistemic assumptions and socio-technological conditions. I mainly rely on examples within the fabrication of the (robotic) gesture of grasping, which plays a crucial role in (collaborative) robotics in actively exploring the environment and responding to the environment: e.g. in the situational embedding of robotic systems, design principles and the question of "embodiment" of formalized knowledge (embodied knowledge). Which epistemic parameters and presuppositions - for example anthropo- and biomimetic models are at work in current implementations of the robotic gripper arm - need to be reflected upon in this context? Through the sensor technologies used in mobile robotics, which on the one hand generate multisensory data from the environment and on the other hand are supposed to facilitate interactional processes by simulating human sensory systems, new perspectives can - so it is assumed - be developed with regard to the question of the possibilities of formalization and the significance of embodied knowledge in the context of AI-based collaborative systems. The interplay of computation and design is becoming increasingly decisive in the field of social/companion robotics and thus evokes general discourses about the role of corporeality and physique in cognitive performance and, to a certain extent, comes to a head with the use of smart materials[1], such as those used in the field of soft robotics or humanoid robotics. The article tries to outline the supposed precarity of the body (or body-bound knowledge) in the context of AI-based environments by re-negotiating the borders of formalizing material-based, cognitive and tacit knowledge in regards to the (robotic) gesture (of grasping).

[1] By smart materials, we primarily mean materials that are deformable (see soft robotics), i.e. that differ from classic rigid materials such as metal, which are primarily used in industrial robotics. Deformable materials - such as silicone elastomer, types of hydrogel, even liquids or gases, etc. - make robotic actuators more elastic and allow them to adapt more flexibly to their environment. In addition, it is also possible to embed deformable, elastic sensors in the material itself (see Gel-Sight Sensor below) or to fuse them with the material, allowing a wider span of data generation from the environment. The term smart materials is also used in a very general ecological sense, referring to the biodegradation of sustainable materials.

THE GESTURE OF GRASPING

The robotic hand has become an emblematic image for automated work. The transfer of activities from the human hand to the robotic hand has long since ceased to be limited to industrial manufacturing techniques, most notably those of the automotive industry, but has penetrated fields ranging from medical diagnostics to automated care work in/as part of so-called ambient assistance living environments. In relation to the latter, technologies such as robotic interaction with the environment encounter specific challenges: Unpredictability in the interaction with humans and an environment that is not (yet) adapted qua mechanization to mobile robotic systems. In the field of machine learning/deep learning-based humanoid robotics, multi-modal sensor technologies are therefore becoming increasingly important to ensure smooth and "intuitive" processes of robotic machines. Sensors increasingly represent a kind of key element in terms of (active or passive) interaction with digital technologies in general. Sensors can be understood here as a kind of threshold medium, since they initially provide the "preconditions that precede [the] translation chains" (cf. Thielmann, 2019, p. 2) In this process, new assemblages are always created in combination with technical things/objects: Embedded in a technical, material structure, sensors are always part of it, acting as contact zones that invite users - depending on the design of the objects or infrastructures in which they are embedded - to participate in specific ways or even guide them to do so. Sensors are openings and closings to infrastructures of processing, which in turn follow their own temporalities and frequencies of data transmissions: Linked back to servers and in exchange with other sensors, they collect data from the environment that is processed in computational processes. In the field of robotic interaction, it is increasingly possible to offload computational processes into the robot "body" via sensor technologies, as is the case with soft robotics or morphological computation systems, for example. The goal of humanoid robotic interaction is to simulate human perception and ultimately to replicate it in interaction with humans as actions, which in the context of machine learning-based robotics can replace humans themselves in some areas as more efficient, secure and safe agents (care robots, medical assistance systems, etc.).

FIGURES OF THOUGHT OF THE SENSORY AND ALGORITHMIC INSTRUCTION

Taken on their own, sensors are confronted with nothing more than an endless noise of unspecified data streams: they are thus initially nothing more than a kind of perforation between the environment and computer systems, spanning zones of translation and transmission. Sensor-based technologies, which unfold both on a data-processing level and as medial practices, can only be understood in the interplay of the technologies employed (artificial intelligence, engineering, design, etc.), which unfold their own dynamics against this background and can only be partially experienced by the human sensory apparatus. The very fact that data-processing media are also always time-critical would exclude any kind of human experience. At this point, it is no longer a question of how and whether the robotic system can be replicated in the human sense, but how the exchange of experience in the interaction from the human side is to be described. And from this perspective, most processes involving sensory data processing are initially no longer directed at human perception at all, because a "microtemporality that subverts intuition and discernment" (Sprenger, 2014, p. 14) underpins what is happening. Sensor-based technologies generate inherent dynamics that lie below the threshold of human consciousness. Mark Hansen captures processes that occur below or beyond human sensory perception with the concept of wordly sensibility, (cf. Hansen, 2018) which refers to a moment of technical-machine processing in which human perception remains outside. At the same time, however, Hansen understands this dimension of machine processing as a "quasi-technical extension of phenomenological reflection" (Krtilova, 2016, p. 102). However, since cognition and reflection in the phenomenological sense require real - i.e. temporally and spatially situated - experientiality (p. 102), this would exclude the possibility of any kind of reflection that includes experientiality as part of it - precisely because it is located outside of human consciousness: neither from the machine nor from the human side. If sensors capture data, the possibility of a description, at least in the sense of a human sensual experience, breaks off at this point. This results in a difficulty in describing sensor-based technologies: And in general, with the emergence of digital mobile, wearable and networked technologies, the classical single medium in the sense of a technical a priori no longer seems conceivable. At the same time, the WHAT has increasingly given way to the HOW, which means that the description of media structures is primarily concerned with performative acts, processes, and relations, which, among other things, in the sense of actor-network theory or actor-media theory, are based on the agency of the actors (human or non-human) and understand media as and in chains of operations, translations, and transformations between things and people. If humans are in constant communication with sensory media, even if this is located outside of human experience, it would rather be a social a priori that one could speak of here. But how can such a program be implemented, if observability - especially in the case of sensor-based technologies - is not possible at places, breaks off or, better, advances into other time-space logics. While the network metaphor was used for a long time to describe operational chains, it seems to have become more and more obsolete. New figurative models to capture these processes are emerging: For example, an expanded understanding of network developed - away from flat and vertical connecting lines that only transmit and translate from one point to another (cf. Galloway and Thacker, 2007), or figures of thought[2] such as that of the fabric (Thielmann, 2019, p. 3-4), which in the characteristics of its micro-architectural nature refers, among other things, to the socio-technical (pre-)conditions of the transmission of data in relation to sensor media (cf. Thielmann, 2019, p. 3-4.). James Ash uses the term phases to capture dynamic processes that smart objects generally produce: the spatio-temporal modes of these

[2] These kinds of figurative models are to be understood as figures of thought part of an epistemological process: Figures of thought - understood as operational terms - allow for shifts in perspective: As culturally situated conceptualizations, they induce certain logics of action, expose thought structures, and imply them again. The historical-epistemological character of these concepts, as well as their operational capacity, must be examined elsewhere.

processes thereby unfold (disclose) (cf. Ash, 2018) the respective specific properties of these objects. As inherent characteristics of smart objects, Ash assigns them an anticipatory orientation with respect to the environment in which they operate (protentiality) and further describes a kind of contingent combinability of different components inherent in smart objects in general (intentionality). (Ash, 2018, p. 10-19) How the modes of the respective phases[3] can be made operable for an understanding of sensor media remains to be further investigated. It remains to be noted here that sensor-based technologies - Ash refers here to smart objects - not only follow their own sequences, but within these sequences address each other qua high-frequency clocking, send sensory signals, locate each other: these processes would - loosely according to Ash - first unfold the agency of digital objects/technologists and repeatedly update them in interaction - but at points independent of human intervention[4]. Sensor technologies can be located here as a kind of key medium, since they provide the pivotal point for feeding in and processing signals (be it gestures to be recognized, facial expressions, but also sensory data such as temperature, pressure, etc.). To not only detect and gather *white noise*, sensory systems are embedded in a compound of ML-based systems that are executing a set of algorithmic techniques (cf. Rieder, 2020) to process and translate sensor-based signals. Bernhard Rieder (2020) understands AI-based systems to be – amongst other things – specific combinations of algorithmic techniques: A set of heuristic procedures for producing operations and behaviors in the context of computation (cf. Rieder, 2020). An algorithm can be understood as "a computational method of calculation" (Jaton, 2021, p. 5) and is "a procedure that takes any of the possible input instances and transforms it to the desired output" (Skiena, 2008, p. 3). Jaton considers the practices and actions brought forth because of algorithmic commands as an "action- oriented way." And he further specifies: "In view of the inquiry's empirical results, algorithms may be considered, but certainly not reduced to, uncertain products of ground- truthing, programming, and formulating activities." (Jaton, 2021, Glossary) In this sense, algorithms are hence the explicit instruction to process the input signals into behaviour and rely on the same time on the soft-and hardware technologies they are embedded in and executing instructions with. Yet, in the context of soft robotics and morphological computing, researchers are aiming for more intuitive operations on a behavioural level, especially within unpredictive and unstructured environments. Here the process of translating tacit or embodied knowledge into explicit directives as behavioural ouput is contested. To further elaborate on this point, I will first describe the complexity of translating and synchronising multi-sensory signals from the environment in order to simulate the gesture of human grasping.

[3] Spatial modes: diffusion, partition, envelopment; Temporal modes: gradation, dispersion, dilatation; (Ash, 2018, p. 5)

MULTIMODAL REPRESENTATIONS/INSTRUCTING MULTIMODAL OPERATIONS

The simulation and simultaneous optimization of the human hand, in particular the gesture of grasping, is a central research topos in the field of robotic interaction. In the field of industrial robotics, the gestures to be performed by robots take place in pre-structured environments specifically engineered for this purpose. Each gesture is pre-programmed, the planned steps can be performed precisely and repetitively, and far exceed human capacities in the environment of assembly line work. The control of the environment on the one hand and the control of and by the monotonously working robotic system on the other hand are important parameters for this work performance, because it is rooted in "monofunctionality, specialization and isolation from the world" (cf. Hauser & Freyberg, in press).

In unstructured, unpredictable, or even dangerous environments where cooperative robotic systems are used, multimodal, sensory gripper control systems (gripper actuation) (Gong et al., 2017, p. 1-3) prove to be instrumental for a better, more "initimate" interaction. (Gong et al., 2017, p. 13) In routine tasks, such as unlocking a door, humans typically seamlessly combine multiple senses, most notably sight and touch, to accomplish the task. Our visual feedback lets us semantically interpret geometric objects and their properties in order to accurately reach for them; our haptic feedback provides information about the current surface situation and structure of the object and also the conditions between the environment and the object. (cf. Bohg in Clark, 2020) Multisensory information meets here and is processed simultaneously (cognitively). At Stanford University's Interactive Perception and Robot Learning Lab (IPRL), under the direction of Jeannette Bohg, deep learning-based algorithmic representation models are coupled with multimodal sensing technologies and humanoid design to perfect the robotic grasping gesture: A combination of on-board sensing and motion capture technologies is being tested here to extend the sensory system (Lee et al, 2019, p. 10). Bohg and her team specialize in humanoid robotic systems designed to operate in uncertain terrain-as is the case in healthcare, underwater environments, or mines, for example. Sensors that record and interpret as much information as possible from the environment are crucial for the targeted performance of tasks. (cf. Bohg: in Clark, 2020) Various robotic gestures are tested: Based on deep reinforcement learning methods, self-supervised learning (unsupervised learning) is used here as an obligatory learning model: Thus, in this case, the output y (in the case, recognizing the object and manipulating it) is not given. The input x (for example, images of objects, geometric data) are available, but are present as unordered data. In the inference phase, the system itself determines ways to solve the problem qua learning algorithms that are fed with the sensory data (cf. Sudmann, 2018). Besides the nature of the actuator types (actuators), the main challenge lies in the alignment and synchronization and interpretation of the visual and haptic signals fed in by sensors (fusion) (Lee et al, 2019, p. 9). "We examined the value of learning a joint representation of time-aligned multisensory data for contact-rich manipulation tasks. To enable efficient real robot training, we proposed a novel model to encode heterogeneous sensory inputs into a compact multimodal latent representation...[...] Once trained, there presentation remained fixed when being used as input to a shallow neural network policy for reinforcement learning. We trained the representation model with self-supervision, eliminating the need for manual annotation. Our experiments with tight clearance peg insertion tasks indicated that they require the multimodal feedback from both vision (RGB and depth) and touch." (Lee et al, 2019, p. 10)

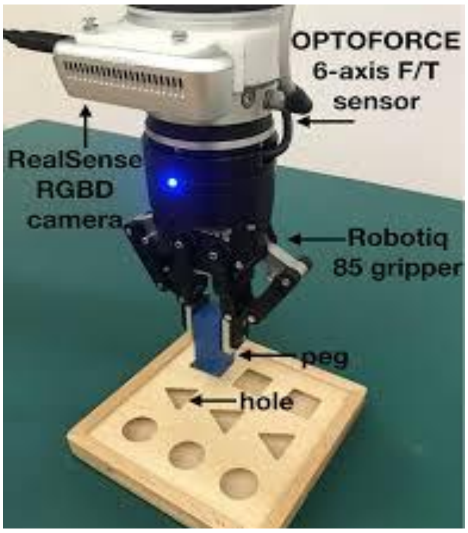

Figure 1. Robotic gripper arm performing the Peg-In-Hole experiment. The OPTOFORCE 6-axis force-torque sensor is used here. The RGB camera is used for initial alignment (Ding et al., 2019)

Using the example of peg-insertion, in which an object was to be brought into the correct opening by the robot arm (here a two-limbed model), this task cannot be performed without haptic feedback. The system was able to start the task, but visual sensor signals were not sufficient to let the system know when this task had been completed. (cf. Bohg in Clark, 2020) Therefore, as part of the peg-insertion experiment, the force-torque (F/T) sensor was used to detect haptic data such as hardness/softness and vibration. (Lee et al., 2019, p. 2) This had delivered 6 measurement signals of the 3D surface every millisecond; whereas the camera sensor delivered 648 pixels every 34 milliseconds. (cf. Bohg in Clark, 2020) The feedback of the tactile sensor emits signals in much shorter frequencies: The challenge, then, is to synchronize this data. To connect these different modalities so that the data can be recognized, processed, and "fused," specific model architectures (Multimodal Fusion Model) (Lee et al., 2019, p. 3) are needed for each, which can make computed model representations usable even in combination. (Lee et al., 2019, p. 3) Tactile sensors are also critical in the context of robotic manipulation accomplished with multi-limb actuators: especially when there is uncertainty about the position and/or shape of the object being manipulated. Biomimetic sensors, such as the BioTac sensor from Syntech used elsewhere by Bohg and team, (cf. Bohg: in Clark, 2020) attempt to replicate the human fingerprint, and can provide measurement data on temperature values in addition to surface acquisition of the object. In this example the highly complex multi-sensory interplay on an embodied level is disclosed. The question *if* and *to what extend* human intelligence is embodied and hence can be formalized is still an ongoing discourse. In “What Computers Can´t Do” Hubert Dreyfus (1978) already argued that human intelligence and expertise depend primarily on unconscious instincts rather than conscious symbolic manipulation, and that these unconscious skills could never be captured within formal rules. Dreyfuß (1978) states that “so-called algorithmic programs follow an exhaustive method to arrive at a solution, but become rapidly unwieldy when dealing with practical problems “. By the notion of practical problems he is pointing out the role of the body or embodied knowledge in terms of intelligent behaviour. It is nowadays well known, that not all cognitive interplays and processing of information is happening in the brain or in the nervous system, but happens *within* or *as the body* (cf. Brock, 2021). In an interview Oliver Brock, Professor at the Robotics and Biology Laboratory at the TU Berlin, refers to this problem via the example of human vision: Visual perception is a very strong and important sense in humans, our retina has probably thousands of task specific feature detectors. (cf. Brock in Clark, 2020). But the information that comes out of the optical nerve to the brain is not really an image as we imagine it pixel by pixel, it has already been filtered to a significant degree for information that allows us to survive: in some sense our retina is the embodiment that has encoded the learnings of our evolution that allows to operate our visual system in a much lower dimensional space (cf. Brock, 2021). Therefore one could say that certain sensory systems process information aside from the brain. Another example for embodied knowing in humans might be the performance of locomotion, as I will point out in the case of so the called *Passive Dynamic Walkers* (see below).

TACTILE SENSORS - INTELLIGENCE OF THE MATERIAL

"Vision starts with the eyes and touch starts with the skin, but in both cases, the most important work is done in the brain, where the raw signals are transformed into a meaningful model of the scene." (Adelson, 2021) Ted Adelson heads the Perceptual Science Group at the MIT Computer Science and Artificial Intelligence Lab (CSAIL). However, the fact that robotic systems need more than force feedback information (i.e., pressure and resistance) to approximate the haptic sensitivity of the human hand was one of the starting points in the development of the GelSight sensor by the Perceptual Science Group led by Ted Adelson at the MIT Computer Science and Artificial Intelligence Lab (CSAIL). (cf. Yuan et al., 2017). In addition to surface sensitivity and perception of mechanical values such as pressure and vibration, the deformable material is also used to simulate a type of tissue stretching based on which further sensory signals are generated (Yuan et al., 2017, p. 2) "We try to address the question with the answer that geometry sensing is equally important as force sensing for robots. To better measure the geometry, a deformable surface, and high spatial resolution sensing are required. With the measurement of high-resolution geometry, the robot will be able to learn more about the objects' shape and texture. Moreover, the dynamic interaction between the soft sensor and the environment can reveal more physical properties of the object being contacted, such as the slipperiness and compliance." (Yuan et al., 2017, p.

2) The prototype of the GelSight sensor was already developed in 2009 at MIT by Wenzhen Yuan, Siyuan Dong and Ted Adelson (2017, p. 4). This is attached to the fingertips of the robot arm: the sensor converts mechanical deformations of the material and the touched objects during contact into visual data. This image information allows conclusions to be drawn about the surfaces of the objects to be manipulated (shape, hardness, friction) and also provides information about the mechanical interaction to be performed (pressure/force, shear/shear, glide/slip). (Yuan et al., 2017, p. 4) The GelSight sensor can measure surfaces in the micrometer range, and because the signals are geometric in nature, the system can calculate position of the object to be grasped. (Yuan et al., 2017, p. 13)

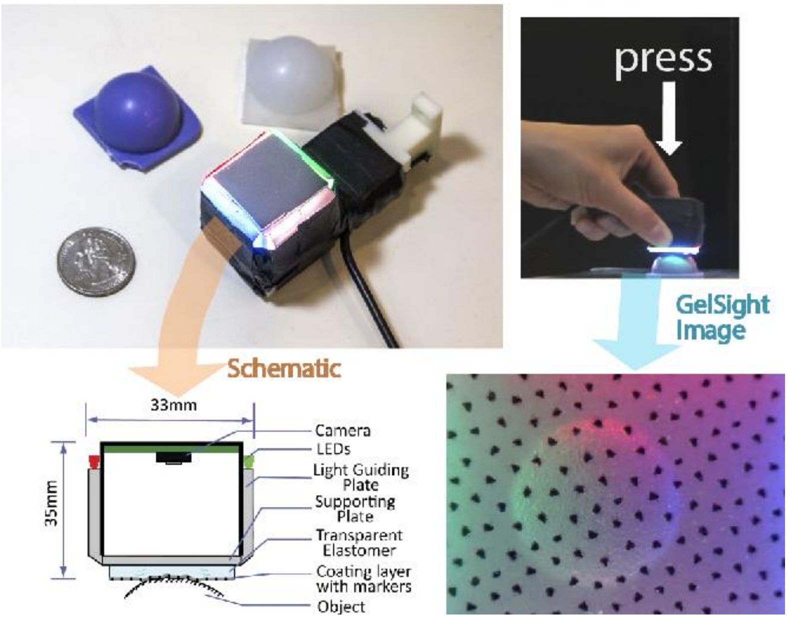

Figure 2. Here you can see the GelSight sensor to be attached to the "fingertips" of the robot arm, used by Ted Adelson et al. Here, this is being pressed onto hemispherical silicone samples on an experimental basis to obtain data on the hardness of the material. (Yuan et al., 2016)

With this sensor technology, it is possible to measure pressure, distance displacement, or friction during the interaction, as well as the likelihood of the object slipping out of the grasp - the latter is also crucial for the successful execution of the grasping act (Yuan et al., 2017, p. 18). Cameras are embedded in the deformable elastomer layer attached to the fingertips, which film the deforming material during manipulation and derive haptic information from this same visual data: How fast and in what way the material deforms provides additional information about the object's texture. (p. 1) These geometric parameters can thus be calculated from the high-resolution images and are additionally supplemented with coloring-marking data. Because primarily visual data (vision based data) (p. 2) is used here to gather haptic information, learning algorithms applied in the field of computer vision are also used here (p. 2). "Unlike other optically based approaches, GelSight works independently of the optical properties of the surface being touched. The ability to capture material-independent microgeometry is valuable in manufacturing and inspection, and" (p. 2) There are now several generations of the GelSight sensor: one of which is the application described above: "The fingertip version of GelSight has been successfully applied on robotic grippers, and the new design makes the sensorfabrication and the data accessibility much more convenient. With the tactile information provided by GelSight sensor, a robot will be able to perform much better in multiple tasks related to both perception and manipulation" (p. 20).

Adelson et al. describe the challenges of tactile sensors as follows: Measuring pressure and resistance when touching an object to be manipulated represents only one of the tasks here. Likewise, measurements often involve only one or a few contact points, but of course multiple contact zones are needed to generate haptic information during grasping (Yuan et al., 2017, p. 4). And the hardware, respectively the design of the robotic extremities also prove to be too rigid and inflexible ("too bulky") (p. 4) The material nature in the design and the associated rigidity of the actuators in motion make a more "natural", i.e. more elastic grip on the object difficult. In addition, it is costly to attach elastic sensors to these same hard surfaces (usually metal). (p. 3) The fabrication of these special tactile sensors themselves is equally difficult: they are initially costly and, in the case of robotic manipulation, are produced in collaboration with (product) designers and engineers. Access to these sensor technologies is often not possible outside the laboratories where they are produced, for technical or legal reasons. The TacTip sensor is an exception here: the 3D printing processes are released as open source methods laboratory. In the case of the OptoForce Sensor (OptoForce Kft., Budapest, Hungary) (p. 4) and the BioTac Sensor (SynTouch Inc., Montrose, CA, USA) (p. 4), researchers have founded start-ups to make this technology available to other robo-labs. On a socio-technical level, these developments are thus dependent on an interdisciplinary network of developers, engineers, product designers, etc., which in turn are framed by technological, economic, and legal parameters in both fabrication and production.

Above described examples of multimodal sensing is only one aspect of robotic manipulation that unfold in use within the parameters of input/output logics of processing learning algorithms on the one hand and material design on the other. Robotic mobile systems build on technological developments such as pervasive/ubiqitous computing and artifical intelligence in addition to the field of sensors: sensors thus play a key role in the implementation of mobile and efficient robotic systems in various ways: for example, in conjunction with actuators of the robotic systems (tactile sensors such as the BioTac sensor) or the offloading of computational processes as sensors embedded in the material itself (soft robotics, morphological computation). Therefore, robotic sensor-based systems can be understood as an epiphenomenon of ambient intelligence (AmI) located within or as IoT (internet of Things) environments: It is a technology that only ever appears in a media network. Based on algorithms, a vast amount of environment-related signals are extrapolated qua sensor technologies. Like electronic environments, humanoid robotic systems aim to respond anticipatively to the presence of humans and thus interact with the environment, yet cannot "grasp" their environment in the human sense (Flusser, 1991, p. 67). For Flusser, the gesture of be-grasping is both theory and practice, unfolding as a non-dichotomous counterpart oscillating between material and mental space. "[T]o touch an object with the fingertips [...], they follow its outline, weigh its weight on the palms (ponder it), pass it from one hand to the other (consider it). This is the 'gesture of apprehension'. It is not (despite the claims of our scientific tradition) a 'pure' gesture of 'objective' observation. [...] The gesture of apprehension is practical." (p. 67) This concept of gesture does not exclude (bodily) techniques as practice and the theoretical reflection of them from each other. A gestural being-in-the-world of humans would thus also be understood as a producing and reflecting of the technical world, which would be inherent to a concept of mediality of grasping in Flusser's sense. Within humanoid robotics it would thus be a matter of locating a newly directed bodily situatedness: The description of the simulation of human sensory systems should not end here, however, in the statement that a replication of human perception is not possible. In the following, it will be a matter of tracing the epistemes underlying this simulation. How concepts of embodied knowledge are inscribed in the fabrication of the systems, how they can be recognized and how human corporeal involvement can be described on different levels of fabrication and use, is therefore part of the analysis: For the special case of humanoid designed robots the challenges are located in the anthropomimetic fabrication on a computational level, as well as in the production of anthropomorphic design and thus connects to a specific knowledge of the human movement and the human sensory apparatus.

EXPLICIT LANGUAGE VS. EMBODIED KNOWLEDGE

In the context of the GELSight sensor technology, images become information carriers of haptic dimensions of the object to be manipulated, which are extrapolated from these images as a computational process. Here, an attempt is made to replicate human sensory systems in the interplay of computation, sensor technology and design and thus to make them more adaptable to unpredictable environments: The challenge here lies, among others, in multi-sensory "sensing" of the environment. Another problem area that opens up in the field of humanoid robotics is the recognition of body language and emotion recognition. Gestures, facial expressions, as well as the voice and increasingly physiological measurements are data that the interdisciplinary research field of affective computing attempts to systematically capture, interpret, and simulate via machine learning/deep learning technologies: this field of study is increasingly coming into play in the development of humanoid robotics. Here, too, the language and translation performance of whatever (body) knowledge and understanding must always be an explicit one for the system, meaning that the system does not allow ambiguities at the computational level, and any activity of the robot translated as an action must be explicitly formulated within algorithmic models. In order to be able to guarantee the translation performance during the human-machine interaction on a performative-physical level, certain performative processes such as gestures and facial expressions have to be recognized, processed, (re-)produced and applied as sign systems. (cf. Bächle et al., 2017) Especially in the field of social robots, which are used on both a functional (socially simulated behavior) and formal level (anthropomorphic design) in diverse social contexts, the use of DRL methods should make it possible for the system to react to the environment as "spontaneously" and "intuitively" as possible. (cf. Bächle et al., 2017, p. 72) Due to these deep reinforcement learning (DRL) methods, which in use select data qua random algorithm, Bächle et al. (2017) also attribute to the system a kind of "functional equivalence" (p. 68) of embodied knowledge: the authors see this embodied knowledge in the learning of social structures, their rule systems and the implementation of these as robotic actions. However, it is also stated elsewhere that it is always only a "subsequently simulated representation" (p. 76) of the physical world, in the context of which social behavior is adapted by the robotic system. In addition to a variety of explicit learning models from different disciplines (behaviorism, cognitivism, constructivism), phenomenologically influenced models of representation can be identified (cf. Sudmann, 2018), which inscribe themselves as models of reality in/as algorithmic models of the world; and conversely, can again be identified input in the description of and reflection on the interaction with ML/DL- based (robotic) systems. The concept of embodied knowledge, as the idea of a corporeal constitution of experiences, takes a central role in the phenomenological lineage of Husserl, Merleau-Ponty, Dreyfuß et.al. The body as the condition of the possibility of world- and self-perception beyond a Cartesian separation of body and mind may be identified as a central intersection. Merleau-Ponty, for example, sees projection, conscious distancing, and perspective vision as conditions for the successful movement of one's own body through space. The interaction of motor skills and vision is fed by the memory of the body and can be recognized in a temporal structure in the successful movement through space. In the second part of the Phenomenology of Perception, Ponty describes the "spatiality of one's own body and motor activity" (Merleau-Ponty, 1966/1974, p. 123-129). On the basis of the pathological case study of the patient Schneider, who had been treated by Kurt Goldstein. The chapter reveals, among other things, that the ability to move in space or to move towards something is bound to the ability to distinguish figure-background. The spatial perception, as a kind of body memory, underlies the process as a temporal structure: Patient Schneider suffers from a neurological damage, which makes it impossible for him to connect individual bodily functions, which interact in a successful body-space orientation. (cf. Merleau-Ponty, 1966/1974) For a successful motor function it is necessary "to hold directions, to draw lines of force, to open perspectives, briefly to organize the world according to an instantaneous principle, to base on the geographical environment a milieu of behavior and a system of meaning that expresses in the outside the inner activity of the subject." (Merleau-Ponty, 1966/1974, p. 138) "It is also this "projection" or "conjuring" function (in the sense in which a medium conjures up and makes appear an absent one) that makes abstract movement possible: for in order to possess my body independently of any urgent task, in order to be able to play with it at will, in order to be able to write movements in the air[...], I must likewise be able to reverse the natural relation of body and environment [...]." (p. 138). Here, then, it is not mobility or thought per se, but the faculty of motor projection, a kind of virtual relation to the world and movement that is thus always actualized as such in physical-mental connection and central to physical interaction with the environment. Reference should be made at this point above all to the temporal structure, which Merleau-Ponty has each specifically (humanly) defined as a condition for senso-motor activity, and to which Merleau-Ponty here refers: Experience is thus local in the sense in which it is (back-)coupled to the environment and to the time-space experience of the body. In contrast to this, sensor-based robotic systems span different, parallel space-time continua in the processing of data: Here, the sensors are the interface at which this decoupling from the physical world takes place. Moreover, the reference to the world remains coupled to a formalized transmission of information, i.e., based on a decision-logical calculability (cf. Mersch, 2013). This follows a "mathematized communication" whose "basic category [...] is transfer, transmission, translation or mediation [which] is itself still subject to mathematization" (Mersch, 2013, p. 25) and is located within an "algorithmic rationality." (cf. Mersch, 2013) Any form of machine learning-based action and "perception" of robotic manipulation can thus only be meant as a temporally and quantitatively limited, reactively shaping act (cf. Rautzenberg, 2020). Thus, even the capacity of machine "sensing", which Bächle et al do not set as a categorical quantity here, can only be read as a functional mode as a metaphor, since it - in contrast to the concept of embodied knowledge or tacit knowlegde (cf. Polanyi, 1985) - must be based on formalized, i.e. explicit language.

DE-CENTERED CENTRALIZATION

With respect to Artificial Intelligence research, cognitive systems, respectively the "intelligence" of machine systems, were initially equated primarily with the translation of symbolic orders into algorithms; with respect to problems such as the example of AlphaGo, known from DEEPMIND, which was developed using traditional brute-force algorithms, the system outperforms human cognitive abilities in terms of time-critical pattern recognition and computational capacities. (cf. Lyre, 2013) The fabrication of "cognitive" embodied systems that face uncontrollable and unpredictable environmental conditions, and here are expected to interact with humans and the environment, as is increasingly the case with robotic systems, is therefore far more difficult. A bodily situatedness and constitution of cognitive systems therefore becomes clear especially in the example of robotics. (Lyre, 2013, p. 186) Passive robotic walking machines that move in a self-stabilizing manner by pure mechanical performance using gravity can serve as an example. In the early 1990s, Rodney Brooks (1991) introduced the concept of a subsumption architecture (subsumption architecture) in `Intelligence without representation' (p. 146). This architecture should reduce internal representation models (p. 145) in robotic systems as much as possible in order to implement certain behavioral modes directly qua sensory input and thus enable the most flexible navigation possible through unknown environments.

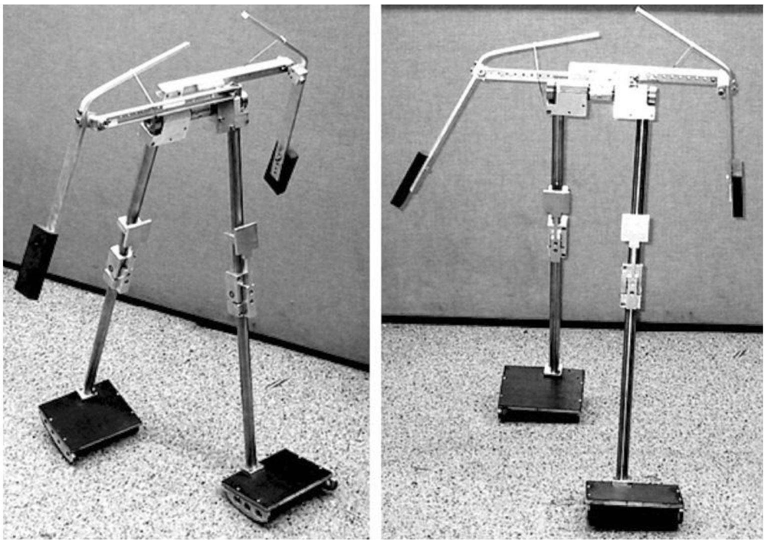

Figure 3. A bipedal Passive Dynamic Walker that runs without propulsion. A follow-on model to Tad Mac Geer's 1990 prototype (Collins et al., 2001).

A central problem for Brooks at that time was the question of how many levels could be fabricated within the framework of the model of subsumption architecture without the interaction between these levels turning out to be too complex. What level of complexity with respect to actions of the system would be possible even without a central representation. (Brooks, 1991, p. 145) and whether this approach of "leaner computerization" could also integrate higher-operating functions such as "learning" of the systems was equally unresolved at that time (p. 155).

Figure 4. The walking robot CASSIE. Developed by Agility Robotics in 2017, the walking robot will be used for parcel delivery.

This approach of "leaner computation" is also being (re)pursued in more recent models of walking robots: In the case of CASSIE, designed by Agility Robotics in 2017, locomotion is increasingly detached from central computational operations of the system. (cf. Hurst, 2019) A mass-spring system allowed the central drive motor to be smaller and the model to be more efficient: In the following, several smaller drive motors distributed in the walking body were used. In addition, the robot no longer has visual sensors, but is only equipped with propioceptive (depth) sensors. (cf. Ackermann, 2022) This makes it possible to reduce computational processes that would normally control the entire system, since parts of the locomotion feedback directly to the environment by means of depth sensors. In an attempt to control CASSIE in uncertain terrain exclusively via DRL algorithms, there were comparatively far more complications than in the application of the multi-modal system described. (cf. Ackermann, 2022) Under reduction of computational processes and the use of mechanical driving force in the form of a multi-modal system, a more "spontaneous" behavior of the robotic system becomes possible here in the first place: Although in combination with ML-based processes, but nevertheless parallel to computational automation, the system gains a kind of autonomy. While here it is mechanical principles that implement these non-linear action sequences, in the field of soft robotics and morphological computation it is materials and sensor technologies that merge with actuators themselves in order to move computational processes out of the system. (cf. Hauser & Freyberg, in press).

SOFT ROBOTICS/MORPHOLOGICAL COMPUTATION

In the discussion of multi-modal, sensor-based systems and the accompanying reduction of a centrally organized controller-control system, it can thus be stated that a transfer of the assumption of translating bodies as mere centrally controllable tools into/as humanoid robotic systems quickly reaches its limits. With the Gestalt principles of soft robotics and morphological computation, one therefore tries to outsource certain controls into the robotic system, respectively into the material used for the body itself. The morphological nature of the body itself becomes part of the (motion) intelligence of the robotic system and can be understood as a kind of embedded intelligence (cf. Bongard & Pfeifer, 2007). For example, the human hand "knows" through the pressure produced by the touched object and the way pressure is distributed how firm the grip has to be without the object escaping during the grip. The softness of our fingers and hands, the information that is transmitted and feedback processed by millions of neurons in the hand as feedback between the brain and the hand, is crucial for a successful grip. (Bakhy & Al-Waily, 2021, p. 382) Soft movement components, such as soft fingertips, are essential in the field of soft robotics. Materials that combine sensing, actuation, and computation are being developed at Harvard's Wyss Institute for Biologically Inspired Engineering and the Harvard John A. Paulson School of Engineering and Applied Sciences, for example. For this purpose, a platform for 3D printing processes has been founded that can pick up and process motion, pressure, touch and temperature signals embedded in so-called smart materials. This type of "integrated sensing" (cf. Burrows, 2018) is to be used, among other things, for robotic assistance systems in the medical field and can seamlessly embed a wide variety of capabilities and materials within a soft body by means of "embedded 3D printing" (cf. Burrows, 2018).

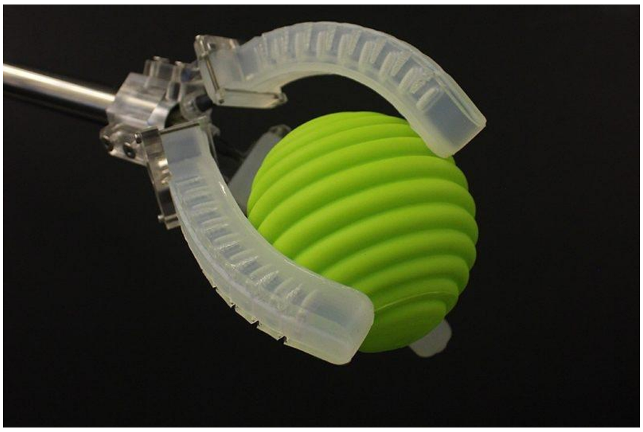

Figure 5. This soft robotic gripper is the result of a platform technology developed by Harvard researchers to create soft robots with embedded sensors that can sense inputs as diverse as movement, pressure, touch, and temperature (Burrows, 2018)

For this, an organic, ionic-technology-based conductive liquid ink produced via 3D printing within the soft elastomer matrices on which many soft robotics technologies are based. (See Burrows, 2018) This process allows sensors that are normally too rigid to be embedded directly into soft tissues. This tripartite "soft robotic gripper" seen in the image is capable of detecting pressure relief, contact, temperature, and curvature. In this case, additional light sensitive and depth sensors (deep touch sensors) are fed in. Freyberg and Hauser discuss how new design principles of soft robotics and morphological computation, which go beyond conventional robotics, can possibly be re-located away from "functionally isolated working bodies" (cf. Hauser & Freyberg, in press) along the principles of mimesis and poeisis: "Our thesis is that the bionic developments presented here in the field of robotics show important points of contact with principles of morphological thinking, as it has developed especially since Goethe. The terminological equivocation in the term "morphology" proves adequate when one considers the implications of the starting point of Gestalt and structure and its connections with theories of embodiment as they present themselves in the environment of discussions of cognitive science, artificial intelligence, and philosophy of mind, to which researchers from robotics have made important contributions." Morphological Gestalt principles give not only the material but also the form a specific mode of functioning in each case in the movement and interaction with the environment and thereby refer to the dynamics intrinsic to a body: these are coupled to a neural system of the body and function only in cooperation. (cf. Bongard & Pfeifer, 2007, p. 361-364.) Bongard and Pfeifer understand the process of off-loading (p. 361) of certain neuronal processes into the morphology of the body and the environment nature as indispensable and of essential condition for the functioning of a biological system. " [...] for recognizing objects in the real world, agents have to achieve data reduction through sensory-motor coordination, thus inducing correlations; for object manipulation we have to exploit the morphology-the anatomy-of the hand and its material properties, i.e., the deformable fingertips and the elasticity of the muscle-tendon system." (p. 361) Using smart materials, we can thus speak of a kind of "encoded" embodiment, through which processes such as walking or grasping can be completely outsourced to the "body" by taking over computational processes not centrally controlled by the body itself. "This makes a task much easier, since part of the "work" will already have been done by the body, reducing the complexity of the robot's computational problems and the corresponding control and learning tasks. This may even extend to situations where parts of the robot break down, resulting in highly resilient, adaptive and intelligent machines." (Hamacher & Hauser, 2015) Here, not only is a knowledge of the physical body itself invoked, but it also breaks with the view that the body must be controlled at all times by a central controller, which in turn is based on the notion of a separation of head and hand, and which carried over into early robotics as these same dichotomously organized Gestalt principles. However, the fact that this proves to be a hindrance for multifunctional tasks in unpredictable environments has been taken up by fields such as soft robotics: The specific material itself becomes - to put it bluntly - the sensor, or the robotic body can be thought of as a sensor in an extended sense being in feedback with the system and serving as an impulse transmitter. The material is to be understood as a carrier of action without instruction from a centralized command and can be regarded as an dynamic variable in use: It is not always foreseeable how it interacts with unstructured environments and behaves in relation to them. On a functional level embodied/tacit knowledge within AI-based mobile systems is only made possible in this example *because* of the (partial) “becoming-analog” of the body: It gains a kind of autonomy within pre-calculated rules of automation and can be thought of as a tactile body (Tastkörper), acting upon a certain performative surplus in the interaction.

GESTURES OF THE DIGITAL - DISTRIBUTED EMBODIMENT

Media practices that unfold against the backdrop of a non-experience of processed data nevertheless naturally help shape social spaces that are to be renegotiated. The approach that at this point "tacit knowledge" does not inscribe itself "categorially", but nevertheless in its "functionality" in practices of action as a (novel) form of knowledge, is able to illuminate the understanding around the shaping of social spaces in human-machine interaction: Against the background of a lifeworld situatedness, i.e., a language-action and gestural procedure that unfolds with the use of digital technologies, a certain intrinsic sense and unpredictability can be sounded out in and as action practice. There are specific gestures that emerge from this and that also find application in the fabrication of the technologies. The concept of gesture, which I will understand below as a formation that is meant to grasp the physical bodily action as well as theoretical reflection on it, can perhaps contribute as a figure of thought of the gestural to the question of a describability of digital practices of use. If one wants to understand the development of digital sensor-based technologies as a kind of caesura moment, in which it is no longer possible to describe individual chains of operations linearly, then the description and analysis qua gestures are possibly a model for illuminating processes selectively, and to be applied as a kind of open taxonomy, always directed at specific technological arrangements. A seamless description of data and media practices as interlocking causal chains of operations is not only problematic due to an increased emergence of sensor technologies. But these complicate such an endeavor, as discussed above. This also includes a bodily involvement to be re-located, which also includes the human perceptual apparatus. Digital technologies have each produced specific gestures (cf. Heilmann, 2010) and demand the same from us in their technical production. The figure of distributed embodiment (cf. Engemann & Feigelfeld, 2017) points to the necessity of human gestures - of bodily work and bodies in general - as input for machine learning-based technologies, which as sensory environments register movements of the bodies and thus can only complete the machine learning process. The human hand, of course, also contributes in aggregating and labeling the underlying training data for this process. Here Engemann ties in with the discourse of an indexicality of the digital and understands these gestures as traces of the physical world inscribed in and as digital technologies: These working gestures are also made for labeling processes in the field of training data for robotic systems. Furthermore, the gestures in the laboratory, which are made during the training of robotic systems ¬-often repetitively - are to be mentioned, as well as gestures of fabrication and in the design and creation of robotic bodies, gestures of communication, assistance, division of labor, etc. With recourse to McLuhan, Till Heilmann (2010), for example, disentangles the gesture of pressing a key as the gesture of the digital and grasps digital technologies in general as "technical implementation of tactility" (p. 132) Tactility in McLuhan's is a synaesthetic concept and is neither congruent with that of the haptic nor is it the mere addition of the human senses, but precisely that which opens up as a complex mesh as a disposition to the world. (cf. McLuhan, 1964/2005) According to Heilmann and with reference to Leroi-Gourhan (1964/1988), the hand as well as language as a structured disposition are the prerequisite for digital thinking and becoming and being-in-the-world in the first place. (cf. Heilmann, 2010) Benjamin Peters also emphasizes this distinction when he states: "Perhaps the most ancient of the predecessors to digital discourse dates back to the Latin source of the term itself - the original digit, or the index finger. This essay takes that origin point -a digits an index finger- literally. [...] I will explore how digits do what index fingers do - namely count, point and manipulate. ("Manipulate" of course is a back -formation from Latin for handful - a handful of fingers.)" (Peters, 2016, p. 94). Thus, not only would a respective directed tactile dimension of human sensory endowments be realized only in the fabrication and use of digital technologies. Our bodies, and in particular our hands, against the backdrop of a historical language-action, moreover, constitute the condition for the historically contingent bringing forth of just such technologies. In a description of robot-human interaction that understands the interplay of machine and human gestures as a mutual learning process, it must also be taken into account that the technical object as a media compound of anthropomorphically designed robot, action-related artificial intelligence, and human-inspired sensor technology is as it were, encounters the human being quasi as a Doppelgänger.

CONCLUSION

The extent to which body-bound knowledge is indispensable for cognitive processes is attempted to be revealed or opened up for renegotiation in the above-mentioned examples of sensor-based robotic interaction. The paradigm shift that took place in a Western industrialized tradition of thought at the latest in the 1980s with respect to machine-learning based systems and body-bound knowledge (cf. Dreyfuß (1978), Brooks (1991) et al.) focuses on the fact that corporeality or body-bound knowledge is grasped as (one of) the preconditions of cognitive performance in the first place: This insight is momentous in the context of physical interaction with AI-based systems. Addressing the question of situationally bound learning and maneuverability of automated systems in unpredictable environments can and should further deepen reflection on the underlying epistemic parameters of applied knowledge models of learning, intelligence, and cognition. In the second part of the article, the question of bodily involvement for the genesis of knowledge concepts was sharpened insofar as the human body - first and foremost the human hand (cf. Peters, 2016) - is understood not only as involved in, but as a precondition for abstract symbolic thinking (cf. Heilmann, 2010): the digital itself is thus identified as a historically contingent, each specific, human achievement, These are the horizons against which the analysis of the examples presented takes place. With the above-mentioned examples it should be shown that multi-sensory data genesis qua sensor technologies may give new accesses and perspectives on the connections between learning, cognition and corporeality by looking at the challenges to translate human language and multi-sensory signals into machine action: Already on the level of fabrication it becomes clear - in the interplay of (IT) engineering biological expertise and humanistic reflection - that situational and intelligent collaboration is not only exhausted in/as formalized computational processes and hence is not sufficient to instruct machine behavior. The Passiv Walking machines shows that especially sensor-motoric actions like locomotion of the body in unstructured environments are the biggest challenges to be translated into algorithms, because they are embedded within highly intuitive lower-dimensional human cognitive acts in the first place (cf. Brock, 2021). Furthermore the example of soft-/smart materials lays out that matter itself, hence the body itself has its own agenda in encountering its environment. On a media philosophical account one could think about it in terms of a performative surplus of the material itself. The concept of some form of centralized *general intelligence* delegated by the brain only is hence contested: On the background of the research on ML-based robotic gripping systems it is outlined that the complex interplay among cognitive processes and multi-sensory signals are intertwined throughout the body and cannot be captured on an algorithmic therefore instructive level only. In this regard I layed out that mobile *sensing technologies* serve as a way to observe this complexity. On a more general account, these questions about the material conditions of knowledge are also to be classified within the framework of the material turn of science studies: Here, the body is not only essentially involved in the feedback and applicability of knowledge, but also makes comprehension in the cognitive and figurative sense (cf. Lakoff & Nunez, 2000) possible in the first place.

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Research article

Do it Yourself at YouTube

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Abstract

Every person at least once in his life is faced with an instruction – a certain set of rules, which spells out how to use a household appliance, how to behave in a given situation, perform this or that type of work, and so on. It can be a multimodal text that describes the actions, the implementation of which should lead to a result. If earlier the text with illustrations served as the main form of instruction, nowadays there are video instructions. The modern name for video instructions is DIY video, the authors of which strive to convey to the viewer in a short period of time how to create some thing or tool on their own at home.The purpose of this article was to analyze DIY video as instructions for creating tools. More often than others on YouTube there are videos for creating a holder for a tool, a clamp and an attachment for an angle grinder, and the most difficult tool to create is a grinder. A comparative analysis of video instrumentation and magazine articles (using the example of creating a lathe, an electrolyzer and a collet holder for files) showed the difference between instructions in text format and video format. In a video of this format, the authors visually provide the viewer with information about the choice of material, the creation of a device, how to correct possible mistakes, how the viewer can improve and subsequently adapt the created device for himself. Based on the study, it was revealed that the information in the video is presented more clearly and contributes to understanding the essence of the process itself. However, due to the large amount of visual information, the reasons for doing certain technological operations are omitted. This prevents the viewer from realizing the essence of the actions, it will be more difficult for him to adapt to other conditions. Viewing the video is much easier, the viewer has the opportunity to step by step repeat all the actions of the author. However, in order to make changes to the design, come up with your own self-made products and refine them, you need to study and analyze several sources of information.

Keywords: DIY; Self-made tools; Visual information; Manufacturing process; Visualization; Information presentation

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Научная статья

“Сделай это сам ” видео на YouTube

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Аннотация
Каждый человек хотя бы раз в свое жизни сталкивается с инструкцией– неким сводом правил, в котором прописано то, как нужно пользоваться бытовым прибором, как вести себя в той или иной ситуации, выполнять тот или иной вид работы и так далее. Она может представлять собой мультимодальный текст, в котором описываются действия, выполнение которых должно привести к результату. Если раньше основной формой инструкции служил текст с иллюстрациями, то на современном этапе появляются видео-инструкции. Современное название видео-инструкций – DIY-видео, авторы которых стремятся донести до зрителя за небольшой промежуток времени то, как самостоятельно в домашних условиях создать какую-либо вещь или инструмент. Целью данной статьи являлся анализ DIY-видео, как инструкции по созданию инструментов. Чаще других на YouTube представлены ролики по созданию держателя для инструмента, струбцины и насадки на углошлифовальную машину, а самым сложным из предлагаемых к созданию инструментов является гриндер. Сравнительный анализ видео-инструкции и журнальных статьей (на примере создания токарного станка, электролизера и цангового держателя для надфилей) показал разницу между инструкциями в текстовом формате и видео формате. В видео подобного формата авторы визуально предоставляют зрителю информацию о выборе материала, создании прибора, исправлении допущенных ошибок, улучшении и адаптации созданного прибор под себя. В видео-формате информация представлена более наглядно и способствуют пониманию сути самого процесса. Однако, за счет большого количества визуальной информации опускаются причины, по которым делаются, те или иные технологические операции. Это мешает зрителю осознать суть действий, ему сложнее будет подстроиться под иные условия. Просмотр видео намного проще, так как у зрителя есть возможность пошагово повторять все действия автора. Однако, для того чтобы вносить изменения в конструкцию, придумывать свои самоделки и дорабатывать их необходимо изучить и проанализировать несколько источников информации.

Ключевые слова: DIY; Самодельный инструмент; Визуальная информация; Процесс изготовления; Самоделка; Визуализация; Подача информации

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Мы хотели бы выразить благодарность Дарье Сергеевне Быльевой, которая была наставником работы. Мы также хотели бы поблагодарить всех, принимавших участие в создании проекта, особенно Диану Якименко и Анастасию Козлову за помощь в подготовке и переводе информации.

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INTRODUCTION

Due to the pandemic situation in recent years, people began to spend more time at home, engaging in various hobbies. They had time to go to long-forgotten workshops and garages. Every garage owner who has at least some tools has done something with his own hands at least once in his life. Many receive initial skills of manual work in schools, in technology clubs, or in the process of studying in colleges and vocational schools, and some knowledge is also provided in universities. The greatest influence on the development of the ability to work with hands comes from direct work at a construction site, in a shop, at a workbench, etc. But what do those who received bad grades for crafting at school, skipped classes at a university or college, or did not work in places where you need to make something yourself? Of course, these people will first visit the world's largest video hosting site YouTube to find videos in which the author will tell you in detail how to pursue a particular project. The problem is that no one checks such videos for accuracy, compliance with safety measures, correct operation of the tool, or for meeting other criteria. Sometimes the authors do not even show the manufacturing process, but only tell how they made it and show the finished product.

METHODS

For this paper one hundred YouTube videos were analyzed that demonstrate how to make your own tools. The search for videos was carried out according to the queries: “DIY tool” and “homemade tool” in the YouTube search bar. Also considered were videos offered as recommended videos on the “Main” tab of the hosting site after watching the previous ones. The set of products presented in the recommended videos is very diverse, but it also includes videos on similar topics. For a more detailed analysis, three videos were highlighted, one of which devoted to the creation of a lathe at home, the second to an electrolyzer (a system is designed to separate the components of a compound or solution using an electric current), and the third to a so-called collet-holder, that is, a tool that serves as a holder for other tools (rasps or files). Three videos were compared to printed articles on similar topics, and diagrams were created to compare the way information is presented.

LITERATURE REVIEW

Do-It-Yourself (DIY) can be defined as activities in which individuals engage raw and semi-raw materials and component parts to produce, transform, or reconstruct material possessions (Wolf & McQuitty, 2011). Frequently DIY is considered as an activity to improve one's own home, household, etc., only rarely as a creative (Bennett & Guerra, 2018; Spencer, 2008; Threadgold, 2018) or scientific activity (Sarpong et al., 2020).

When prefer to produce something themselves, their motives are sometimes economic (connected with availability and suitability of available goods) or to confirm a certain self-image (fulfillment provided by craftsmanship, empowerment, community seeking, need for uniqueness) (Luckman, 2015; Rosenberg, 2011; Williams, 2008; Wolf & McQuitty, 2011).

Watson and Shove (2008) point out that DIY is a field in which the relation between tools, materials, and competence is plainly significant (p. 72). On the other hand, they neglect the extent to which people rely in their activities on the instructions that are used by them to organize their material resources in the modern world.

All over the world, the DIY phenomenon has been integrated into culture in a variety of activities. A bright example of the modern expression of DIY culture in Europe and the USA is the DIY & Household industry, represented by DIY construction and furniture stores such as IKEA, Leroy Merlin, Castorama, OBI, etc. The buyer is offered a wide selection of tools for repair, construction, and design for self-assembly of furniture and creating an interior from particular parts. In a certain sense, such practices are *bricolage*, that is, the creation of a new object from improvised elements of the natural or socio-cultural environment (Belhadi, 2014; Duncan, 2011).

It is simple to suppose that these manifestations of DIY culture appeared by the growth of demand for categories of goods for self-assembly. Many people have started to carry out their construction and creative ideas. The instruction can be defined as a form of written or oral set of guidelines on how to create a particular object (Rodionova, 2017). The instruction is a bridge between knowing and doing (Brass et al., 2017). Technical writing researchers today show interest in instructions created by non-experts for non-experts (Kimball, 2016; van Ittersum, 2014). After all, they are the mainstay for network users.

Moreover, the development of digital technologies has introduced some opportunities to improve DIY instructions. The most popular educational videos on YouTube are precisely those videos where the authors not only share information that could be learned from written instructions, but also clearly show the process and sequence of work. Most of the current research on instructional videos focuses on making them effective technical communication products, relying on the psychology of education and instructional design (Shroyer, 2019; van der Meij & van der Meij, 2013).

The main feature of a well-written DIY instruction should be the simplicity of its perception by a person with even the lowest level of skill in this sphere (Behnke et al., 2019). Video instruction standards are not well-organized enough (Mogull, 2014) and many communication strategies for printing instructions have been applied to video instructions (Morain & Swarts, 2012). However, the distribution area of DIY instructions falls mainly on internet resources, and among them the leading position is occupied by the video hosting site YouTube, since most users need to consider the so-called "visual" instruction rather than read the printed one because visualization of the process helps a person imagine how his work will look and what the result should look like. Selber (2010) argues that the internet generates new genres. Pflugfelder (2013) similarly argues that the genre of the tutorial is changing: "What we see in the video of the web application is a relatively new form that functions as a short guide rather than a complete guide, and often promotes the product by presenting it" (p. 133).

PROVIDED IN THE VIDEOS OF DIY

Of interest is what kind of self-made products are presented in the videos. What exactly is it that people want and can create themselves in the modern world of the availability of almost any tool. We have divided the self-made products of all authors into hand-tools and the rest – power-tools and machine-tools (fig. 1). The most popular hand-tool has proven to be the tool-holder. This homemade product allows you to modify the factory tool and make it more convenient to use. The second most popular tool is the clamp, while a third group of tools makes up a total of 12% of the videos from our sample: thickness gauge, core and pipe bender.

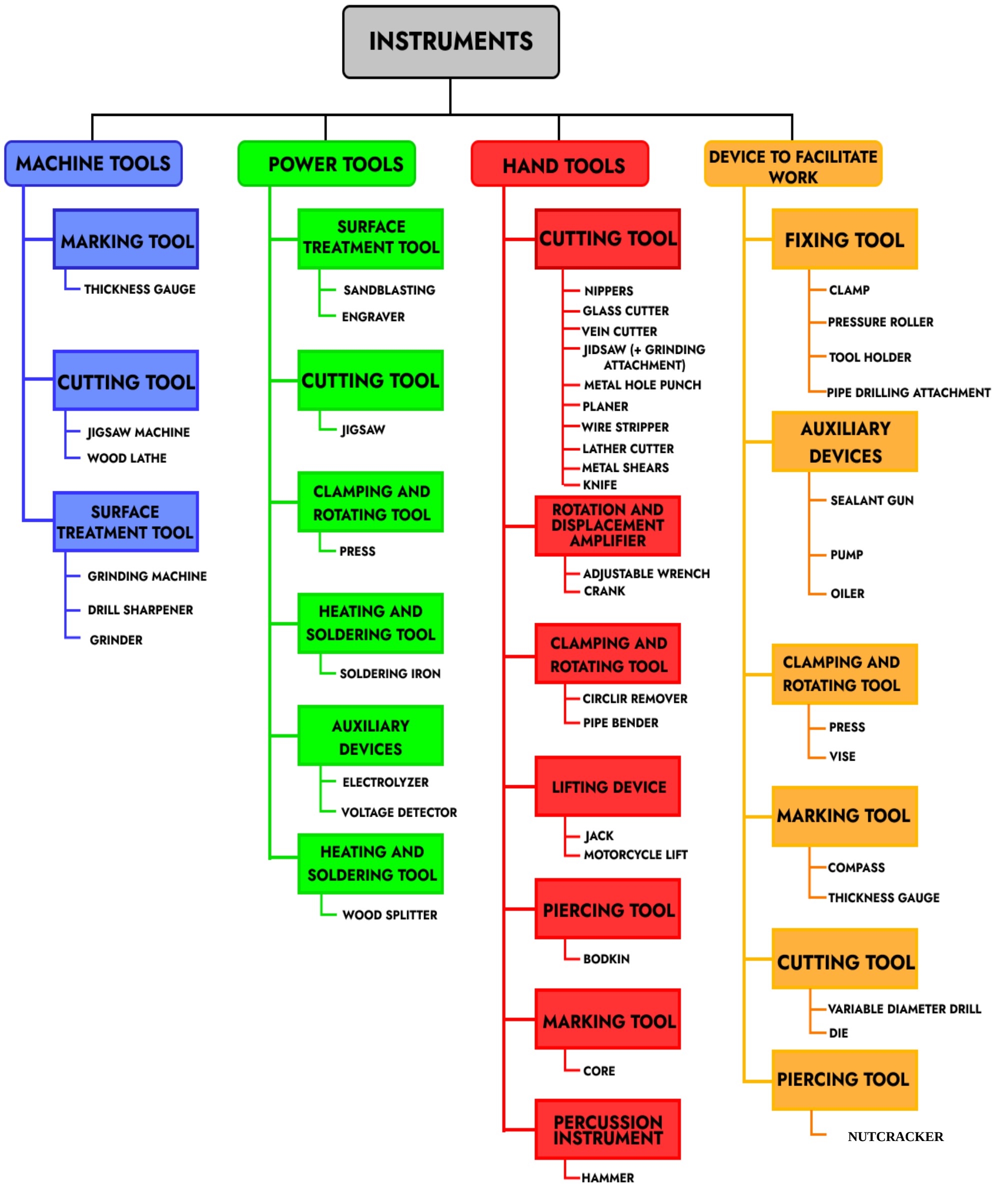

Figure 1. Classification of the tools presented in the videos

The following is the distribution of tools in order of increasing complexity of manufacturing (fig. 2), next to it is the percentage of videos in the total sample that are dedicated to this self-made product: Hammer – 3%; Sealant gun – 1%; Vorotok – 1%; Thickener – 4%; Retainer ring remover – 1%; Shiloh – 2%; Drill with variable diameter – 1%; Attachment for sharpening drills – 1%; Glass cutter – 1%; Wire cutter – 1%; Knife – 2%; Jigsaw – 1%; Pressure roller – 1%; Kern – 4%; Adjustable Wrench – 2%; Compasses – 2%; Wood splitter – 2%; Nutcracker – 2%;Puncher for metal – 1%; Clamp – 5%; Scissors for metal – 1%; Pump – 1%; Jack – 2%; Pipe bender – 4%; Tool holder – 6%; Nippers – 1%; Vice – 3%; Turning tool – 3%; Planer – 2%; Die – 1%; Oiler – 1%; Press – 1%; Motorcycle lift – 1%.

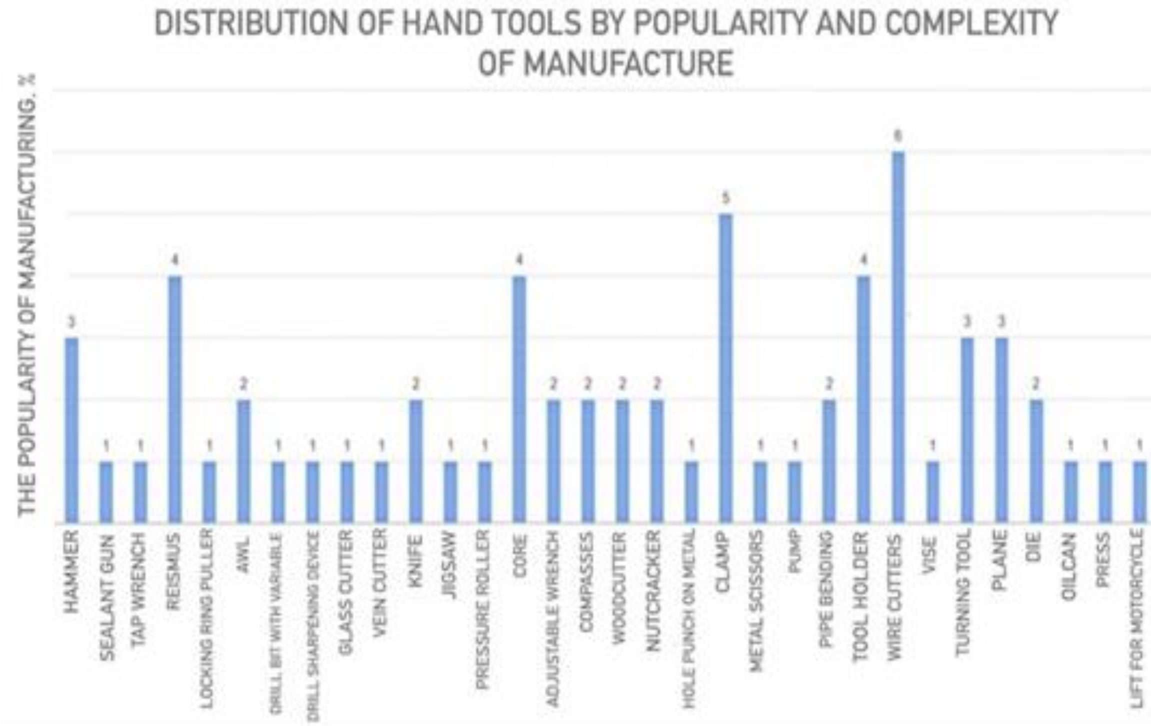

Figure 2. Distribution of hand tools by popularity and degree of difficulty

The most manufactured tool, the drive of which is an electric motor or power tool, is a nozzle for an angle grinder – 8% in its various forms: a renovator nozzle, a reciprocating saw nozzle, a grinding nozzle. The grinder is one of the most popular tools in the workshop, so many are trying to get the most out of its potential by creating various attachments and accessories, as this can significantly save on tools. The second most popular product was the grinder, about 6%. This is a fairly expensive machine required for metalworking. The third most popular tool for making a tool is a grinding machine, videos on its manufacture take 5% of the total number of videos. Further, as for hand tools, the distribution of tools is presented in order of increasing complexity of manufacture (fig. 3), and for clarity, this distribution is presented: Sandblasting – 2%;

Soldering iron – 1%; Engraver – 1%; Grinding attachment for jigsaw – 1%; Device for stripping insulation – 1%; Voltage detector – 1%; Device for drilling pipes – 2%; Wood lathe – 1%; Electric jigsaw – 1%; Grinder attachment – 8%; Electrolyzer – 2%; Jigsaw – 3%; Grinding machine – 5%.

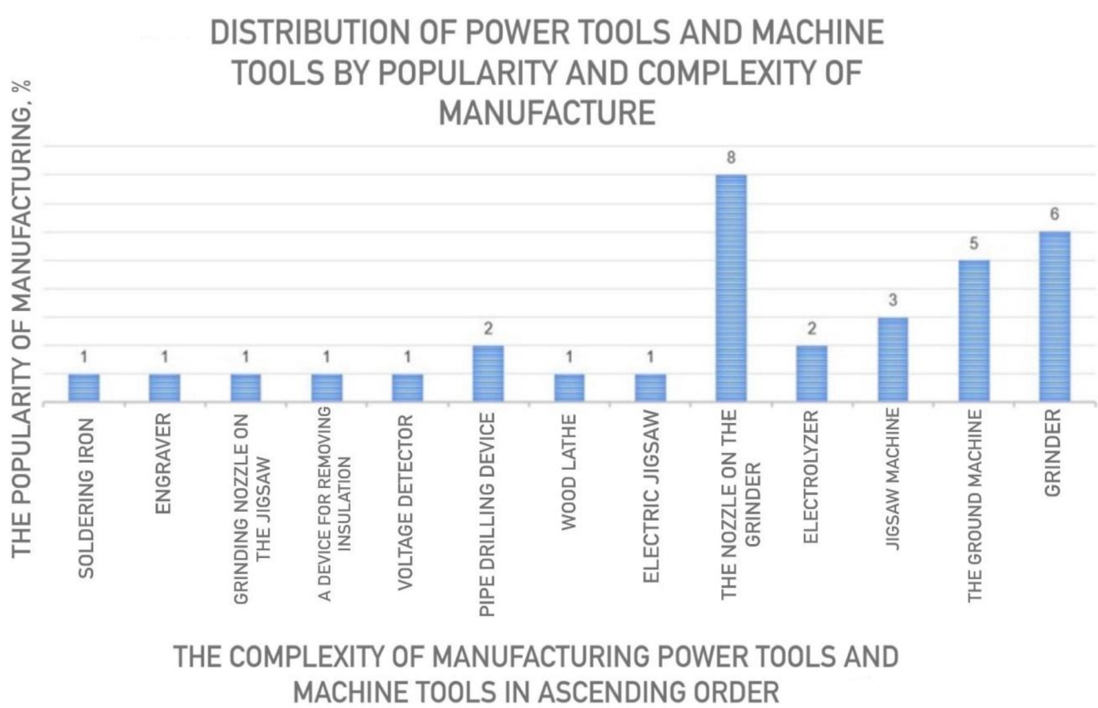

Figure 3. Distribution of power tools by popularity and degree of complexity

Based on the videos we analyzed, the content authors do not primarily seek to help the user but give their videos uninformative clickbait names, for example“ “DON'T WASTE YOUR MONEY!!!DO IT YOURSELF!!! COOL TOOL with your own hands!!!” Videos with similar names in our selection turned out to be 27%. However, there are titles containing the topic of the video, but not reflecting the essence. They mention materials, tools and manufacturing methods, but do not mention the product itself: “THE SECRET of an ordinary anchor makes for a cool tool.” Such names turned out to be 30%. There were also videos in which the name of the manufactured tool or machine is indicated most informatively, for example “GRINDER MADE OF RAIL.” There were 43% of such videos.

In their tool-making instructions, authors can interact with the viewer in different ways. In some videos, they talk in detail about the manufacturing process and the scientific principles of the processes taking place. In the video about creating a reyer from a chisel, the author tries to interest the viewer in blacksmithing, talks about the basics of this business, about the physical and chemical components of the processes taking place. Such videos in our selection are 9%. In other videos, DIY-makers provide useful tips to the viewer, talking about alternative methods and important subtleties of manufacturing. Videos with a similar DIY approach to content creation are 45%. It is also possible to highlight videos in which authors do not understand the technological process and do something according to the guide of other self-made artists, as a result of which they are not ready for non–standard situations and cannot explain to the viewer what and for what purpose they did something – an example of such an approach can be a video in which a blogger makes a radius cutter from an automobile valve. He clearly repeats the content of someone's video, since he has no idea what the tool he makes is for, and tries to come up with the uses of his product on the go. However, most DIY people understand what they are doing, there are 78% of them. In some videos there are "harmful tips" – the author, who does not understand the technology or the process, tries to explain in his own words, but due to lack of competence misleads his audience. There are quite a lot of such videos, as many as 24%. The best example is a video in which the author creates a jack made of PVC pipe. This design would not able to lift the weight of the car. The authors of such videos resort to deception and insert a second factory jack, which is not visible. More than once, other DIY makers have refuted this invention, proving that this design does not work.

Because of the tools and machines in our sample are very different, the technological operations used in their manufacture also have different degrees of complexity and require caution in handling machines, cutting tools, heating and electrical equipment. In some of them DIY-makers violate safety regulations at work in order to perform a complex operation without the necessary equipment. Videos in which safety regulations are violated in any way (lack of personal protective equipment, eating at the workplace, misapplying tools by using them for the wrong purpose) account for 38% of the entire list. In one of them, the author created a milling cutter for angle grinders by screwing the screws into an old petal disk. Such a construction can fly apart when used and injure both the author of the video and its operator. At the same time, in 21% of cases, violations of technology for workplace safety are not dangerous to the health of the DIY maker. Most often, when trying to repeat such an operation, viewer will not harm themselves, but may break or damage the instrument. For example, in one of the videos, the author uses a screwdriver instead of a lathe. This reduces its service life by creating an unusual load for the tool.. There are masters who do not violate technology for workplace safety and do everything very carefully, there are about 57% of them. Some of them (12%) explain possible errors and urge the viewer to comply with TB.

One of the most important parameters of self-made crafts is their replicability. A criterion that reflects how easy it is to repeat the author's actions and make such a tool yourself. First of all, a person who wants to repeat something should evaluate their abilities. Videos with homemade tools vary greatly in the necessary skills. So, for example, in a video about making a reismus from a ruler and wooden bars, the author needed skills with a hand tool (he used a chisel, a hacksaw and a screwdriver, which can be replaced with a manual screwdriver). There were about 23% of videos with a similar level of complexity. It is worth highlighting the most popular category, videos in which a power tool is used. These are about 79% of the total. Also, in the video about the creation of a homemade grinder, a whole machine park is used, requiring professional work skills. Products of similar complexity are presented in 41% of videos. Thus, everyone can choose for themselves an suitable method of making a particular tool.

It is worth considering the material used by the authors of the video. A self-made product is easy to replicate if materials that can be purchased at any hardware store are used in its creation, such as plywood, wood, metal profile, sheet metal, various hardware. Similar materials were found in 69% of the videos, but this does not mean that anyone can buy all the materials in the first construction store they come across, since usually, in addition to easily accessible materials, in 71% of cases DIY makers use materials that are purchased in specialized stores, such as metal round bar, non-ferrous metal blanks, plexiglass. But that's not all. Often the author uses materials that are difficult to acquire, for example, an engine from a broken angle grinder, a gear of a certain size with the right number of teeth, an old sewing machine or a thick sheet of alloy used in some narrow industry. Such materials are quite difficult to acquire. Videos with their use make up about 18%.

It is most convenient to replicat self-made things, knowing the necessary dimensions. About 4% of DIY workers attach drawings and additional materials. The videos in which the author shows such attention to the possibility of replicaing the self-made work came from two channels. Danya Craster, the host of the Galileo TV show and the founder of the SuperCrastan YouTube channel, provides drawings or 3D models of his products in file format for Fusion 360 for free, while Alexey Burkan from the ALEX LAB channel provides drawings of his inventions when one agrees to a sponsored subscription to the channel. In the video itself only some dimensions are indicated. About 40% of authors voice or demonstrate basic dimensions in their videos. Often the author does not specify a certain size, since it is associated with some other already specified size, or depends on some variable parameter. For example, in the video about creating a jigsaw, we understand that the height of the frame must correspond to the length of the saw used, so this size is not specified. In such cases, we can say that the size is indicated implicitly. This approach occurs in about 39% of videos. 41% of DIY makers completely neglect the size, making it difficult to replicate the product. In 52% of cases, the dimensions are not specified, since only the principle of the self-made work is important, and not its size or shape, as, for example, in the video about creating an awl or soldering iron.

Before you do something according to the guide from YouTube, you need to assess how appropriate it is to replicate the tool in question, how well it works compared to the original. When analyzing the data, it turned out that 8% of the self-made tools do not work. This is a small percentage, but, having stumbled upon such a video, an inexperienced viewer can waste time and resources. It is quite difficult to achieve factory-made quality in garage conditions, it requires a large number of tools and skills to work with it. Therefore, in about half of the cases, about 51%, the tool works worse than its factory counterpart, but it performs sufficiently well the tasks for which it is intended. There are DIY crafters who are able to ensure that their products work on a par with their factory counterparts. Such videos make up 42% of the sample.

Also, the feasibility of manufacturing a product is affected by how long it will last. Often, the tool that the DIY makers create cannot be used more than once, as it quickly fails. About 19% of the instruments are disposable. For example, a core made of a bolt will fail after the first use, since the steel from which the bolts are made does not have the necessary hardness. Most tools justify their manufacture, for example, in the video about the creation of the press, the machine resource pays for the time and materials spent. There were 65% of such videos. In 58% of the videos, the manufactured tool will last a long time, even if it is used daily, for example, a grinding machine with an inclined mechanism.

An important component of any tool is its appearance. Not only engineers, but also designers work on any tool sold in the store to make it ergonomic and aesthetic. It is much more pleasant to work with such a tool, and in any case, careful manufacturing can be considered a guarantee that this tool works and will actually be used by a DIY specialist in subsequent projects. However, 19% of the tools from our selection were made carelessly. They did not receive any additional processing which is why they have a bad appearance such as untreated welds, an inhomogeneous surface structure of the product, or fastening of parts with duct tape or hot glue. The 69% of correctly and beautifully made tools and machines received additional finishing treatment, for example, by being processed with sandpaper, a grinding machine or sandblasting, after which they are painted. The final processing of the products was carried out in 64% of the viewed videos.

INSTRUCTIONS FOR TOOL CREATION

Do not think that DIY became widespread only with the advent of the internet. Today, the YouTube video hosting site is the easiest way to get information, it allows you to unite individual DIYers in a community and make their work publicly available. This creates the illusion that this is a new and evolving direction.

In fact, craftspeople have always made self-made products, but the way of exchanging information between each other and the lay people was different. Before the advent of the internet, DIYers, builders and makers used books, magazines, and oral speech to transmit and receive information. For example, *Do It Yourself* magazine describes a method for creating a lathe from a hand drill. Also, this method has been repeatedly presented in videos by DYI makers on YouTube. It is worth analyzing two different sources that represent the same product in order to discover why people choose YouTube instructions over those in a magazine. In order to make our analysis more visual, we decided to break the information in the sources into structural groups that are presented in the diagram.

This diagram shows the criteria by which we analyzed videos as well as articles from the magazine. We decided to look for the difference in the presentation of information and the way it is presented. The diagram shows that information can be verbal (orange), non-verbal (green), information that is presented in the analyzed sources in combined form (purple) (fig. 4).

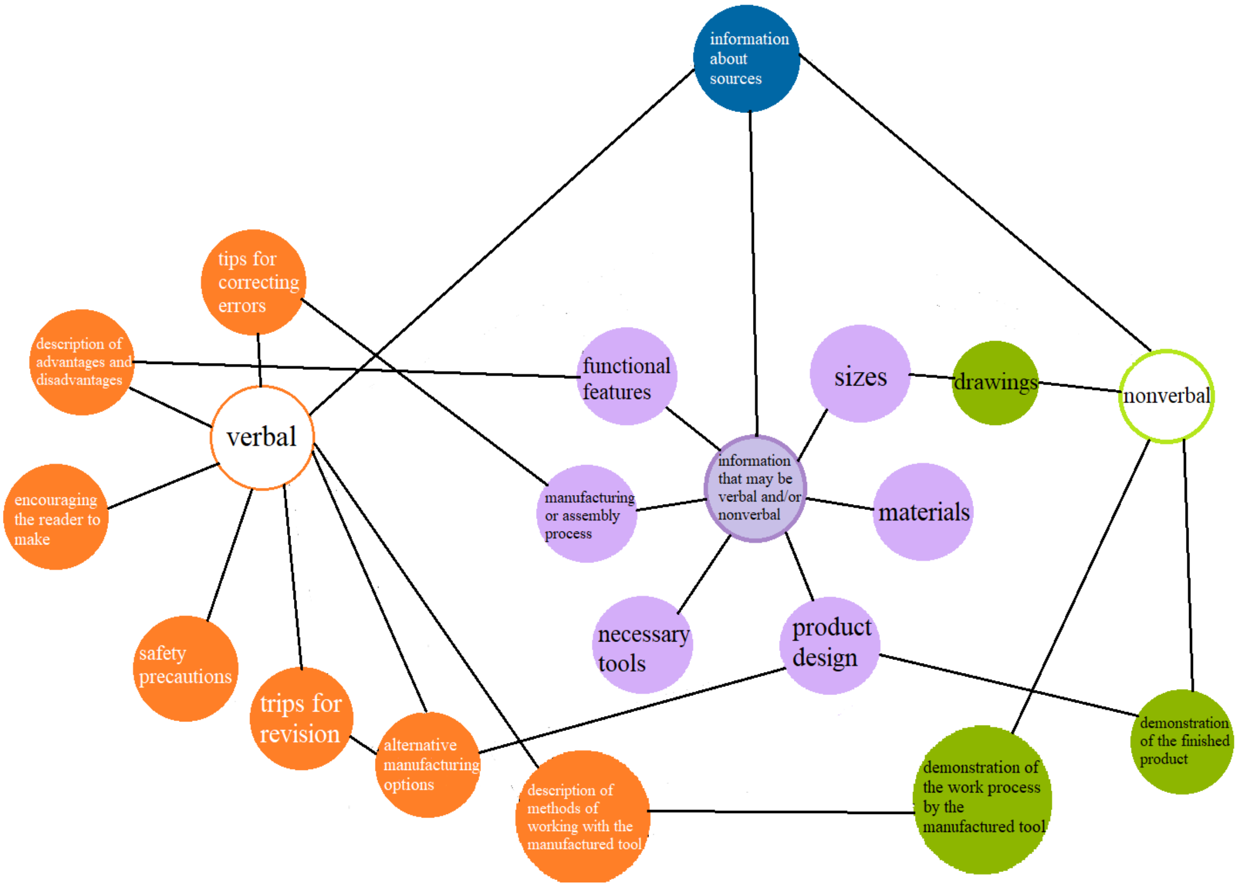

Figure 4. Diagram of criteria for video and article analysis

First of all, a clear difference between a magazine and a video is the form of information submission. The magazine contains a large amount of text and several pictures, while YouTubers try to focus on visual information, often filming videos without voice guidance (only music and the production process). We watched about 10 videos about creating a lathe from a drill and chose the most informative one with a description of the assembly process and the method of manufacturing parts. Below are the schemes for the video and for the magazine, respectively. The arrows show the chronology of information presentation. Double lines for a structure indicate that it is presented during the demonstration of the finished product, as well as during the assembly process, for advice on rework and alternative manufacturing options – that they are related to the manufacturing process, but do not have a specific place in the text. that is, they are represented by fragments. The yellow oval contains loop elements that appear several times both in the video and in the article (fig. 5).

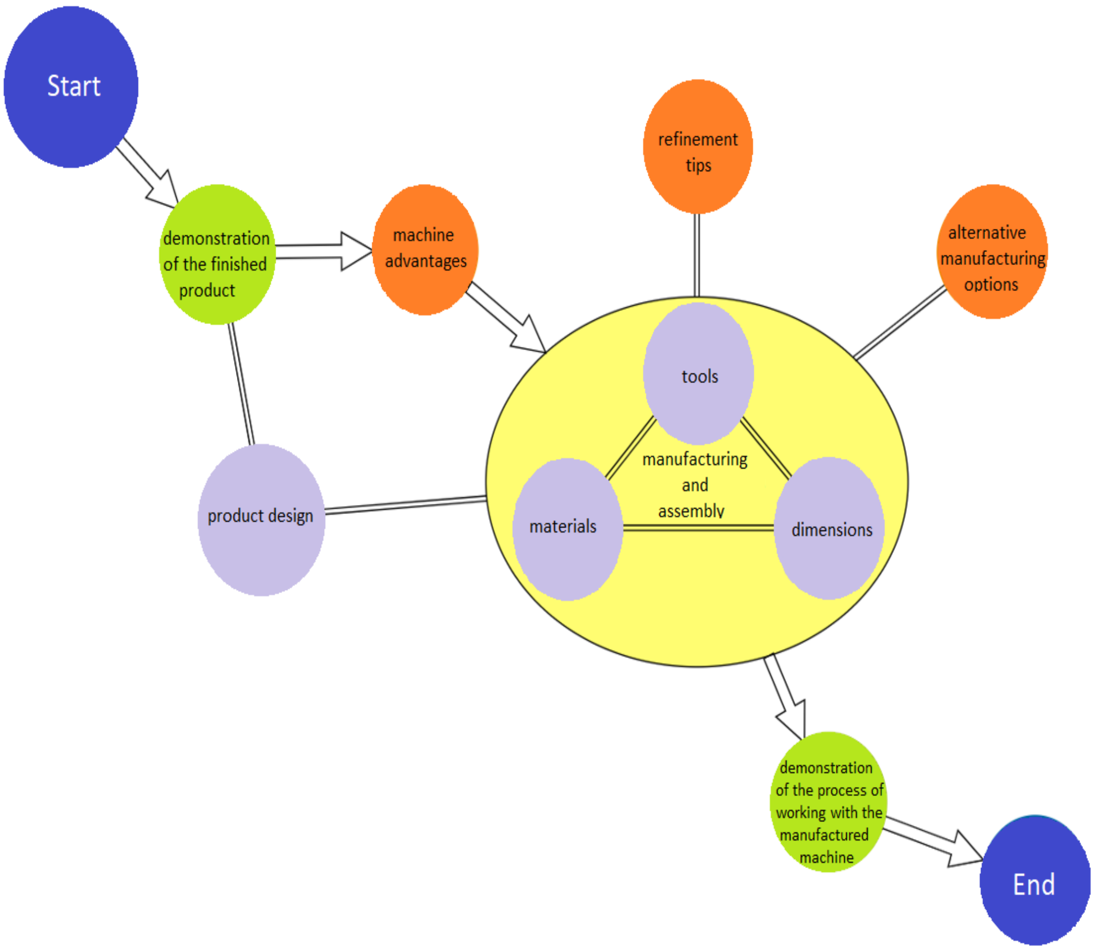

Figure 5. Scheme of presenting information in the video (creating a lathe from a hand drill)

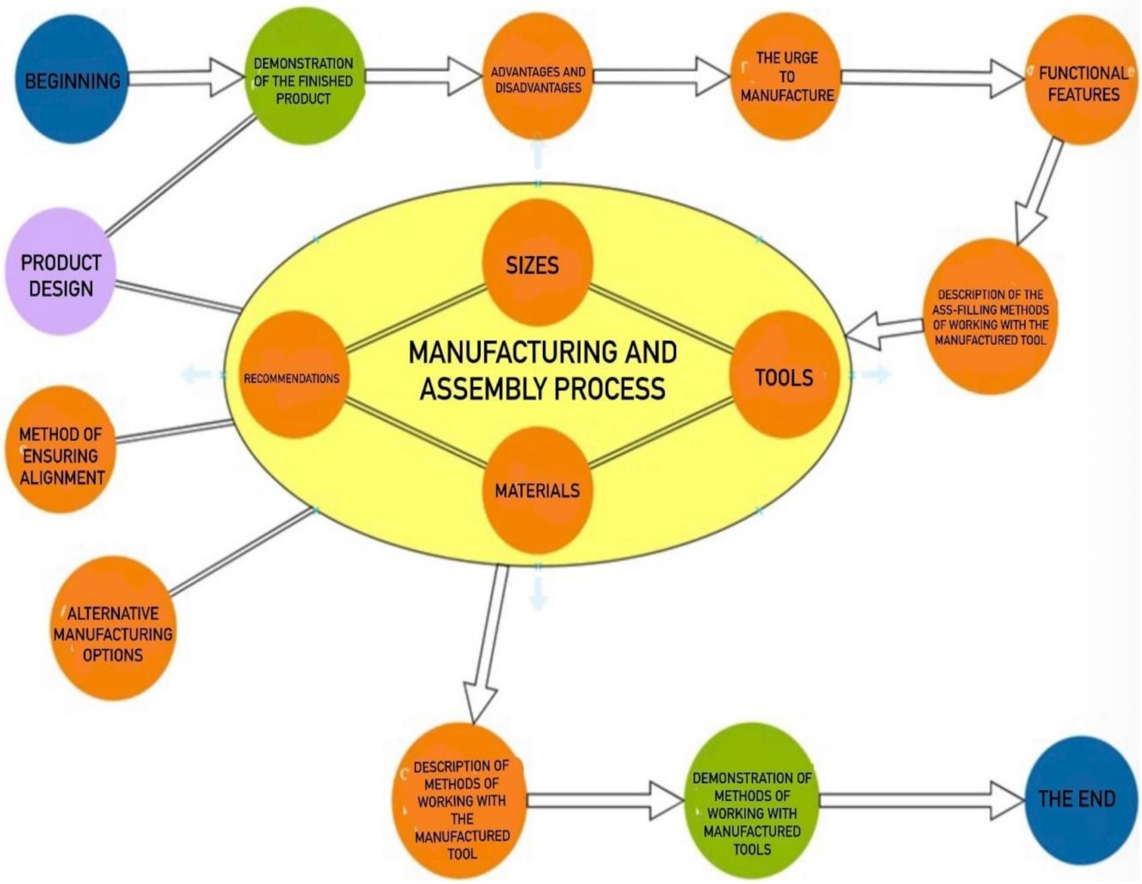

Figure 6. Scheme of presenting information in the article
(creating a lathe from a hand drill)

In both types of source, the story begins with a verbal description of the advantages, disadvantages, and functions of this machine, but there are differences. The article focuses on ease of use, and in the video on the versatility of the product. The article also adds the reader's urge to make self-made products: the authors say that the machine being manufactured has already been tested and justifies its manufacture: “Working with the proposed manual lathe has proven itself in practice. It gives an excellent result when turning small parts, is easy to use and, most importantly, it allows you not to get nervous that the noise from it causes trouble for neighbors.” (Sarafannikov, 2008, p. 15). It is worth noting that both kinds of source present information as accessibly as possible for the purpose of repetition. In the video, the DIYer pays special attention to this, before scoring the dimensions, the dimensions are also demonstrated visually using the tape measure attached to the parts. The text of the magazine gives exactly the size recommendations and explains why this one was chosen. As for the materials, in both cases the information is transmitted verbally. In the watched video clip, a description of the manufacture of parts is given, but the process of their manufacture is not demonstrated either. The magazine describes in detail the manufacturing process of each part, the pictures show some finished parts, the operations for marking the parts are presented. The authors of both options indicate alternative options for the manufacture of some parts or structural assemblies. This helps the reader or viewer to repeat the process of making the self-made product, but such options are not shown either in the video sequence or in the picture in the magazine. In addition to alternative options, the authors tell you how to eliminate some of the mistakes that you might have made at your first attempt. This proves once again that these guides are aimed to enable repetition. The finished product is presented in both cases, it is demonstrated at the beginning and at the end of the video, as well as in the figure at the beginning of the article before describing the design of the machine, which is not required in the video, since everything is already visible. At the same time, nowhere are the safety precautions for the manufacture of the machine described, on the assumption that the product itself is not dangerous if handled correctly. The very work with the machine is described in detail in the article with a proposal for several ways of working, one of which, the most convenient, is described in detail. In the video, the process of work is not described in words, the author simply sharpens the workpiece to the music for several minutes, demonstrating the capabilities and performance of the machine. At the end of the video, the author demonstrates the resulting detail, and the article talks about the possibility of sharpening products for use in an upcoming project.

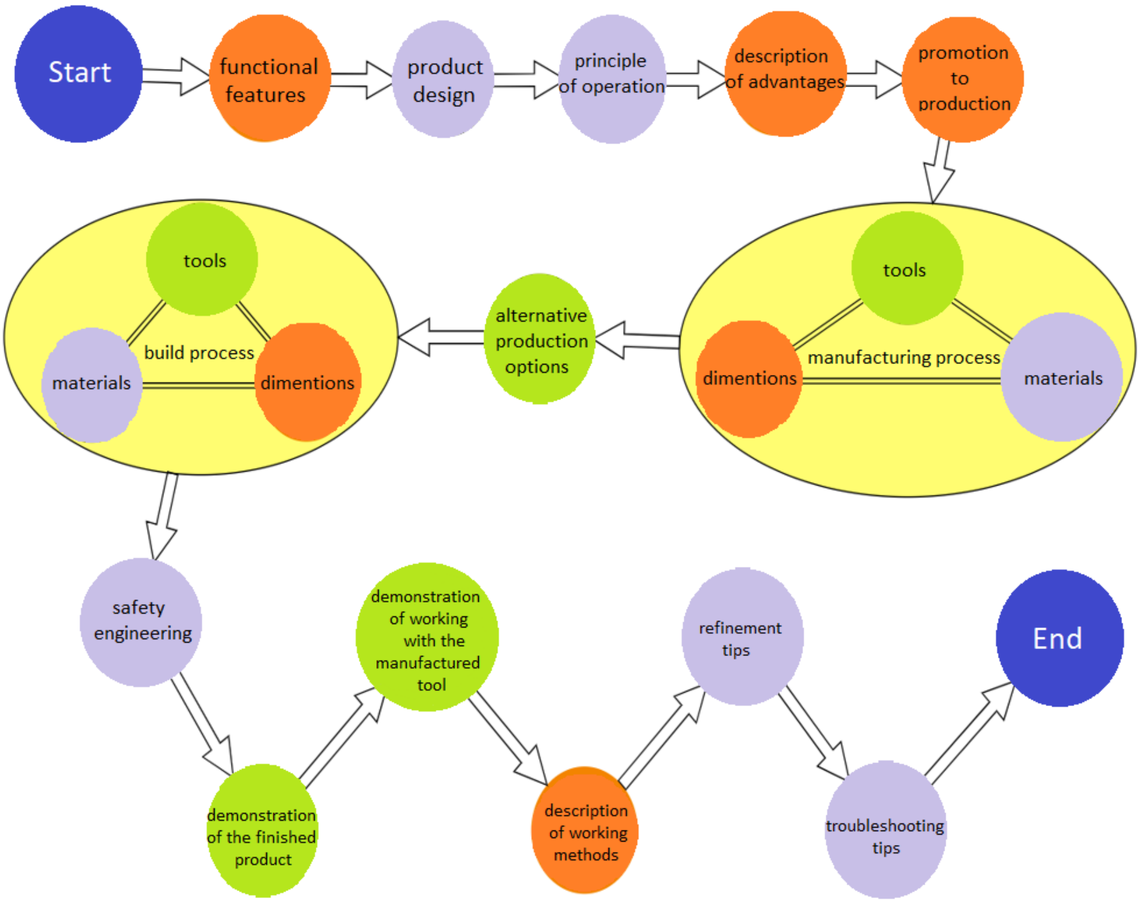

Figure 7. Diagram of the flow of information in video (manufacture of an electrolyzer)

An electrolyzer is a special device that is designed to separate the components of a compound or solution using an electric current. The author of the video is Alexey Burkan from the YouTube channel of the same name in his videos about the manufacture of an electrolyzer. Along with E.V. Kubasov in his article “Plasma torch” in the magazine “Do it yourself” 2/2007, he suggests using the electrolyzer as a generator of oxygen-hydrogen fuel for the burner. In figures 7 and 8 there are diagrams showing the sequence of supplying information for both sources.

As one can see from the diagrams, the information in the sources is presented more structurally than in the previous example. The authors have broken the presentation of information into separate parts in order to simplify the experience of the reader. The video is divided into three parts, in the first part, the builder tells how to make the electrolyzer itself, the second video concerns the manufacture of a hydrogen burner and the rest of the systems of this tool, the third video is devoted to advice on manufacturing and correcting errors. The article in the journal is no less voluminous and is subdivided into paragraphs, such as: a few preliminary words, the principle of operation of the device, the purpose of the device, the composition of the device, the electrolyzer, the dryer and the water seal, the burner, the power supply, the layout of the structure, some of the results of experiments with the burner, about safety measures during the operation of the burner, a few final words.

Figure 8. Diagram of the flow of information in text (manufacture of an electrolyzer)

As one can see from the diagrams (fig. 8, 9), the information in the sources is presented more structurally than in the previous example. The authors have broken the presentation of information into separate parts in order to simplify the perception of the reader. The video is divided into three parts, in the first part, the home-builder tells how to make the electrolyzer itself, the second video concerns the manufacture of a hydrogen burner and the rest of the systems of this tool, the third video is devoted to advice on manufacturing and correcting errors. The article in the journal is no less voluminous and is subdivided into paragraphs, such as: a few preliminary words, the principle of operation of the device, the purpose of the device, the composition of the device, the electrolyzer, the dryer and the water seal, the burner, the power supply, the layout of the structure, some of the results of experiments with the burner, about safety measures during the operation of the burner, a few final words.

At the very beginning of the video, the author, using illustrations, talks about the functional features of his self-made product, shows and tells how the device (product design) works, verbally and visually explains the principle of operation, and also lists the advantages of his invention. Thus, he wants to induce the viewer to make such an instrument, which he repeatedly talks about in the video. The author of the article acted in a similar way, describing at the beginning the principle of operation, functional features, advantages and disadvantages. We observe the design of the product together with the finished product in the article on the drawing and photographs of the already assembled device.

The process of making an electrolyzer in the video can be represented by the first cycle, located in Figure 7. It includes blocks: the sizes voiced by Alexey, demonstrations of the work with tools in the manufacture of each part, this is how we understand what we need to repeat, as well as enumeration and visual demonstration of materials. In the article, the main information load falls on the drawings, from which we learn about the necessary materials, and also see the dimensions. Information from the drawing is partially duplicated in the text of the article. The structural block responsible for the manufacturing process, including drawings, we see in the yellow oval in Figure 8.

The second part of the video begins with alternative options, after which the block of the manufacturing process is repeated, but for the burner parts. During the manufacturing process, the author warns of a possible danger, showing a video sequence, with an explosion of a fuel cylinder, as a result of the absence of a flame arrester valve. He tells how to avoid this by using additional structural elements (water seal and fire arrestor valve). The author of the article talks about the same dangers, but at the end of the article. Following further on the diagram for the article from the magazine in Figure 8, you can see the description of the tool, which is the power supply unit of the manufactured device. The author offers several options for manufacturing the device. Further, he gives advice on improving the product and correcting mistakes, and a description of the process of working with the manufactured burner is also important.

Let's move on to the video again, after finishing the assembly of the device, the DIYer demonstrates the finished product and methods of working with it. The following is a description of the methods of working with the tool. The third video from this series on the manufacture of an electrolyzer is devoted to correcting mistakes made in the design of this device so that the viewer does not allow them, and the home-builder also gives advice on revision.

Thus, we see that the considered video and magazine text practically do not differ in content. However, the difference in the presentation of information is significant. While in the video the DIYer talks about the essence of the ongoing processes, tries to explain complex things so that the viewers, understanding the principle, can think out, improve or adapt the design for themselves, the author of the article from the magazine focuses on drawings, product standardization and accurate numbers, even regarding the concentration of the chemical solution required for electrolysis.

Another example would be a pairing where the video is the more informative source. Two needle file collets were considered. Below are block diagrams (fig. 9, 10) by which you can see the difference in the presentation of information. As you can see, there is much more phase in the video. The circuits turned out to be simpler and the sequence is shorter.

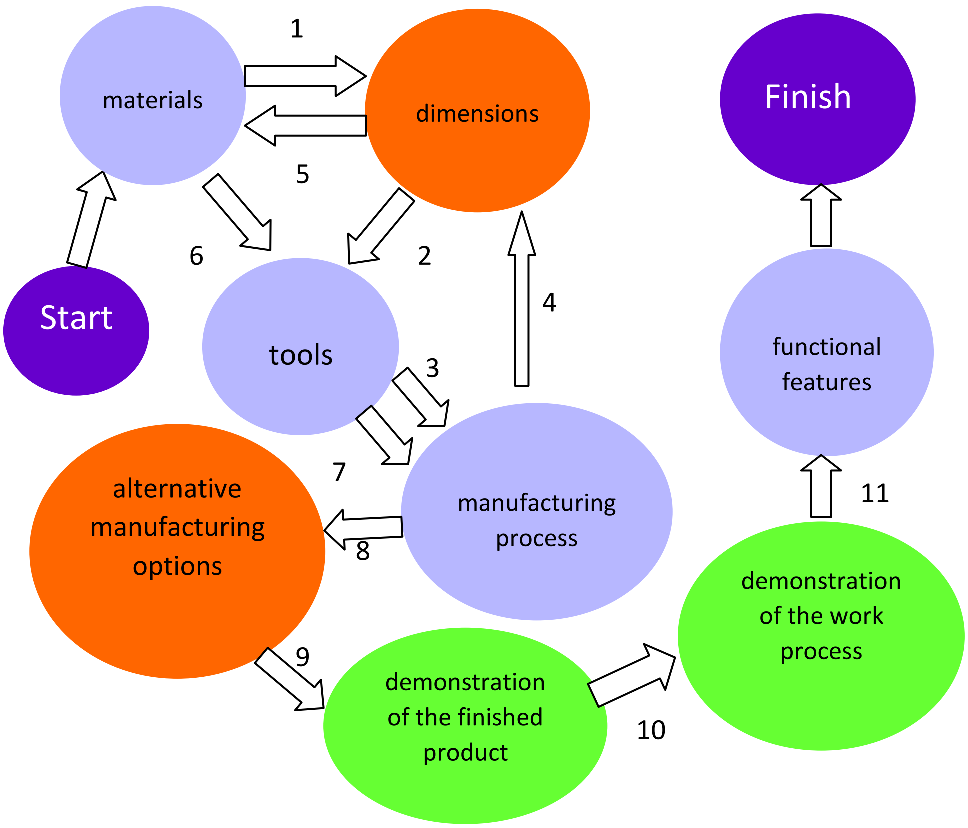

Figure 9. Block diagram of information presentation in video (needle file collets)

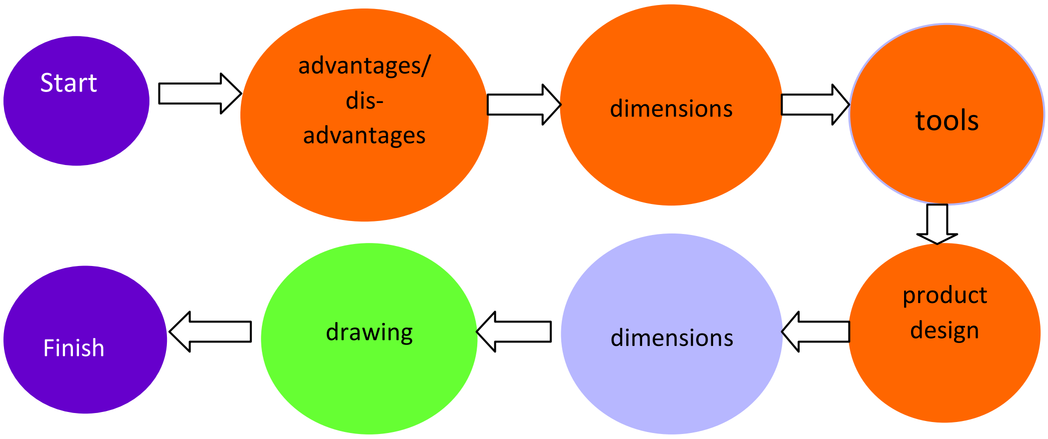

Figure 10. Block diagram of the presentation of information in the article (needle file collets)

First of all, the dimensions in these sources are presented twice. In the video, all sizes are presented verbally. First, the dimensions for one part are presented, then the dimensions for the manufacture of another. And in the article, the dimensions are first presented verbally, and then non-verbally in the drawing. As for the tools, in the video, the tools are not only announced by the DIYer, but also shown in the video series. In the article, the specified tool is part of a self-made product, while the tool necessary for manufacturing is not indicated, and the manufacturing process is also not indicated, which is described in detail in the video. At the same time, the video does not describe the design, the author only makes parts and assembles them together. The video demonstrates the finished product, as well as the process of working with it, which is also in the article. Importantly, the DIYer talks about alternative manufacturing options that require more sophisticated equipment. In the video, in contrast to the article, materials are indicated, moreover, for various structural units. The video demonstrates the functional features, the author tells how you can use this self-made product, and in the article the author talks about the advantages of his product, talking about the convenience of working with it.

Comparing the presentation of information from these sources, we can conclude that the journals provide a very detailed textual description, where the readers themselves have to analyze and present all the actions performed. In the video, due to the large amount of visual information, the viewers learn how to make things work but do not grasp it intellectually for lack of explanations. This prevents the viewers from realizing the essence of the actions, it will be more difficult for them to adapt to other conditions. Viewing the video is much easier, the viewer has the opportunity to repeat all the actions of the author step by step. However, in order to make changes to the design, to come up with one‘s own self-made products and refine them, one needs to study and analyze several sources of information.

Among the articles and videos, there are options varying in quantity and quality of information. We believe that magazines can be very useful for DIYers even now, perhaps they are undeservedly forgotten. However, it is difficult to deny the fact that videos on developing YouTube channels can already surpass even the most detailed articles in their usefulness. It has always been easier for people to visualize complex processes so as not to imagine them in their heads, modern videos with DIY themes, selected competently, are able to give a person who wants to do something with their own hands, not only a guide, a drawing or the procedure for carrying out technological operations, but also understanding of the ongoing processes, as well as the ability to improve the device based on the author's mistakes.

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Research article

Explicit and Implicit Components of Social and Technical Instruction

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Abstract

Instructions are increasingly part of our lives and become the subject of research by linguists, philosophers, political scientists, sociologists, and marketing professionals. Instructions not only regulate social aspects of our life, but also allow us to control technical systems and devices. Analysis of the explicit and implicit components of instructions provides knowledge about the types and functions of instructions, their direct and indirect impact on individuals and the human community at large. The paper takes a close look at “job descriptions” and “user manuals,” of instructions as algorithms for actions. It explores the discrepancy between the centrality of instruction for social life and the comparatively recent appearance of the term „instruction“ in our vocabulary. In linguistic terms, the paper refers to the Russian uses of „instruction“ but its conclusions apply more universally.

Keywords: Instruction; Text type; Functional style; Implicitness; Explicitness

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Научная статья

Явные и неявные компоненты социальной и технической инструктции

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Аннотация
Инструкции все чаще входят в нашу жизнь и становятся предметом исследований лингвистов, философов, политологов, социологов и маркетологов. Инструкции не только регулируют социальные аспекты нашей жизни, но и позволяют нам контролировать технические системы и средства. Анализ инструкций с точки зрения явных и неявных компонентов расширяет наши знания о типах и функциях инструкций, их прямом и косвенном воздействии на человеческое сообщество и каждого отдельного человека в отдельности. В статье подробно рассматриваются “должностные инструкции” и “руководства пользователя”, инструкции как алгоритм действий. Исследуется несоответствие между центральной ролью обучения в общественной жизни и сравнительно недавним появлением термина “инструкция” в нашем лексиконе. С лингвистической точки зрения статья относится к использованию слова “инструкция” в русском языке, но имеющиеся выводы универсальны.

Ключевые слова: Инструкция; Тип текста; Функциональный стиль; Имплицитность; Эксплицитность

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INTRODUCTION

In Russian, the word “instruction”, as noted in Fasmer's (1950) Dictionary, appeared under Peter I, denoting instruction, guidance, directive, prescription, instruction, installation. Now “instruction” is included as a term in many industry dictionaries: the legal dictionary (Dodonov, 2001); Terminological Dictionary for Construction in 12 Languages (Russian, Bulgarian, Hungarian, Spanish, Mongolian, German, Polish, Romanian, Serbo-Croatian, Czech, English, French) (Eingorn, et al., 2016); Terminological Dictionary for Concrete and Reinforced Concrete (Mihajlov et al., 2007), Brief Dictionary of Used Terms in Informatics and Modern Computer Technologies (Kratkij slovar' upotreblyaemyh terminov, 2020). But, regardless of the industry, an instruction means an algorithm for an action.

The lexeme “instruction” contains many more frames than can be seen in dictionaries. This is due to the fact that the phenomenon itself, which received the name “instruction”, existed long before its first official vestment in a lexical unit. It would be correct to say that instructions as a phenomenon have existed for as long as humanity has existed. The instructions were originally implicit. They were present in gesture and oral speech as one of the main ways of transferring experience. It can be assumed that the instructions in implicit form appeared with the advent of human speech. Human speech was formed in the process of evolution rather slowly and went through various stages in its development. Most likely, the first forms of instructions began to build during the formation of sign speech. Communication via sound speech contributed to the development of the transfer of experience in various types of oral texts. Many of them had a hidden subtext of the algorithm of behavior or action, which is the main characteristic of the instruction. Texts with an implicitly instructive character which appeared even before the term “instruction”, include:

- proverbs ("Don't put all your eggs in one basket.");
- folk signs (cut your hair when the moon is waxing and you will have good luck / if you marry in Lent, you will live to repent /if a girl catches the bride’s bouquet after a wedding, she will be next to marry);
- cooking recipes: 2nd to 3rd millennium BC (Bottéro, 2004)
- medical recipes of Ancient Egypt (Pommerening, 2006).

An example of one of the oldest instructions is the ancient Egyptian erotic papyrus of Turin (Shokeir & Hussein, 2004). The experience described in fables (Gesiod, 1999), or fairy tales such as Little Red Riding Hood created a model of behavior, recommendations on how to act in a given situation. Any manual also contained instructions on how to independently acquire new knowledge, to complete tasks, and to use the rules in practice.

Since the 18th century in Russia, such a phenomenon as an instruction has taken on a form enshrined in linguistic signs. From this point on, we can talk about the explicitness of the instructions. If initially these were job descriptions (Instrukciya polkovnich'ya, 1826), then with the development of technology appeared instructions for the operation of technical devices.

The development of tools and technological progress have significantly changed the way of preserving and distributing instructions. If earlier they were saved on clay tablets, then on paper, now the instructions are recorded on audio, video tapes, and electronic media.

In the course of history, instructions were transformed, their content and way of expression expanded. But, despite this, in terms of Solomonik's (2010) classification of sign systems, the means of expressing instructions have not changed since the appearance of writing. Instructions can be expressed by six types of sign systems that were distinguished by Solomonik: a system of natural signs, a figurative system, a language system, a recording system, formalized systems with constant signs, formalized systems with variable signs (Solomonik, 2010).

The instruction can be represented by a system of natural signs expressed by signs of natural passage, for example when a person is guided by the terrain. If you get lost in the forest, then using natural signs as instructions (ants build anthills south of the trees, moss grows on the north side, etc.), as well as the ability to interpret these signs, you can find your way in the right direction. Instructions can also be represented by figurative systems, the basic sign of which is icons. The images on the Turin erotic papyrus are iconic instructions. Most often, instructions are recorded using a language system (expressed in words) or a recording system (expressed in hieroglyphs). The multiplication table can be attributed to an instruction consisting of a formalized system with constant signs. And, for example, the formula of the combination law for ordinary fractions

$$\left(\frac{p}{q}+\frac{r}{s}\right)+\frac{m}{n}=\frac{p}{q}+\left(\frac{r}{s}+\frac{m}{n}\right)$$

is an algorithm for their addition. In contrast to the multiplication table, the instruction for working with fractions is presented using a formalized system with variable signs, the base signs of which are variable symbols.

Thus, though modern instructions refer to different genres, they are expressed by the known types of sign systems and implemented both explicitly and implicitly in discourses and texts.

BACKGROUND

A broad understanding of the term "instruction" finds its confirmation in the works of linguists who study this type of text. According to Igor Borisovich Lobanov (2003), most of the texts that surround us are instructions or are instructive in nature. In some works, instructions are called the supra-genre text (Horohordina, 2013, p. 11).

In the modern sense, instructions go far beyond the official style. These instructions include laws, guidelines, regulations, recommendations, rules, directives, arrangements, enactments, decrees, orders, requests, advice, recipes, plans of action, schemes of actions, order of actions, homilies, testamentary burdens, exhortations, edifications, commandments, covenants, fables, parables (Horohordina, 2013, p. 8); job descriptions, public instructional texts (checklists; instructions governing the rules of public conduct, behavioral rules in emergency situations); instructions for consumers (instructions for medicines, food products, instructions for using industrial goods, manuals for the operation of technical equipment) (Rekhtin, 2005, p. 4). Lobanov (2003) introduces the concept of instructional, combining user, departmental, and job descriptions, recipes, tips, training and practical manuals describing how to perform certain operations (p. 3). And the “instruction” and the “guidance” are recognized as synonymous terms (Trebovaniya tekhnicheskogo reglamenta, n.d.).

RESEARCH RESULT

The Concept of Instruction

The author of *Principles of Constructing an Instructional Text in Russian* (Lobanov, 2003, p. 3) uses the general term „instructional text“ to refer to the texts of this type and to the actual instructions – definitions of departmental dutiesas well as job descriptions. Departmental instructions and job descriptions often contain the word “instruction” in their names. The relation of such documents to the type of text “instruction (i.e. description)” is expressed explicitly. Many texts that regulate a certain order of action do not contain lexical units that allow them to be explicitly referred to as “instruction.” Proverbs, for example, provide instructions only implicitly (“An apple a day keeps the doctor away”). Their belonging to instructional texts is determined not so much by the plan of expression (the presence of lexical units inherent in the texts of instructions) as by the plan of the content (the text is organized in such a way that it performs the functions of an instructing text without a direct reference to the "instruction" text type). Such instructions are implicit. Thus, all instructions can be divided into explicit and implicit.

Moreover, it is necessary to distinguish between the concepts of departmental instructions and job descriptions, noting that, according to the Great Legal Dictionary (Dodonov, 2008), a departmental instruction is a subtype of a departmental regulatory legal act. In addition to job descriptions, there are production instructions. The concept of “job description” is typical for determining the content of the performed labor function of an employee filling a certain position. The production instruction has many interpretations, but it can be concluded that this is “a certain algorithm for the actions of an employee with certain equipment.” (Ivanova, 2021)

Thus, it is possible to distinguish job descriptions and production instructions for the employee to fulfill his or her employment duties. The term “employment duties” is fixed in the Labor Code of the Russian Federation (The State Duma, 2022). In this case, the concept of “employment duties” is a relative concept. The rights of some workers may be the employment duties of other workers. For example, the right of an employee to timely payment of wages becomes the employment duty of accounting employees. Thus, the prescribed labor rights of some employees in the legislation become the job descriptions of other employees. The occupational standard–as “a characteristic of the competence levels required by an employee to carry out a certain type of professional activity” (Professional Standards, n.d.) – is an implicit instruction for the personnel department or recruitment agencies.

In the work of Moshchanskaya and Kinderknekht (2013), the term “user manual” has appeared (p. 135). Based on the provisions of the Law of the Russian Federation dated February 7, 1992, No. 2300-I On Protection of Consumer Rights, a consumer is “a citizen who intends to order or to purchase, or who orders, purchases, or uses goods (works, services) exclusively for personal, family, household, and other needs not related to the implementation of entrepreneurial activity.” (Government of the Russian Federation, 1992). Based on this definition, the purchase of a product by a consumer does not always mean its use. And the instructions are primarily intended for those who directly use goods (works, services). So, the Civil Code of the Russian Federation contains the concepts of “instructions for use” (Art. 628), “operational manual” (cl. 2, Art. 691) (The State Duma, 2012). It should also be noted that there are no such concepts as “consumer instruction,” “instruction on consumption” in the Civil Code of the Russian Federation. Therefore, in Russian, when choosing between “consumer instruction” and “user instructions,” it is more expedient to adhere to the terms “instructions for use” or “operational manual.”

A literature review shows that instructions as a type of text are present in many styles. First of all, instructions are associated with an official style (Yashina & Nikiforova, 2018, p. 98). Based on the classification of styles by Elena Eduardovna Gribanskaia (2017), we can say that instructions as a type of text are present in colloquial, scientific, official, journalistic, and artistic styles (pp. 123-127).

Initially, instructions have appeared in a colloquial style as a means of transferring experience, upbringing, or teaching in the form of orders, requests, advice, a plan of action, homilies, testamentary burdens, exhortations, edifications, commandments, covenants, fables, parables, fairy tales. They can be both implicit and explicit. In the artistic style, instructions are present, for example, in fables, fairy tales, stories, short novels and they are always implicit. Scientific-style instructions can describe the order of experiments, research tasks and be expressed both implicitly and explicitly. The largest number of explicit instructions contains an official style: instructions for goods, departmental instructions and job descriptions, public instructional texts (checklists; instructions governing the rules of public conduct, behavioral rules in emergency situations); guidelines, regulations, instructions, rules, directives, arrangements, enactments, decrees, orders, consumer instructions. A journalistic style contains exclusively implicit instructions: reports, interviews, conversations, articles, reviews, feuilletons.

Table 1 shows the correspondence of instructions to styles:

Table 1. Correlation of the "instruction" text type with functional styles.

Functional styles	Type of instructions	
	explicit	implicit
colloquial	+	+
scientific	+	+
official	+	+
artistic		+
journalistic		+

The Table shows that instructional text appears in each of the functional styles. Explicit and implicit instructions are contained in colloquial, scientific, and official styles. Highly implicit instructions are contained in artistic and journalistic styles.

Before the development of computers and computer systems, the user of instructions was exclusively human. But according to Alexander Petrikovskij, a program that works, on the basis of a task algorithm, created by a person, that is, according to his/her instructions, might be called subject-oriented (Petrikovskij, 2006). Usually, the activity of technical instruction is aimed at the object and the object changes under the influence of the subject. Here it would appear that the program that affects the object and changes the ego becomes the subject.

Instructions can be defined as explicitly and implicitly regulatory texts for users, workers performing their employment duties, individuals and programs. In other words, instructions are texts that implicitly and explicitly regulate the activities of subjects. The terms of "individual" in this paper is chosen based on its definition in the Psychological Dictionary, which is understood as a separate representative of the human community, a social being that goes beyond its biological limitations, using tools (Karpenko et al,, 1998).

Functions of instructions

Instructions are one of the means of knowing the world. They record the experience of previous generations, allowing descendants to move forward in the study of the surrounding reality, to avoid mistakes that are harmful to life and health.

Instructions can be tied to a specific object of reality, but often they set out an algorithm of action for a group of similar objects or phenomena. Thus, instructions systematize an experience, classify knowledge. The restrictive function of instructions, on the one hand, warns people against mistakes; on the other hand, it is often the deviation from the instruction that becomes the engine of progress, it is due to the deviation from the instructions that discoveries are made. Their restrictive function prescribes certain behavior for us. Largely due to instructions, society functions smoothly. The presence of action algorithms optimizes our life, creates calmness and confidence.

This calls for the reflection of a problematic tendency. Gradually, the habit of searching for an algorithm is developed before embarking on a particular type of activity. The algorithms acquaints us with the accumulated both theoretical and practical experience, allowing us to synthesize new knowledge on its basis. But often the habit of acting, according to a template, its unconscious automated use leads to a decrease in the criticality of thinking, a lack of the skill to act independently and to make decisions, to develop instructions independently. A person in a finished form accepts a model of the world, established values. Society begins to divide into the creators of algorithms and their users, that is, a significant part of society begins to see the world through the prism of a certain circle of people. Instructions are a fairly simple and effective way to manipulate people's minds. Therefore, an important role is played by the moral and ethical appearance of the compilers of the instructions, their political views, life principles and beliefs. Instructions can be drawn up both for the benefit of people, protecting their rights and freedoms, and, for example, by totalitarian regimes, becoming a significant obstacle to the full life of each member of society, its personal growth, the preservation of its rights and freedoms, they can be a serious obstacle to the development of the individual.

Before the development of information technology, instructions were created by a person for a person. In the modern world, the instruction has become an integral part of computer programs and their sequential execution ensures the functioning of the entire technical system. Here, instructions are created by humans for their implementation by machines. If earlier instructions were read by people and the result depended on the accuracy of their execution by each individual, then the reading of instructions by machines ensures their absolutely accurate and identical execution by different automated systems. The instructions that form the basis of the program increase productivity and quality of work in those industries where accuracy of adherence to instructions is required. These areas include, for example, pharmacology, the production of technical devices. But humanity is not limited to the creation of automated systems that facilitate hard physical labor. Robots are starting to appear in areas that are related to creative ones. Currently, generators of ideas, poems, plots for books are popular.[1] They carry out a specific program based on human-generated instructions. A person can create several types of instructions for several computer systems. The result of creativity of each of the computer systems will be limited by the instructions contained in its program. Can such programs compete with the creative flight of thought of a gifted person? Most likely, it's hardly. They mimic the creative process by helping non-creative individuals get things done that involve solving creative problems. Often such programs are used by lecturers to create a large number of assignments and exercises.

[1] https://novoseloff.tv/generator/
https://www.poem-generator.org.uk/
https://www.poem-generator.org.uk/didactic-cinquain/
https://randomall.ru/appearance
https://randomall.ru/country_description

Also, ideas suggested by a computer can lead a person to interesting ideas. In this case, the programs do not pose any danger to a person, but only facilitate and optimize his/her work. Currently, various training programs have begun to be actively used, which train individual skills well, in the field of education. Furthermore, robots are being developed to appear in kindergartens, schools, and universities, replacing lecturers (Polishuk & Verner, 2018, Serholt et al., 2017; Velentza et al., 2021). Teaching a certain subject, communicating with students, explaining new material, and exercising control over what has been learned, such robotic lecturers will likely follow certain instructions, which might lead to a template in teaching, namely, to standardization of knowledge. Were we to actually use robotic lecturers in all educational institutions, the quality of education might, on the one hand, be the same in all schools, but, on the other hand, students would only acquire a certain set of knowledge. There might then arise the danger of knowledge that is transmitted through the prism of a certain group of people who have drawn up instructions for the educational process software.

Traditionally, instructions were drawn up in order to indicate an algorithm of actions for using an inanimate object or an algorithm of actions aimed at achieving a certain result or goal (a job description, instructions for breeding chickens). Now the question arose about the advisability of drawing up instructions for oneself. Drawing up such instructions allows persons to know themselves better, to understand themselves. As the authors of countless unscientific self-help sources will insist, such instructions to oneself will also help to avoid conflicts and improve communication with others.[2] These ideas further testify to an expanding culture of instruction in which we seek to control ourselves and others.

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[2] for example, *Instructions for Using Yourself* https://zen.yandex.ru/media/prazdnik_k_nam_prihodit/instrukciia-po-primeneniiu-sebia-chast-1-5e46ab3e7358840beff9648a and *Personal instructions for you: Human mechanics* http://reiki-newlife.com/blog/personalnaya-instrukciya-k-sebe-mexanika-cheloveka/

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Research article

Program and Code

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Abstract

The nature of computer programs can be characterized from two different viewpoints: as executable artifacts that create signals on a computing device or as pure mathematical objects with a rigorous, unambiguous semantics. To distinguish both usages I use the word “code” for the first and “program” for the second. This distinction is relevant to avoid confusion when discussing notions such as validity or correctness of software. The point is illustrated by refuting a well-known claim on the impossibility of verification and misleading claims about commercial products. At the same time the distinction “program versus code” is insufficient: I show that a “program” is always accompanied by an implicit or explicit application context which is necessary to scope its semantics. Ultimately, the analysis performed in this paper helps to distinguish relative from mathematical truths when discussing qualities of software.

Keywords: Program; Code; Formal Verification; Semantics; Relativism

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Научная статья

Программа и код

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Аннотация
Природа компьютерных программ может быть охарактеризована с двух разных точек зрения: как исполняемые артефакты, создающие сигналы на вычислительном устройстве, или как чисто математические объекты со строгой, однозначной семантикой. Чтобы различать оба употребления, я использую слово “код” для первого и “программа” для второго. Это различие уместно, чтобы избежать путаницы при обсуждении таких понятий, как достоверность или правильность программного обеспечения. Данный момент иллюстрируется опровержением известного утверждения о невозможности верификации и вводящих в заблуждение утверждений о коммерческих продуктах. В то же время разграничения “программа против кода ” недостаточно: я показываю, что “программа” всегда сопровождается неявным или явным контекстом приложения, который необходим для охвата ее семантики. В конечном счете, анализ, проведенный в этой статье, помогает отличить относительные от математических истин при обсуждении качеств программного обеспечения.

Ключевые слова: Программа; Код; Формальная верификация; Семантика; Релятивизм

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THE TWOFOLD NATURE OF COMPUTER PROGRAMS

Our starting point is an observation about the twofold nature of computer programs: On one hand, programs are designed to be executed on a machine, a “computer”.[1] When connected to suitable hardware – microphones, displays, sensors, and actuators – programs become active, possibly even autonomous agents that are able to influence our reality, including human behavior.[2] On the other hand, programs are formal mathematical objects with a rigorous, unambiguous[3] semantics (Mitchell, 1996). But in contrast to other mathematical structures, for example, equations, functions, algebras, topologies, measures, a program’s *executability* posits it directly in the physical world. To be sure, mathematical models also have physical impact, but, unlike programs, they need a dedicated mediator, for example, the bridge or the car that *is being* modeled, or in fact, a computer program that *is based* on a mathematical theory.

Before we continue, let us address an objection against singling out programs in this manner: one can argue that, similar to mathematical models of physical objects, instructions of a program need to be manifest in a physical medium to render them actually executable. In the old days, such media were punched cards or tape, nowadays electrons, soon quantum states. But this difference is inessential for two reasons: first, and most importantly, one can view either punched tape or electrons in a memory cell as a mere physical representation of a program, just as one can view a piece of text such as “$f(x) = x^2$” *as a* representation of a mathematical function. Second, in modern computing the execution tool chain of a program via compilation, loading, and initialization is a fully automatic, transparent process. This is not the case for mathematical models of physical objects – I come back to this observation later.

To sum up, one and the same representation, for example, a piece of program text, can be seen *either* as a mathematical object *or* as the execution of instructions on a machine. It is useful to distinguish these two views terminologically. Henceforth, I use the term *program* when I refer to a mathematical object and I use the expression *code*[4] when I refer to the entity that is actually being executed on a machine. Based on this terminology, in the present article I intend to substantiate two claims and discuss their consequences:

(A) The distinction between program and code in the above sense is crucial when we talk about the intended meaning of programs and ensuing notions, such as *correctness*, *validity*, etc.

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[1] With the understanding that computers can have many physical shapes: laptops, desktops, supercomputers, smart phones, and, most common these days, embedded into another device, such as a car, camera, household appliance, router, etc.

[2] Considerably so, as any parent of a teenager owning a smart phone knows.

[3] This does not at all preclude non-deterministic or probabilistic programs, whose meaning can be rigorously described as well.

[4] This convention is consistent with other usages: a compiler encodes a program into instructions to be executed by a microprocessor, which in turn decodes each instruction before it effectuates the action associated with it.

(B) The distinction between program and code is *insufficient*, because it does not make sense to talk about a program in isolation. It is necessary to accompany programs with a *semantic model* that takes the *application context* into account.

MATHEMATICAL PROOFS OF PROGRAM CORRECTNESS

We need a concrete setting to meaningfully discuss the above claims, without getting lost in generalities.

The mathematical nature of programs opens up an intriguing perspective, setting the theory of programs apart from other scientific theories. This is, because a mathematical conjecture can be *proven* by a chain of formal, unambiguous, gapless arguments, which are broken down into instances of elementary steps whose truth is universally accepted and that can be verified by anyone with sufficient training, time, and interest. For example: if an expression e_1 is equal to an expression e_2 and expression e_2 in turn is equal to expression e_3, then also expression e_1 must be equal to expression e_3, and so on. A proven conjecture becomes a *theorem* and can in turn be used in other proofs. So far, so well-known.

Now, since programs are mathematical objects, it is possible to *prove* properties of programs in a rigorous, mathematical manner. This was recognized as early as 1949 by Alan Turing (Morris & Jones, 1984). Let us look at a very concrete example. The following text declares a simple procedure named m in the programming language Java:

```
int m( int i ) {
System. out. println ( i );
return i  +  1;
}
```

This procedure (called a "method" in Java terminology) takes an integer argument i and returns the next largest number (we ignore the print statement for the moment). What might be its formal semantics? A plethora of programming language semantics have been suggested over the years, but perhaps the most straightforward approach is to associate each program with a mathematical relation between its input and output values. One advantage is that merely elementary mathematics is needed to present the essentials of *relational semantics*:

Let in denote the value of i when m is called, and let out be the value that m returns. Then the semantics of m is denoted with the symbol [[m]] and simply given as the set of all pairs of integer numbers (in, out), where in is any integer, in other words, it is a relation over **int** × **int**. Specifically, the semantics of m is the set [[m]] = {. . . , (−1, 0), (0, 1), (1, 2), . . .} of (in, out) pairs.

The obvious, and seemingly trivial, correctness claim one might be tempted to prove about m is that out = *in*+1 always holds, that is, all pairs in [[m]] are of the form (*in, in* + 1). The "..." in the above expression suggests this to be the case, but in fact it is misleading, because clearly the claim is wrong! Integers in programming languages are not the mathematical integers (commonly denoted with the symbol $\mathbb{Z}$). To accommodate the finite memory of a computer, only a finite subrange of $\mathbb{Z}$ is represented. In the case of Java integers, four bytes or 32 bits are allocated to store one integer number and the encoding is such that numbers in the interval **int**$=[-2^{31}, \ldots, 2^{31}-1]$ can be represented. So what happens if in $= 2^{31} - 1$? According to Java’s semantics[5] the result is *out* $= -2^{31}$: the part of the result that “overflows” (is greater than $2^{31}-1$) becomes “wrapped around” and is added to $-2^{31}-1$. Already our tiny example illustrates that it might not be obvious to decide what constitutes a correct program.

Since the late 1960s the demonstration of properties of programs with mathematical rigor has been established as a field of research within Computer Science called *formal verification*. Nowadays, proofs about programs are not carried out by hand, but with the help of other, specialized programs called verification tools (Hähnle & Huisman, 2019).[6] Formal verification is a good scenario to discuss claims (A) and (B), because it relies on the mathematical nature of programs and their formal semantics.

PROGRAM VERSUS CODE:THE CASE OF FORMAL VERIFICATION

We illustrate claim (A) with two papers (DeMillo et al., 1977; Fetzer, 1988) that famously announced the futility of formal verification. They stirred a lot of discussion at the time and provoked angry responses (Dijkstra, 1977) from computer scientists working in formal verification. One of the mistakes (there are several) made in these papers, and this is why we discuss them, is the conflation of the concepts “program” and “code”. We focus on Fetzer (1988), where the argument is more explicit.[7]

In the terminology established in the introductory section, paper (Fetzer, 1988) argues that formal verification of *code* is impossible. The central argument is that correct execution of code depends on boundless contingent aspects and assumptions that are impossible to even begin to formalize: the correct functioning of the microprocessor the code is running on, the integrity of memory, the periphery, the connections, etc. Ultimately, one needs to take physics of transistors and other elements into account, down to quantum effects, radiation, and so on. And yes, not only is it infeasible to formalize all of this context, but code as the physical manifestation of a program really is– and literally so–contingent: it cannot be separated from the environment it is executing in.

[5] Not only Java’s: it is the standard approach to integer semantics in most programming languages.
[6] Thus programs become tools to analyze programs. This reflexive stance is typical for Computer Science research (and Literary Studies).
[7] DeMillo et al. (1977) is mostly about validation of mathematical arguments, which they claim to be a purely social process. This is also highly disputable and can be disproven (Hales et al., 2015), but it is not the focus of the present paper.

Fetzer's fallacy is this: because it is impossible to formally verify *code*, he infers that it is impossible to verify programs. In fact, he conflates code with programs. But based on our understanding that programs are precisely specified mathematical objects, it is plainly wrong to claim that programs cannot be verified. Yet it still might be true that program verification is a futile effort, if the gap between program and code turns out to be too substantial. In this case, it would not be useful if a program were verified, because the code derived from it might still be riddled with errors.

I argue that this is not the case for several reasons: (i) The tool chain rendering programs as code is robust–very few, if any, errors are introduced during that process; (ii) error correction and error recovery mechanisms are implemented at any critical juncture: memory, communication, etc.; (iii) scientists working in formal verification are well aware of the gap and tailor their met odology accordingly (Livshits et al., 2015); (iv) different aspects of programs can be isolated and modeled according to the requirements of an application context.

The last two points are closely related and highly relevant for a more detailed understanding of the concept of a *program*. I am now going to discuss them in greater detail. As we will see, this leads to an extension of the concept of what constitutes a program, as stipulated in claim (B).

THE APPLICATION CONTEXT

We come back to the example discussed earlier, where we observed that (at least) two *semantic models* of procedure m are possible:

1. For all integer values *in*, the result of executing m is $out = in + 1$.
2. For all values *in* $[-2^{31}, \ldots, 2^{31} - 2]$ of *in*, the result of executing m is $out = in + 1$ and for $in = 2^{31} - 1$ it is $out = -2^{31}$.

It is tempting to root for the second model: After all, it is fully precise. Moreover, as we saw, the first model is plainly wrong for input values outside the interval $[-2^{31}, \ldots, 2^{31} - 2]$. But is the second model sufficiently precise?

What is the semantics of the so far ignored print statement? It looks harmless enough, because it does not affect the final value of i. Yet, clearly it has an effect when executing the program, consisting in sending the value of i as a text string to the default system output. Can this be safely ignored, provided that we are only interested in the final value of i? What happens, for example, if no printing device is attached? As it happens, the print statement in Java is always executable: whether printing actually worked can be queried afterwards from status variables. But if we are after precise specifications, should we not be able to specify the print statement anyway? How to do so, without knowing which kind of printing device is attached (if any). The printer hardware is carefully hidden inside many nested layers of Java's *application programming interface*. Clearly, it is going to be complicated business to specify the print statement precisely. And not only that: without knowing the application context of our program, it seems impossible.[8]

But suppose we agree we should not worry about print statements–are we happy with semantic model (2.) above? Try the following exercise: specify precisely the outcome of procedure

int mult(**int** x,y)

which computes the multiplication of numbers x, y for values in **int** with “wraparound” semantics. It is surprisingly difficult. And it is not only difficult to specify, but even harder to formally verify.

For this reason, most verification tools offer the option to work with $\mathbb{Z}$ instead of **int** *even though this is generally incorrect*. The justification is that procedures such as “mult” are *intended* to work for input values, where they behave exactly as multiplication $*$ on $\mathbb{Z}$. Put differently, do we really want the correctness of programs to rely on unintuitive properties like mult(2, 2^{30})= -2^{31}? Possibly not, but it certainly depends on the *application context*.

Without such a context, which in the case of procedure m might specify the integer model as well as those aspects of printing (if any) that are relevant, we are doomed to enter an endless series of contingencies. The application context *scopes* the *semantic model* used in formal verification: it defines its boundaries (for example: ignore the print statement or not) and the level of precision (for example, **int** versus $\mathbb{Z}$). Without an application context a given program segues into code and Fetzer’s criticism applies.

RELATIVISM

Perhaps it is no coincidence that paper (Fetzer , 1988) challenging the possibility of verifying *code* mentioned in Section 3 appeared at the zenith of Postmodernism, contemporary with proposals that cast doubt on the possibility of objective scientific truth (for example, Rorty, 1989). Indeed, contingency is inherent to the concept of code and the “application context” coming to the rescue of programs smacks of relativism. It is important to be precise about what is contingent and what is relative.

First of all, much was made in postmodern philosophy about the impossibility to disentangle object and meta language and the consequent loss of an “Archimedean” point for an objective author or observer. This is not the issue here. Program verification and other formal analyses are based on mathematical logic and set theory. Suitable consistent, formal systems of reasoning that are validated against model theoretic

[8] Another phenomenon that is hard to specify precisely are side effects or, rather, there absence. Assume the program that procedure m is contained in declares a globally visible variable g. Obviously, m does not change the value of g, but the semantics [[m]] given above does not reflect this fact. To accommodate it, [[m]] would need to include g (as well as all any other variable visible from m) and state that its value is unchanged by m.

semantics are known since long. Programs and proofs about their properties are unambiguous, rigid, independently verifiable.

Yet it is important not to overstate or to exaggerate what *formally* verified means: the *context* is crucial, because code in our sense is indeed *contingent*. We saw that code can be "lifted" to a program equipped with a specific semantic model determined by an application context. And that context in itself may be economically, socially, or politically motivated. Therefore, scientific truth in Computer Science is indeed *relative*, but not because of flaws in the mathematical arguments or of the language that proofs are expressed in. Rather, it is the choice of the semantic model that is relative to a given purpose. To the extent that this choice is motivated and explained, mechanical correctness proofs are as valid as (in fact more than) any piece of mathematics.

Pragmatism has a stubborn tendency to prevail: happily or, at least, unthinkingly, we entrust our lives to programs running in pacemakers, ventilators, cars, planes and other appliances whose failure has fatal consequences for their users. Some of this software is formally verified, most of it is not. Empirically, the trust seems justified: There are surprisingly few reports about fatal incidences that can be directly traced to software failures. In many cases, a reported incident at closer look exhibits a misunderstanding of the expected application context among different stakeholders rather than a genuine programming error.[9]

There is an important difference between the engineering discipline Computer Science and the Natural/Social Sciences: programs and the languages they are expressed in are designed. All of their aspects can be (and increasingly are) formalized and mechanically checked. Hence, we can place high trust in a formal proof and in at least those aspects of the code represented by a program scoped by an application context. In contrast, outside the Engineering Sciences there are theories about how biological, physical, or societal systems are constructed, but we do not possess the blueprint of those systems.[10] In consequence, these theories are susceptible to relativist criticism (to differing degrees).

Also between Computer Science and the "physical" Engineering Sciences there is a crucial difference: as outlined in Section 3 the gap between program and code is hardly noticeable in practice. In fact, many times the concepts of "program" and "code" are conflated (which compelled me to write this article). Once the program text is written and the application context has been decided, it takes only a mouse click to compile, deploy, and execute the resulting code. In reality this is a highly complex process that not so long ago involved considerable manual steps,[11] but it is lightning fast and fully automatic by now.

[9] Typical examples are https://www.bbc.com/news/health-43973652
and https://www.heise.de/downloads/18/2/9/4/3/5/6/9/NTSB_Uber.pdf

[10] Admittedly, at least non-quantum physics is widely considered to be indisputable in absence of relativity effects.

[11] I recall punching cards on a typewriter-like contraption and carrying them to the operator room as late

Most importantly, the transition from program to code is invisible, a black box, but at the same time highly robust and reliable. In the world of physical engineering the step from a mathematical model to its physical realization is considerably bigger and much more explicit. CAD/CAM technology drastically shortens the path from model to product, but one still has to deal with the physical aspects of production. The salient point is the existence and usage[12] of universal programming languages in the sense of the Church-Turing thesis that can compute any function that is computable at all, where only memory and speed impose practical limits. But there is no universal physical production material and no universal physical production machine that would permit to do the same.[13]

CONCLUDING REMARKS

I argued that it is beneficial to have two different points of view on software: what is situated in a computing device, interacting with its environment, pushing around electrons, I call code. In everyday conversation and popular texts about software, this is often what is meant. But when we attach qualities to software, such as correctness or validity, it is not meaningful or even possible to do so at the level of code. Instead, we look at a fixed number of aspects determined by the application context, represented in a specific semantic model (for example, idealizing **int** to $\mathbb{Z}$).

The distinction between program and code permits to be precise about where scientific truth can be expected in Computer Science and where one should be wary. For example, some vendors actively exploit the lack of distinction between program and code to advertise (or mislead) by insinuating the code running at a customer’s site is inherently secure while, of course, only partial security aspects of some of the *programs* were analyzed.[14]

I used formal verification of programs as an illustration, however, the distinction “code versus program+application context” is useful in all areas of Computer Science, where software is analyzed with mathematical methods, in particular, in IT security.

Truth in verification proofs and other rigorous mathematical arguments is neither subjective nor socially constructed. Formalization and mechanization in Computer Science constitute a very strong argument that formal proofs are indisputable. On the other hand, *what* is proven, the choice of the semantic model, as we called it, is very much determined by an application context, which in turn is motivated by subjective,

as 1982.

[12] All programming languages in wider usage have this property.

[13] In this light it is unsurprising to observe that functionality that used to be realized in hardware is constantly moved to software, whenever possible at all. Another interesting development in this context is 3D printing, which goes some way towards universal physical production–helped by software, obviously.

[14] A representative slogan: “Security. Built right in.” from https://www.apple.com/macos/security

economical, societal, political factors. Therefore, the appropriate question to ask is not *Verum estne*?, but–as ever– *Cui bono*?

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Research article

Staging Notations

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Abstract

The paper examines the possibility of recording performances by analysing more than 10 types of notations (Lorin, Beauchamps-Feuillet, Tomlinson, Saint-Leon, Stepanov, Zorn, Sutton, Benesh, Ivanov, Varpakhovsky, Schreyer, Nikritin, Eshkol-Wachman and others). The paper foregrounds methods of fixing movements and sounds in space and time and the ways in which iconic and symbolic signs are used. Difficulties and solutions are highlighted, such as the transmission of 3D motion, changes simultaneously in space and time, the recording of the melody of speech or its volume, emotion, accent, speed, and so on. The notations for recording performances are specific languages that have a rich variability and can be written in letters, notes, lines, numbers and specific signs. However, there are no commonly used ways to fix the staged performance. In the face of technological recording tools it may seem that written notations are obsolete. However, technological tools do not only replace notation tools, they sometimes make them more useful. Another dimension of notation is the relation of recording to instructions. Due to the requirements of intellectual work, analysis and synthesis of elements, notation is in demand for digital human and unhuman learning or for creating three-dimensional animation.

Keywords: Notation; Graphic notation; Director's score; Performance; Ballet; Theater; Sign; Movement Analysis

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Научная статья

Запись постановки

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Аннотация
В статье автор рассматривает возможность записи спектаклей. Проанализировано более 10 вариантов обозначений (Лорена, Бошана-Фейе, Томлинсона, Сен-Леона, Степанова, Црона, Саттона, Бенеша, Иванова, Варпаховского, Шрейера, Никритина, Эшколя-Вахмана и др.). В статье рассматриваются способы фиксации движений и звуков в пространстве и времени, а также способы использования иконических и символических знаков. Выделены трудности и решения передачи объемного движения, изменения одновременно в пространстве и времени, указания мелодии речи, уровня громкости, эмоциональности, акцента, скорости речи и так далее. Формы записи спектакля – это специфические языки, которые имеют богатую вариативность и могут быть записаны буквами, нотами, линиями, цифрами и специфическими знаками. Однако общеупотребительных способов записать представление не существует. Также автор рассматривает технологические средства записи. Хотя технологические способы записи, кажется, делают нотацию устаревшей, на самом деле они не только не заменяют запись, но подчас делают ее более востребованной. Еще одним аспектом нотации является отношение фиксации к инструкциям. Благодаря интеллектуальной работе, анализу и синтезу, заключенной в записи, она используется для цифрового человеческого и нечеловеческого обучения или создания трехмерной анимации.

Ключевые слова: Запись; Графическая нотация; Режиссерская партитура; Представление, Балет; Театр; Знак; Анализ движения

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INTRODUCTION

Theater and ballet are synthetic genres whose action is created from many elements. Theater is one of the short-lived arts. Its length and repetition in time is relatively short. Before the advent of video, it was impossible to preserve what was happening on stage. But video can only partially convey a staging. As Leonid Varpahovsky (1978) points out, the director's score of *The Seagull*, composed by Konstantin Stanislavsky in 1898 for rehearsals which at one time were directed by Vladimir Nemirovich-Danchenko, is quite imperfect in its method of recording, but gives us more insight into Stanislavsky than many books written about him.

We are accustomed to look at well-staged theater and ballet productions, but do not muse how to record how the action should take place. The usual form of instruction for actors is verbalization. Obviously, the director explains in words and partly shows how the action should take place. But there are many reasons for the need to record how things should be done, and verbal description is too cumbersome and irrelevant, so various ways of recording were invented, new semiotic systems that made it easier to understand the intention and the way things should be done.

What exactly should be recorded? Broadly speaking, one can divide the action into what the eye sees and what the ear hears – movement and sound. Although words have been used from the beginning to describe both, they are superfluous intermediaries. This is how ways of recording human movement arise. Notation, be it choreographic or even musical, makes it possible to formalize and transcribe in a conventional form (established by a code) the components of a work (Bianchini et al., 2016). In addition, there is the need to represent movement across the stage. It is more problematic to convey any expressive components, such as speed of movement or type of gait. As for music, it has its own notation system, lyrics can be written in words, so it would appear that there are no problems in capturing the sound. It seems to be easy to record the rhythm, because it is just a text, but how to record intonation or a pause, and how long does it last? In addition, the two components: the visceral and the auditory are linked. In dance notation this is especially noticeable. As noted by Guest (1990):

> The parts of the body in action have to be defined, as does the form of movement involved (flexion, extension, rotation, directional placement) and the duration of each in relation to the overall time structure. In group dances the relationship of dancers to one another must be determined and recorded, as well as their location on stage and their paths of travel. In a dance score each performer is like a small orchestra-arms, legs, head, torso, etc. in motion-this is then multiplied by the number of dancers who are performing individual sequence. (p. 203)

At the same time, while there are a number of contemporary studies on various aspects of dance notation (Challet-Haas, 2016; Franko & Nicifero, 2018; Russell, 2020), the ways in which theatrical productions are recorded have not been sufficiently studied.

RECORDING OF MOVEMENTS AND SOUNDS IN SPACE AND TIME

Movements can be recorded in various ways, for example, on paper, in sculpture. For example, it is believed that the ancient Egyptians used hieroglyphs for this purpose. In the temples of South India there are preserved sculptural representations of 108 karans, the basic provisions of the Indian classical dance (fig. 1). The Romans used a system of recording gestures used in pantomime.

Figure 1. Shiva dance poses. Fragment of exposition 108 Karana Nataraja in the Saivite temple Kadavul (Kauai island, Hawaiian archipelago)

At the same time, the recordings used to record performances are usually not just images of body movements. As a rule, they demonstrate "two dimensions" – either changes of movement in time/music or in space. In the latter case the emphasis can be placed on the description of movements as well as on movement, and in the case of a complex composition on the location of all the actors.

Place, movement, relocation in a production

Records of dances have been preserved since ancient times. In Chinese notation, the feet were marked in a square divided into sectors to demonstrate the positions of the feet and the spaces through which they moved (fig. 2)

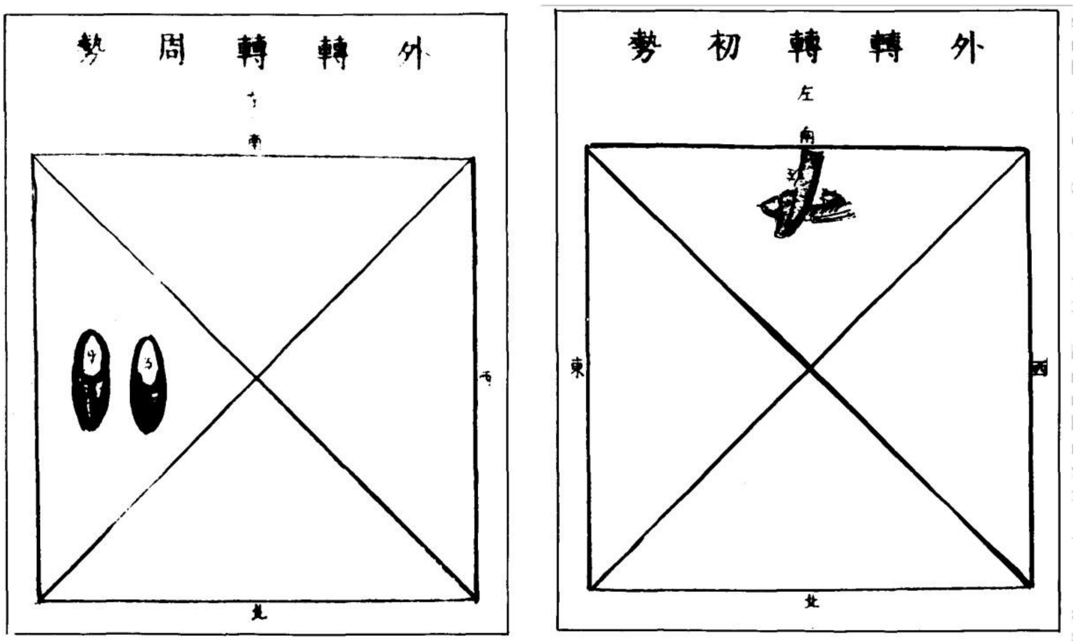

Figure 2. Non-sequential diagrams of foot movements in Ming dynasty ritual dance (Strauss et al., 1977, p. 6)

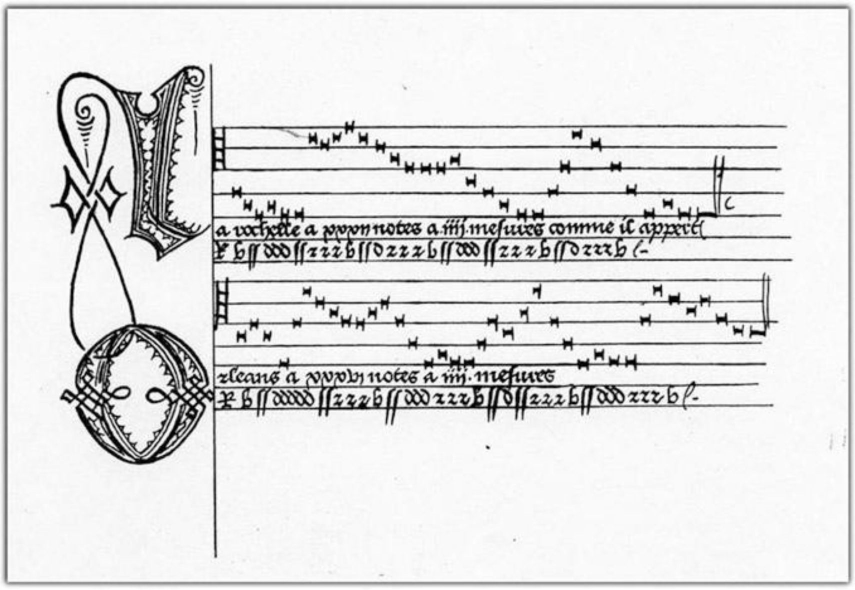

Figure 3. Manuscript of the Library of Burgundy circa 1450 (Challet-Haas, 2016, p. 70)

In XIV–XV in Europe, for recording the popular basse danses (“low dances”). letters were used to denote a certain type of step: s for simple, d for double, b for branle, r for reprise, R for reverence (fig. 3). Thoinot Arbeau (1589/1967) in his book *Orchesographie* didn't use any symbols, but placed the names of the movements next to the vertically arranged music.

In 1686, André Lorin described how to dance the country dances he had learned during his stay in England for the king (fig. 4). Letters means dance steps, line shows the floor route (Esses, 1992).

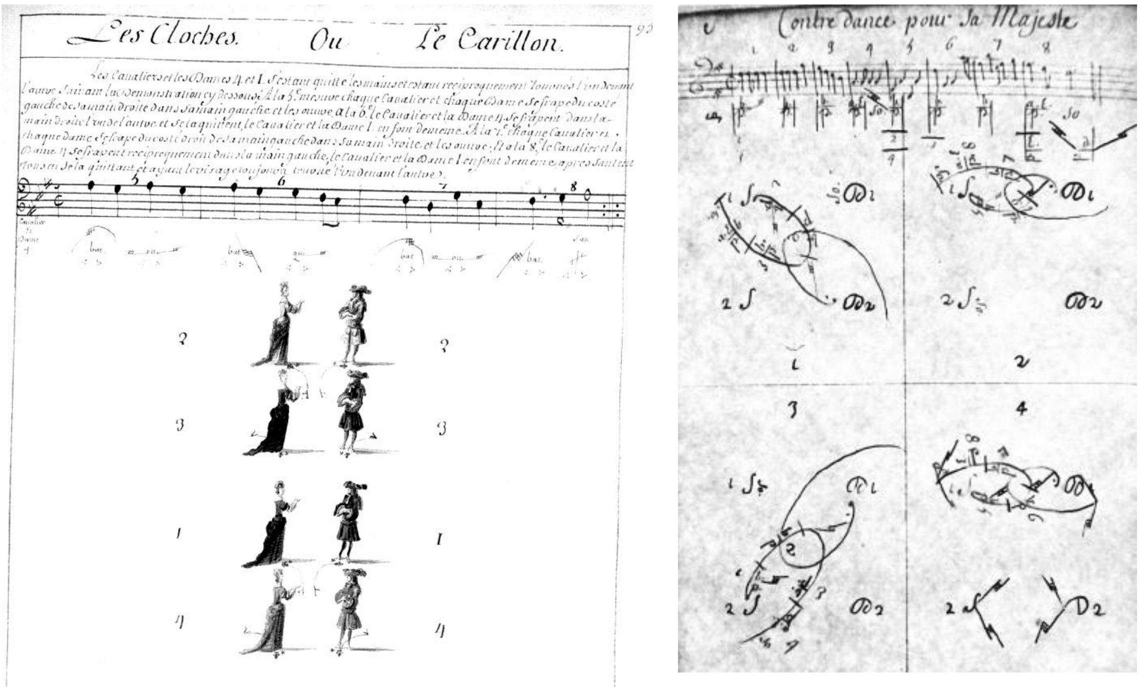

Figure 4. Notation of country dances by André Lorin (1686)

One of the most famous examples of eighteenth-century visual notation is the way of recording Beauchamp-Feuillet, an explanation of which is contained in the book *Choregraphie ou I 'Art de Decrire La Danse*. It was invented in the 1680s by Pierre Beauchamp and published in 1700 by Raoul Auger Feuille. It mainly demonstrates the line of motion in space during movement. Beauchamp-Feuillet represented French noble style of dancing (and some aspects of character or grotesque dancing). When the style lost its actuality, this type of notation also became a thing of the past. Exploring *‚Menuet performed’ by Mrs Santlow* in Beauchamps-Feuillet notation (fig. 5), Dóra Kiss (2014) claims that this “Menuet” is a piece whose writing is an act of encoding, not of composition, citing the form of the minuet since it borrows its steps and alludes to its figures; however, *Mrs Santlow* never quotes it verbatim. Reinvented from a material, the choreography nevertheless "leads" its audience by a calm introduction, multiple variations of known motifs, then regular repetitions of lexical and structural elements so as to prevent the audience from losing their way, Thus the interest of the latter is maintained by surprises. It seems that the form of the "Menuet" does not apply any rule, but on the contrary is similar to an improvisation that would have been transcribed (Kiss, 2014).

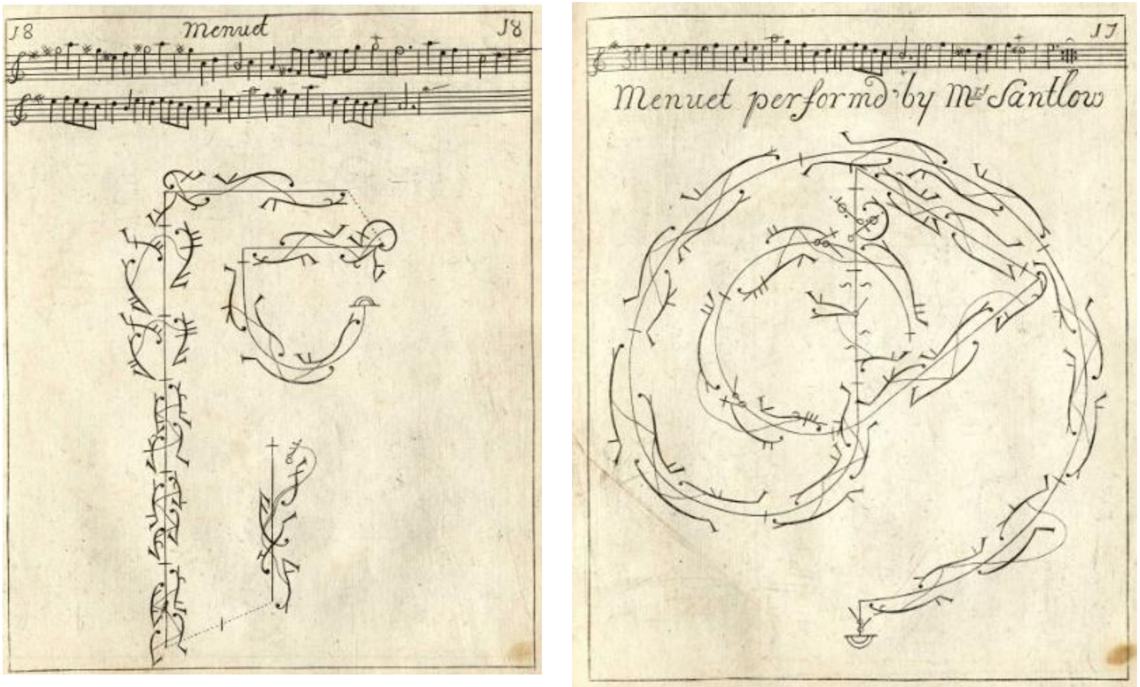

Figure 52. *Menuet performd by Mrs Santlow* by Beauchamps-Feuillet notation. The copy of this choreographic score comes from the Derra de Moroda Library in Salzburg (L'Abbe, 1725/1991, p. 18, 17)

In Figure 6 a male dancer on the left and a female on the right begin upstage, facing downstage. in the first moments of this dance, the couple starts with feet at different angles, with the heel of the back foot touching the floor. time value is indicated by lines that cross over the central line of direction Heyward (2015). This recording required prior preparation for understanding (in particular the relationship of movements to the notes at the top) from other sources or with the help of tutors, in addition captures only part of the movements, in particular there are no hand movements. As noted by Linda Tomko (1999), "One had to have recourse to other period documents to grasp that initial bends in dance step-units should be taken on the upbeats for musical measures, and not on the downbeats, as the notation would seem to indicate" (p. 3).

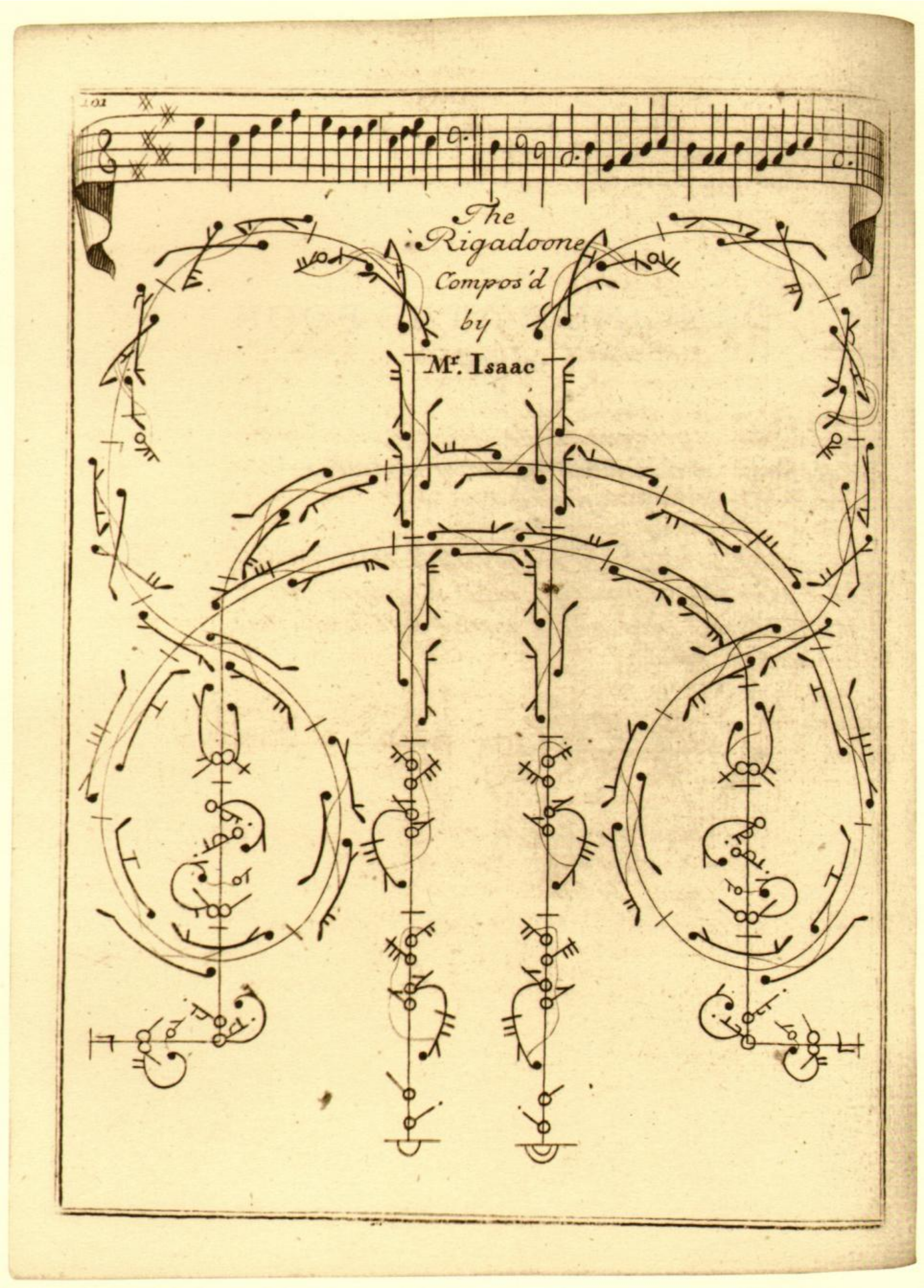

Figure 6. Beauchamp-Feuillet 's dance notation for a rigadoon by Isaac, ca. 1721 (Feuillet, 1721/2018)

Kellom Tomlinson (1735) wanted to revive Fueillet notations for his students by placing the figures of dancers in the list (fig. 7). He united a symbolic notation style and tradition of artistic visualization of pose dancers (like in Thoinot Arbeau (1589/1967) *Orchesographie*, Fabritio Caroso's (1581/1983*) Il ballarino* and Cesare Negri's (1602) *Le Gratie d'Amore*).

Figure 7. Tomlinson's (1735) dance notation for *Saraband*.

In the case of complex compositions, the picture above all shows the location of the actors. For example, figure 8 is a layout plan for the ballet *Amor*, and the displacement is indicated by dashed lines (fig. 8):

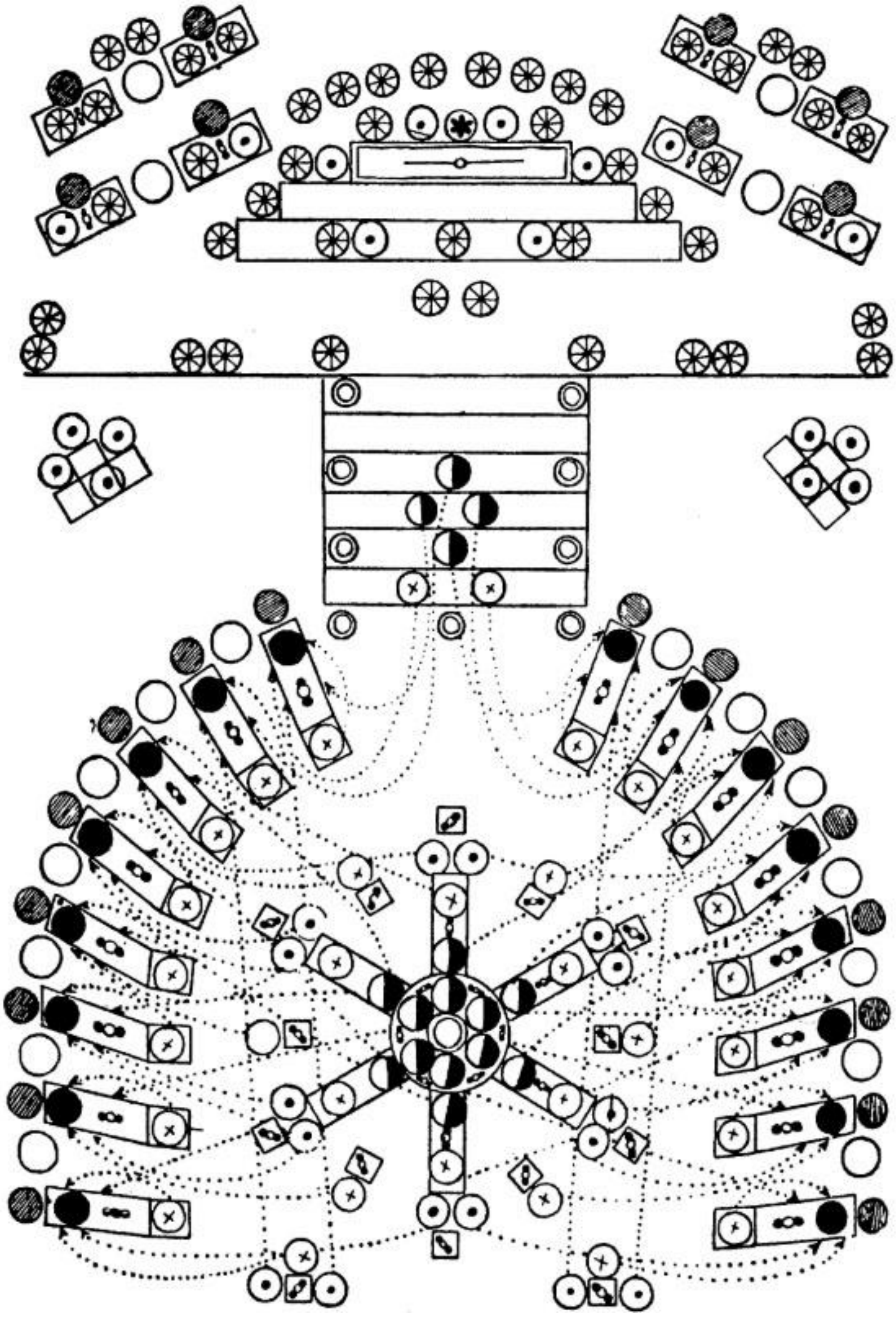

Figure 8. Choreography for the ballet *Amor*, floor plan by Luigi Manzotti, 1890 (Guest, 1990, p. 208)

In their work with music, choreographers often sought to use the stanza as the basis for notation in its various meanings. This is the case, for example, of Arthur Saint-Léon's (1852) notation system in his book *Sceno-Réography, or The Art of Recording Dance*. (*La Sténochorégraphie, ou l'art de noter promptement la danse*). The choreographer used a pentatonic easel connected to the sheet music staff. On the note staff line, he recorded the movement on the ground; above – in the air – the upper sixth line was used to convey the movement of the body and arms. The latter were depicted visually accurately, and a system of symbols was used for the lower part (fig. 9). The staff was useful, since horizontal display on the floor was no longer enough, arm movements, the height of the leaps, the elevation of the legs from the ground were more in demand.

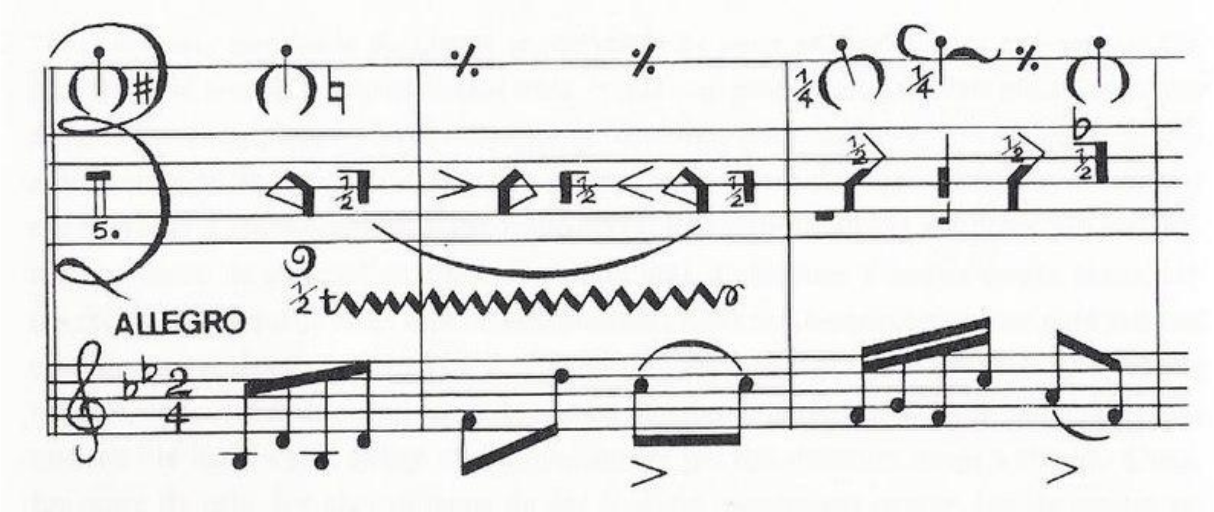

Figure 9. Saint-Leon (1852) notation

Jean-Étienne Despréaux decided to divide notations into analytical one (extremely detailed and organized into systematic classifications that have a primarily didactic function), and abbreviated one in which the dance is transcribed under the musical staff like the sung text. The symbols are adapted from three letters of the alphabet, Z, L, J, whose shapes reflect the lines assumed by the legs in the basic positions: respectively those of *plié*, stretched, and *sur la demi-pointe*. Letters are used also to indicate the directions of the movements of body and leg (forewards, sideways, backwards) but also for certain abbreviations (e.g. Pir for pirouette) (Pappacena, 2004, p. 63).

Sketches by Marius Petipa (fig. 10), chief ballet master of the Russian Imperial Theaters from 1869 to 1903, also primarily emphasize positioning, but contain many comments on movement both verbal and symbolic. Figure 10 shows the recording of body movements and how extremely rich it is in different types of signs: words, drawings, symbols, and numbers are used here. At the same time, two tendencies can be traced in the field of recording body movements: either to present them in the most obvious way, understandable to all (iconic signs), or to develop a system of signs (simulative signs).

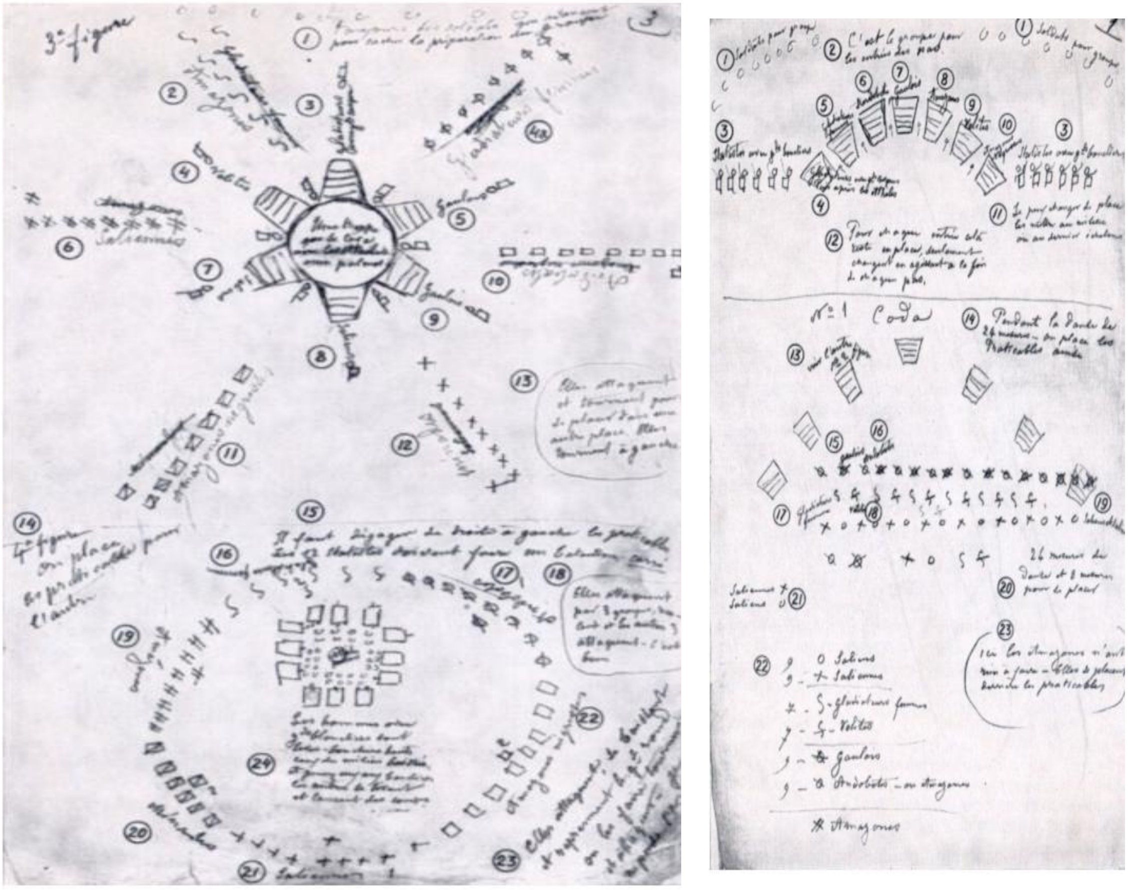

Figure 10. Sketch of a scene in a ballet by Marius Petipa, 1868 (Petipa, 1971).

Functioning like musical notes, these notations are not just records of a performance but instructions for its reproduction. If the records were used only "for oneself," then there was no question if portability in an saunambiguous and clearly decipherable system of notation. It was easier and faster for choreographers to write names or abbreviations of movements over the notes, explaining them with drawings and their own signs. As a rule, the question of exact recording arose when it became necessary to accurately capture the representation for restaging. Marius Petipa instructed in the literal and accurate reproduction of his productions. Therefore, the recording system for the ballet, proposed by the young corps de ballet dancer of the Mariinsky Theater Vladimir Stepanov (1892), and presented in the book in *L'Alphabet des Mouvements du Corps Humain (The Alphabet of Movements of the Human Body*) in Paris in 1892, was accepted by the Directorate of the Imperial Theaters as basic.

Stepanov's system of choreographic recording seeks to streamline the way of recording, again making references to music recording. The type of recording – three musical-like notation stanzas: the lower one for foot movements, the middle one for arms, and the upper one for head and body – reminded some of notations for bell-ringing (and perhaps was prompted by them). Notes and additional signs indicated the positions of the body, so the system did not depend on the terminology (Fig 11). The symbolism of the notation is rich, the numbers indicating the turns, their position indicating the movement during them, symbols similar to music notes with streaks around them showing arm movements at certain beats.

Also Stepanov bases his notation system on an understanding of the anatomical structure of the human body. A modified musical staff provides sections on which to indicate movements of the legs, arms, body and head: Square headed music notes indicate steps in contact with the ground whereas round headed notes indicate leg gestures (figure 12). Note stems that go upward represent the left leg or arm; note stems going down the right leg or arm. Additional notations on the stem indicate movements involving flexion, extension, adduction, abduction, twisting, turns and circular movements (Farnell, 1996).

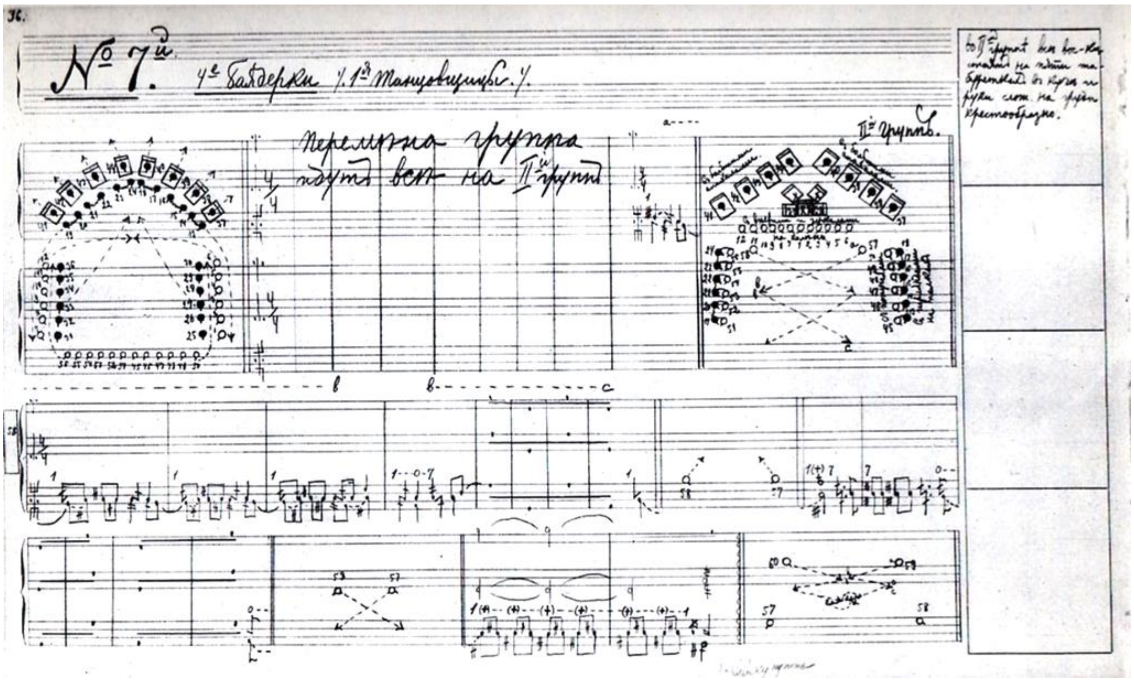

Figure 11. The recording of the ballet *La Bayadera*, made by Nikolai Sergeyev according to the system of Stepanov, circa 1899 (Gorskiy, 1899, p. 3-4)

The famous Russian dancer Vaslav Nijinsky modified Stepanov's system, improved it especially in the indication of directions and levels. It includes many changes and improvements to this system. In Harvard University Library‘s Theatre Collection the writing by Nikolai Sergeyev for Petipa's ballets is preserved. In 2015 the American Ballet Theatre staged *Sleeping beauty* on the base of those notation (fig. 13).

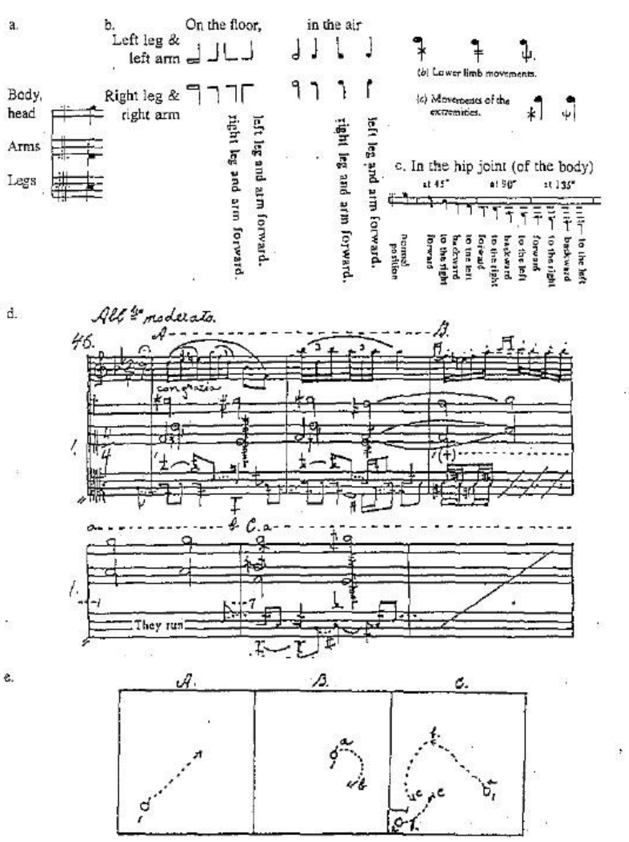

Figure 12. (a) staff for the placement of body parts; (b) different forms of the note signs; (c) notation of flexion and extension of hip joint; (d) an example of writing; (e) floor plans (Gorsky, 1978, p. 11,13,56; Hutchinson-Guest, 1984, p. 73).

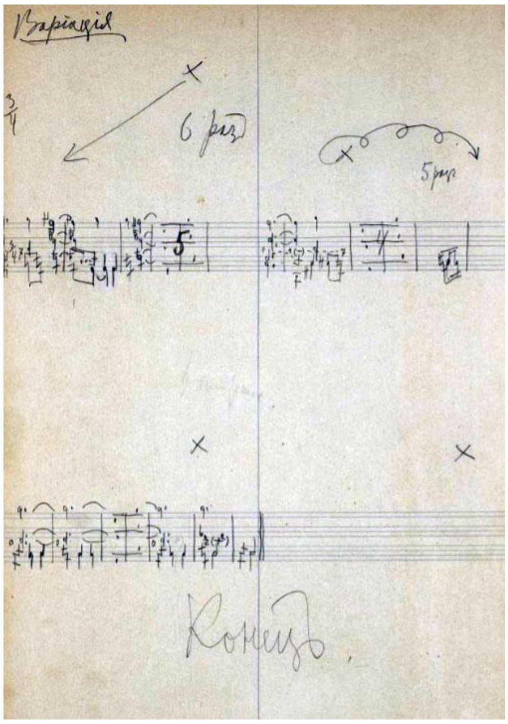

Figure 13. The final page of the ballet *Sleeping beauty* made by Nikolai Sergeyev according to the notations of Stepanov from the Harvard Theater Collection (Tchaikovsky, n.d., p. 187)

Iconic and Symbolic Signs in the Representation of Motion

The oldest dance tutorials show people in dance poses that are carefully and accurately traced (Thoinot Arbeau (1589/1967) *Orchesographie*, Fabritio Caroso's (1581/1983*) Il ballarino* and Cesare Negri's (1602) *Le Gratie d'Amore*). More modern choreographers can make their own sketches. For example, in addition to the floor plans and the mass scenes (fig. 10), Petipa made sketches of real dance movements and figure poses. sketches of profiles of one-, two- and three-figure compositions. For example, sketches of several dancers with tulle (fabric) for the ballet *Mlada*, sketches of duet movements-supports for the ballet *La Bayadère* and *Mlada*, grotesque drawings of buffoons and characteristic movements of the Slavic dance from the ballet *Mlada*, a sketch of the final scene (Odette and Prince), the image of a bird of prey for the ballet *Swan Lake* (Portnova, 2016). The drawings are specific, each showing a particular movement of dynamics or stately poses.

But besides the notes of choreographers there are sketches by dancers. Pavel Gerdt was the permanent Prince of Desire from *Sleeping Beauty* from the premiere until 1903, and, as usual, sketched out the text of his part for memory (fig. 14).

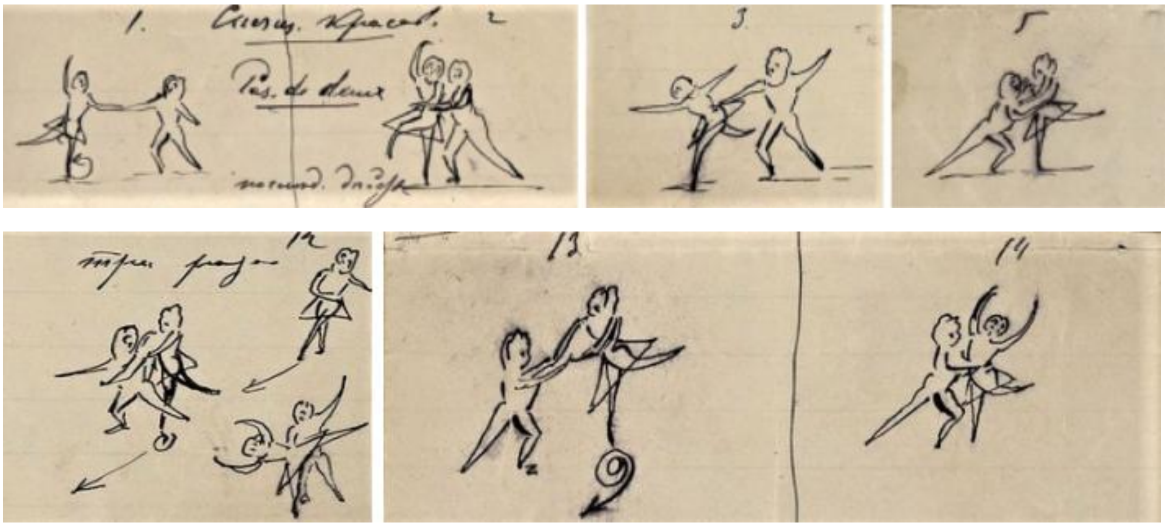

Figure 14. Pavel Gerdt's sequential sketches of the choreography for the pas de deux (pas de quatre) of *Sleeping Beauty*. Museum of the Bolshoi Theater. Circa 1890. (Ratmansky, 2018)

Aleksei Ratmansky (2018) compares Gerdt's sketch and Sergeev's notation to track changes in the performance of *Sleeping Beuty* between circe 1890 and 1903:

> The notation (this moment is not shown in the drawings) contains the words of Aurora, who says, addressing the audience: “I will dance with him,” to which Desire replies: “I love her and marry her.” This important detail, long abandoned, points to the active nature of the pas de deux, which, according to Petipa's idea, was a pas d'axion, and not the concert duet that it has become today. Interestingly, Aurora still does not dare to talk about feelings, while Desire openly declares her love and proudly declares that she will "marry her." According to the plot, these gestures are not required; rather, they are additional colors that Petipa uses to describe the characters. After the "facial expressions" Aurora runs up to Desira and "hugs" him (the notation and the drawing are the same here), standing in a low attitude.

The sketches of the ballet master Mikhail Fokin are drawn in more detail than Petopa's but less schematic than Gerdt's ones. In his recordings one can see how the figures acquire a more conventional character in places. The images of people are reduced to "matchstick" figures in a single line. But the character of sketches shows the difference in the style of the ballets *Blue God* (fig. 15) and *Judith* (fig. 16). Even at the initial stage, these ballets are distinguished by a deep sense of the style of the choreographic text, by the originality of its perception.

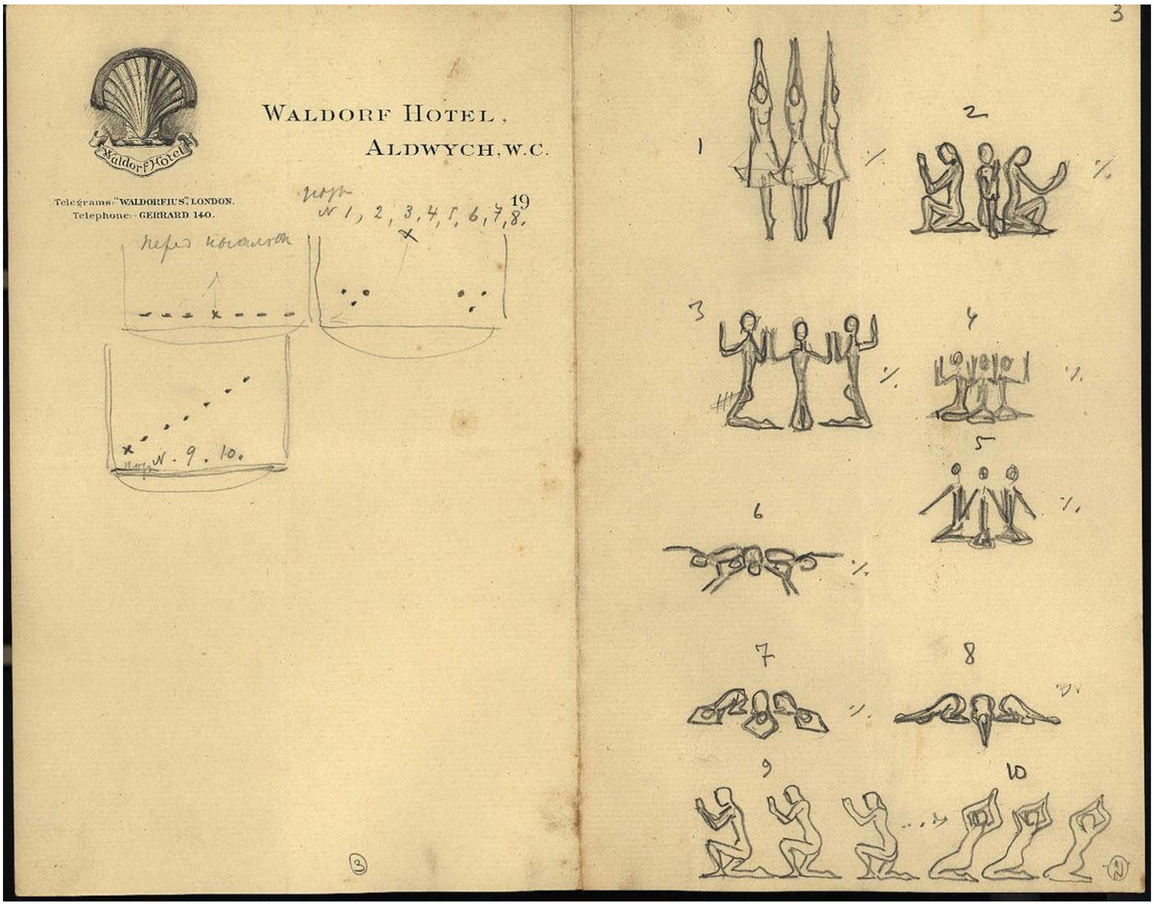

Figure 15. *The Blue God*, Fokine's ballet design (drawings, breakdown and character counts by apparition). 1912 (Fokin, 1912a)

However, the graphic representations of Fokine, Gerdt and Petipa are idiosyncratic and need to be simplified and streamlined in order to be transformed into a recording system. The use of more or less sketchy figures was typical of choreographers around the world (fig. 17, 18, 19).

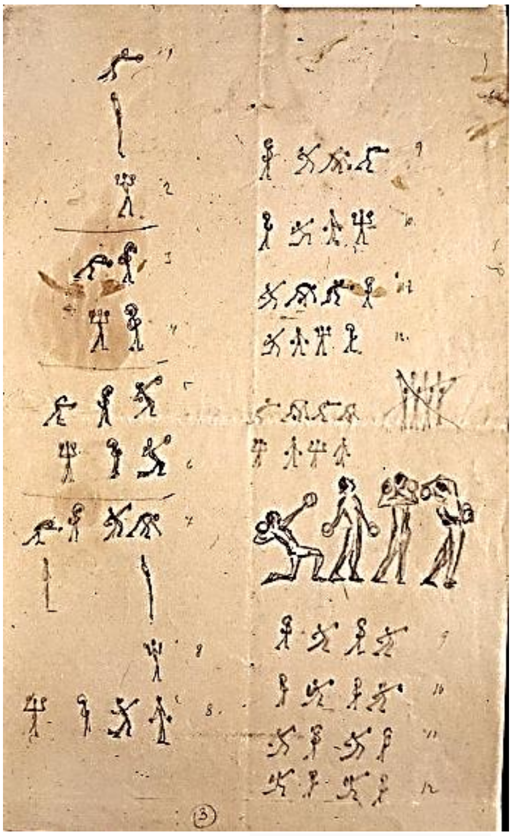

Figure 16. *Judith*, a choreographer's elaboration of the dances for Fokin's opera (schematic representation of the dances and individual groups, list of performers) (Fokin, 1912b)

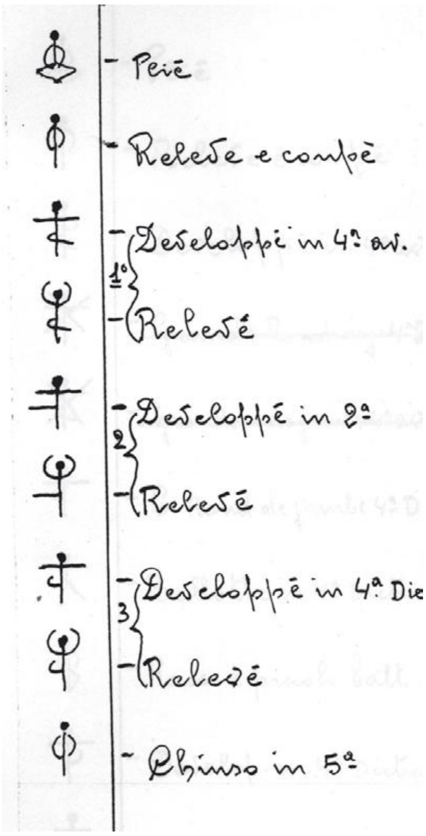

Figure 17. Grazioso Cecchetti, *Adagi*, “Trois relevés” (particolare), Museo Teatrale alla Scala, Milano (Pappacena, 2004, p. 55).

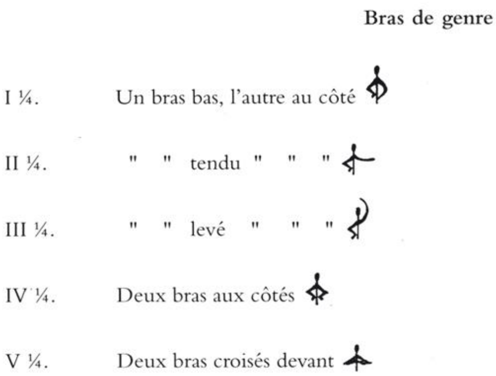

Figure 18. August Bournonville, *Nomenclature par ordre alphabétique*, 1861 (Pappacena, 2004, p. 55).

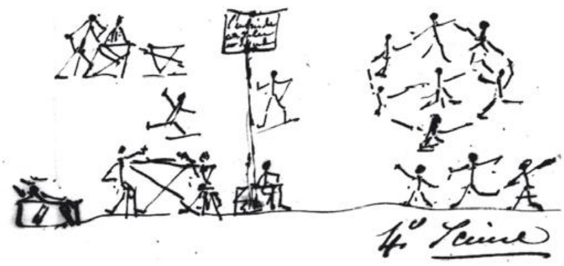

Figure 19. André Jean-Jacques Deshayes, schizzi coreografici, ca. 1820. Bibliothèque-Musée de l’Opéra, Parigi (Pappacena, 2004, p. 55).

Friedrich Albert Zorn crested a notation that continues to be comprehensible when looking at it, but that is also more codified, consisting of conventional human figures (fig. 20). The new notations make it possible to present a multitude of changing figures on one sheet, taking into account the anatomical details of a person.

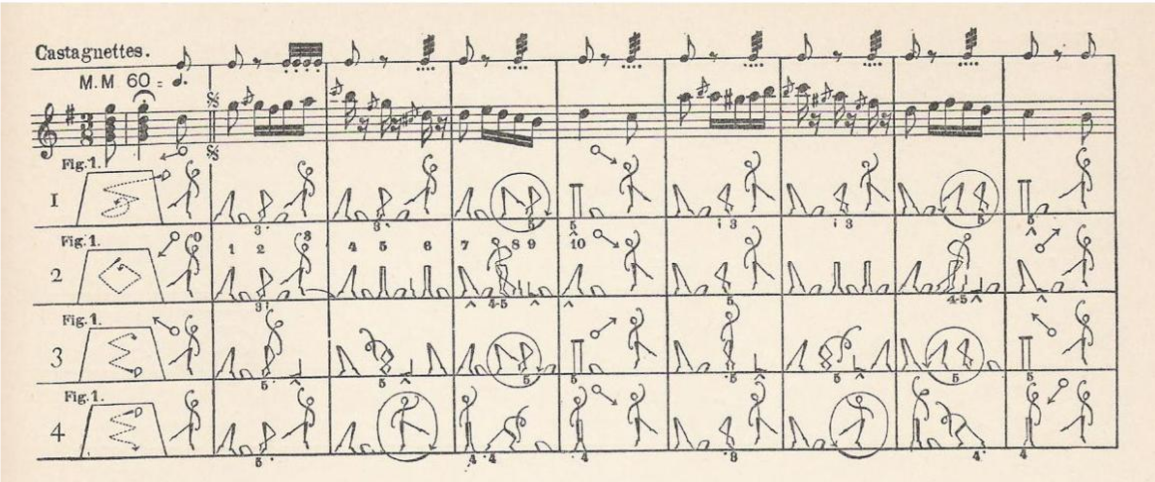

Figure 20. Dance notation *La Cachucha* by Friedrich Albert Zorn (1905)

Using five-lined staff, and the stick figure that was used by many authors, Olga Desmond (1919) presented the movement figure divided by staff in a very realistic way (fig. 21).

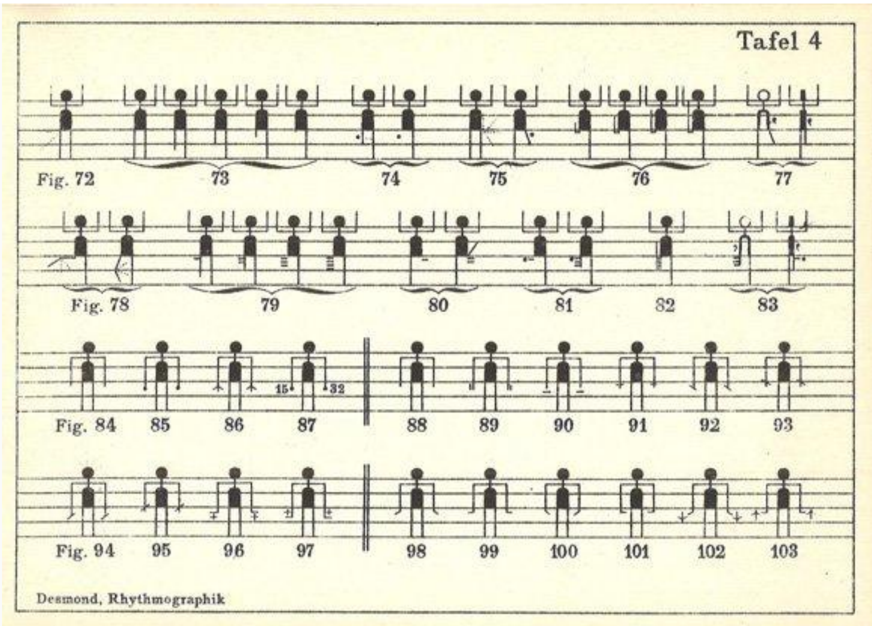

Figure 21. Notation by Olga Desmond (1919)

Valerie Sutton developed her system in a more symbolic direction (fig. 19, 20). She invented Sutton Movement Writing & Shorthand (SMW), a stick-figure movement notation system in use in the dance and sign language fields of the Royal Danish Ballet's system of training, the Bournonville Schools. Later it became clear that the universal motion scores can be used for mime, sign languages used by the deaf, martial arts, gymnastics, physical therapy, and ice skating (Otis, 1979). SMW places a stick figure drawing on a five-lined staff (fig. 22). The third dimension is notated below the stick figure with two rows of round symbols representing the overhead view of the person (Sutton, 1981).

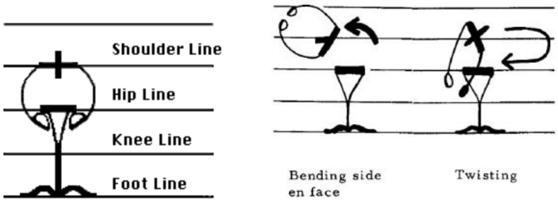

Figure 22. DanceWriting places a "stick figure drawing" on a five-lined staff (Sutton, n.d.; 1981).

When more than one dancer moves at a time in group dances, the notation for each person is placed on a separate staff line. The movements for each dancer are coordinated by counts, placed above the first staff with numbers (fig. 23).

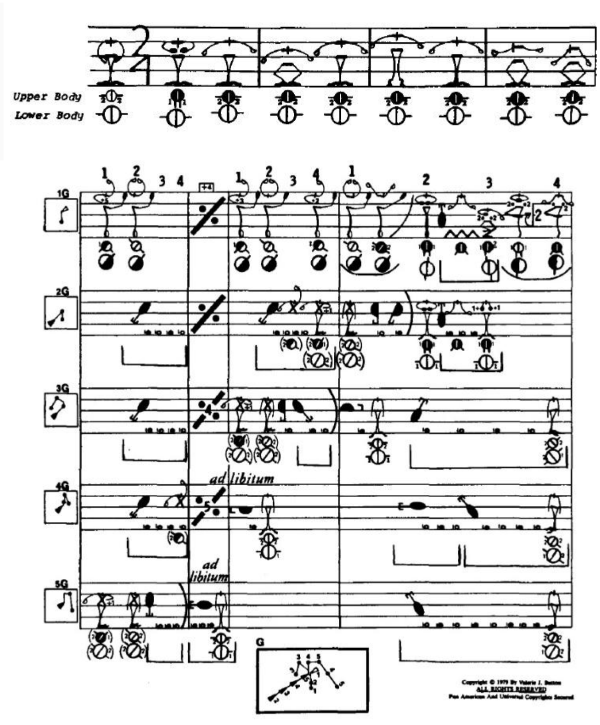

Figure 23. Group dance of five people *The Rose Adagio* (Sutton, 1981)

One of the problems solved in this way was the representation of motion in volume (Taplin, 2014). As Rudolf Benesh wrote in 1947

> Because of the enormous amount of information needed to record all details of movement of all parts of the body, in three dimensions of space and in time, it seemed that a great mass of symbols would be needed – and yet, to be workable, the resultant score had to be fast, economic, simple, universally applicable and as legible as the alphabet or music notation. Completeness and accuracy in fact seemed to make demands incompatible with speed, economy, simplicity, universality, and legibility. (Hall, 1967, p. 188)

The Benesh notation system reduces the human figure to its essentials by using distinctive signs to locate extremities, joints and segments on the stave (Mirzabekiantz, 2016). Figure 24 shows motion line system with which one can track the movement between positions. The dynamics are shown by a scale of six degrees of effort ranging from fff to ppp. In the gymnastic sequence in fig. 25 we see three runs, a step, and a strong pull-up jump (Hall, 1967).

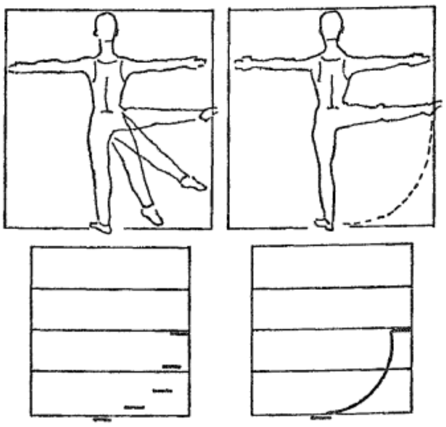

Figure 24. Benesh's motion line system (Hall, 1967)

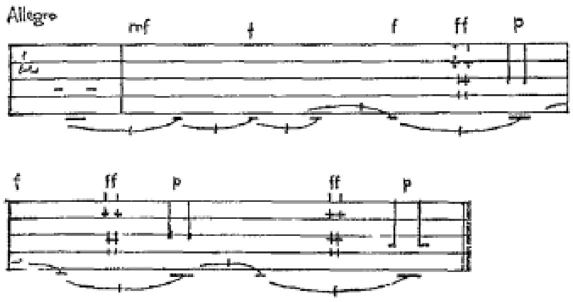

Figure 25. Three runs, a step, and a strong pull-up jump (Hall, 1967)

In order to plot a three-dimensional image on a two-dimensional page, the depth dimension is represented by three differently shaped signs that depict an extremity in front, level with, or behind the body. These three signs that represent the extremities (feet and hands)–a vertical stroke, a dash and a dot–are the foundation of the evolving Benesh Movement Notation alphabet (Mirzabekiantz, 2016, pp. 302, 303). In order to indicate action that takes place over more than one count, legato lines are written (Watts, 2015).

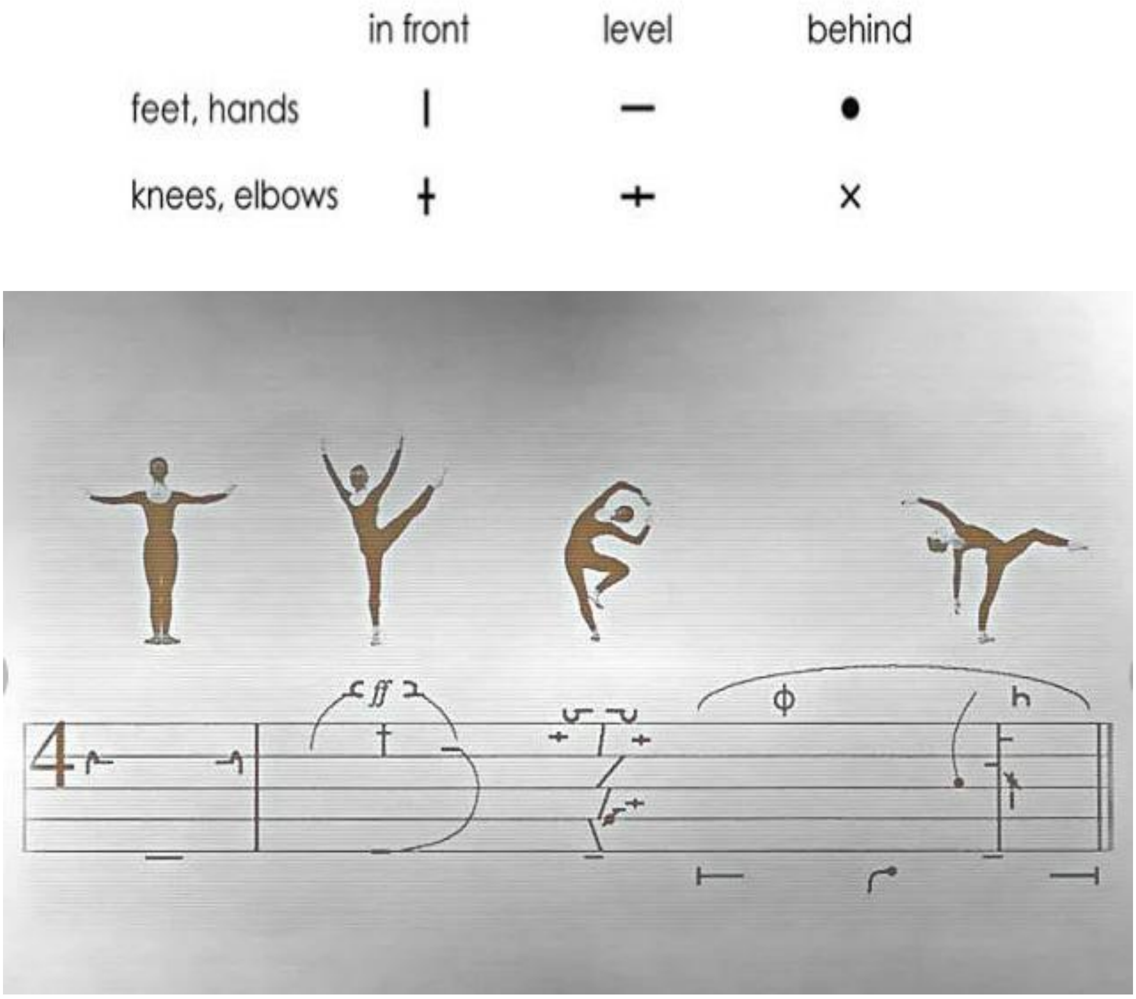

Figure 26. Benesh Movement Notation (Morilla, 2021)

Once the position of the limbs is recorded, the path of the extremities and the transitions from one key frame to another are shown (McGuinness-Scott, 1983). Points of contact of important moments are written on a stave of five lines dividing the human body in sections; these moments are tied by horizontal bows to show the succession of positions; below, the staff is devoted to space indications, and above, the staff time indications are written (fig. 26, 27) (Challet-Haas, 2016, p. 73). The scores record the totality of the actions of dancers performing different movements, they are recorded on the required number of connected staves, similarly to the score of a musical conductor. Each stave is labelled to show who is executing the movement recorded on it. Modifications of the direction sign are used to identify different individuals or groups of people. Women are normally represented by filled in identification heads and men by open ones (fig. 27). Simultaneous movements are recorded on vertically aligned frames.

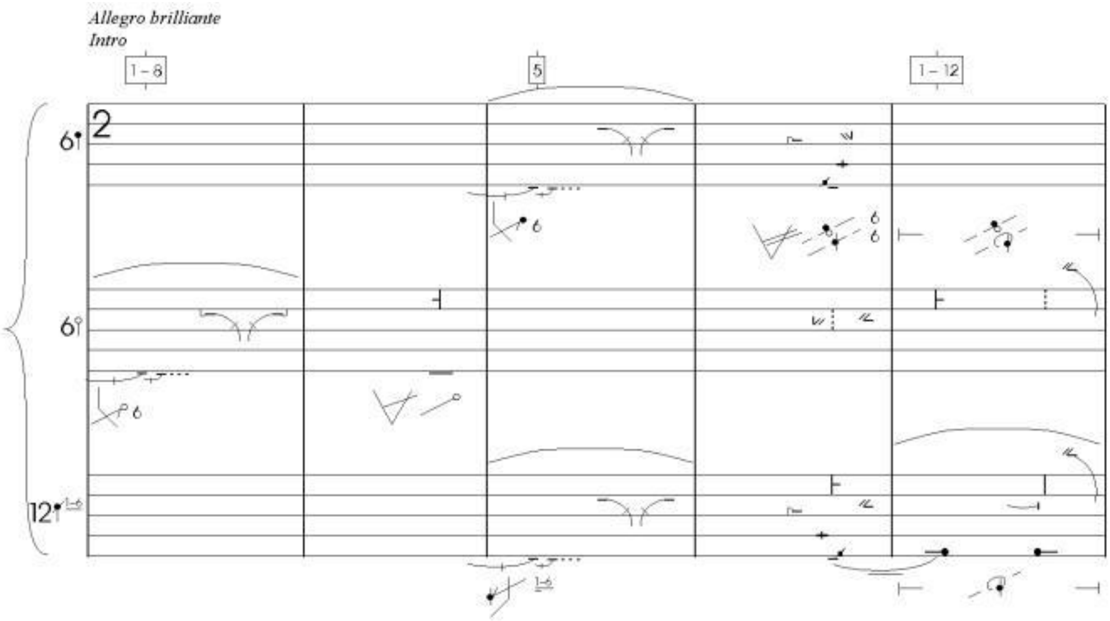

Figure 27. The Multi-person Benesh Movement Notation Score (McGuinness-Scott, 1983)

However, one of the most famous forms of recording movement by way of notation symbols (officially recognized by the Dance Congress in Essen in 1928) belongs to choreographer Rudolf Laban. By means of special notation symbols the duration (size of the notation), amplitude (by means of shading) and direction of movement (shape of the notation) were fixed.

The movements of the arms and legs in the Laban system look more "heavy" and redundant in comparison with the graceful lines of Benesh (fig. 28, 29).

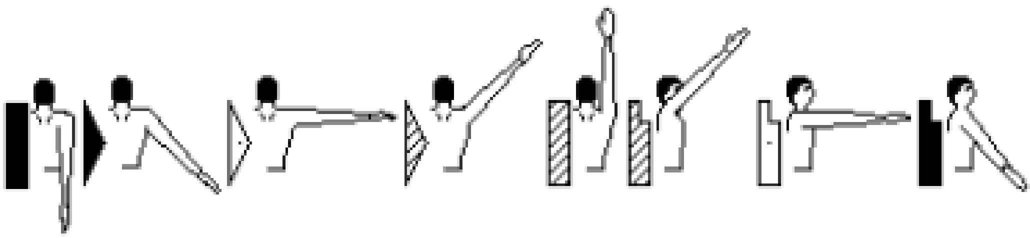

Figure 28. Hand movements (Brandl, 2020)

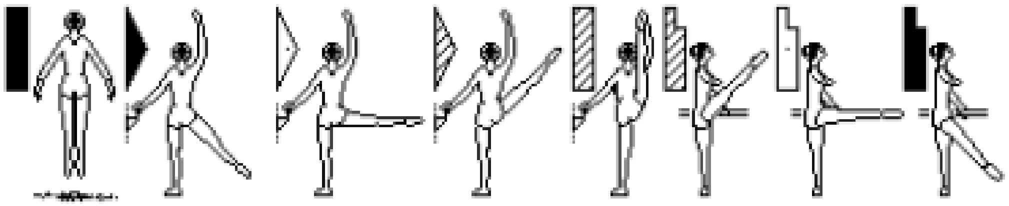

Figure 29. Leg movements (Brandl, 2020)

Laban experimented with various systems of dance script on the basis of his space theory until he achieved the system known as Kinetographie. He separately developed the idea of body movement and movement in space.

In Laban's (1926) German book *Choreographie*, a few times he uses a type of writing or signage which he calls "Diagonal Script." In the most explicit explanation of these signs, he arranges these into a table, each sign associated with one of the inclination numbers (fig. 30).

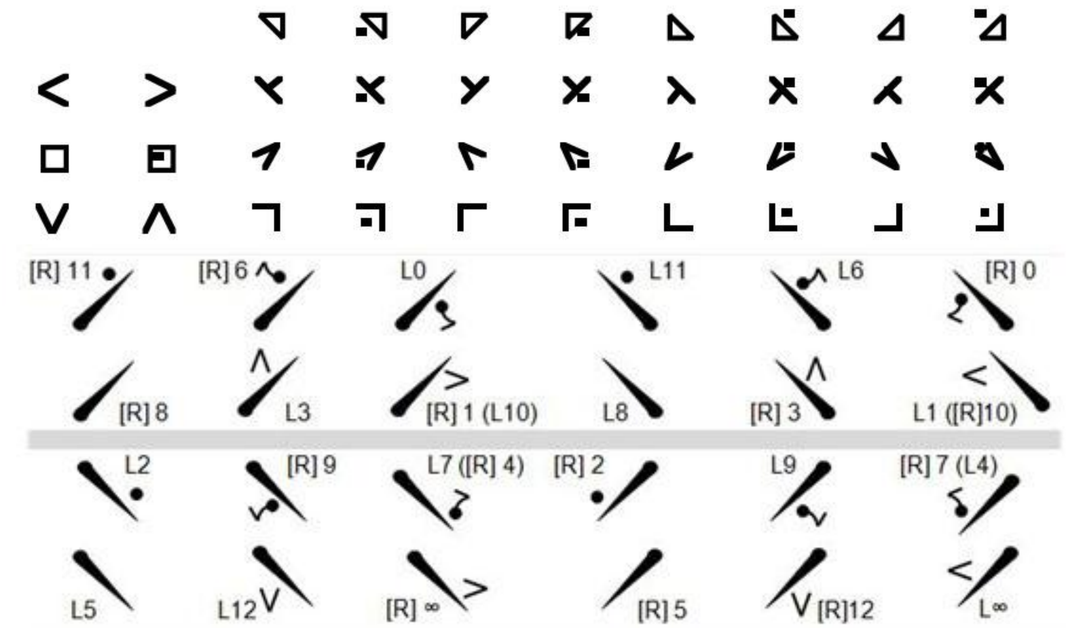

Figure 30. Early symbols used in Laban's (1926) *Choreographie*

Laban used Feuille's idea of using a vertical axis to represent the body in a standing position (fig. 31):

> The axis divides the body into two symmetrical parts (right and left). Parallel lines are drawn on both sides of the axis to identify the different parts of the body. Rectangle shape modifications indicate the direction of movement. The hue of the symbol indicates the level of movement. The length of the symbol indicates the duration of the movement (Barbacci, 2002).

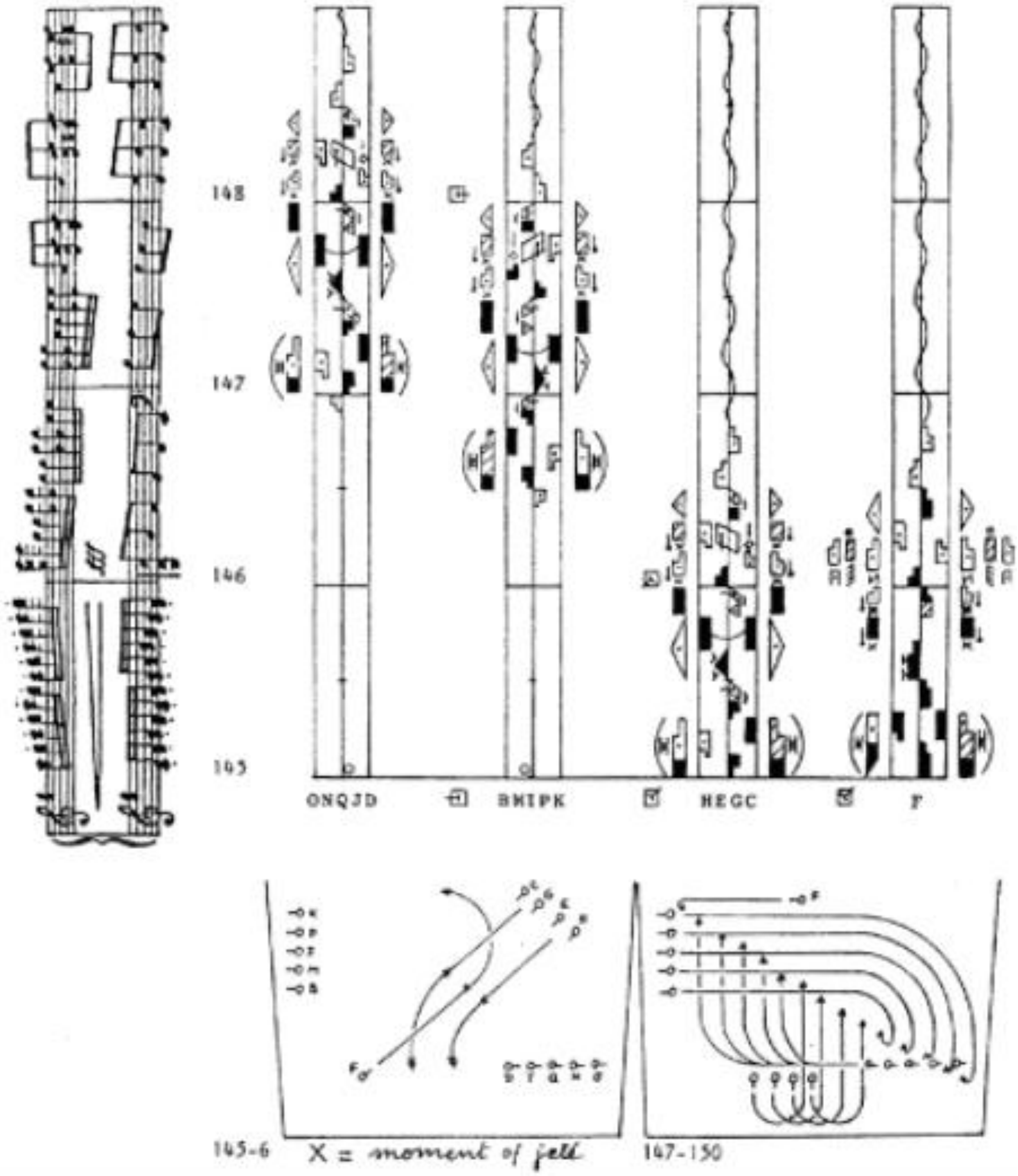

Figure 31. A page from Rudolf Laban's *Schrifttanz*, 1928. (Guest, 2006)

As a result, Laban developed a harmonious system which is the most famous today (fig. 32, 33, 34). The Kinetography system makes it possible to describe motion with a high degree of accuracy, considering weight, space, flow, time, and energy as fundamental parameters. At the same time, Laban sought not so much to create a *Tanzschrift* (dance-writing, a way to record) but a *Schrifttanz* (graphic–written–inscriptions to invent the dance) (Yuzurihara, 2014, p. 289).

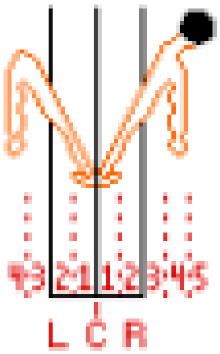

Figure 32. Division of note carrier into columns: L = left column, C = center column, R = right column; 1 = Supportcolumn, 2 = foot column, 3 = torso column, 4 = arm column, 5 = head column (Barbacci, 2002)

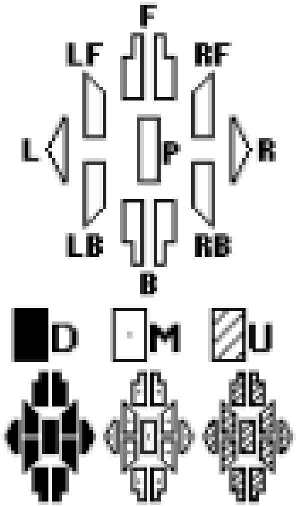

Figure 33. Directions and level of movement: F = forward, LF = left forward, RF = right forward, L = left, R = right, P = place, B = back, LB = left back, RB = right back, D = down, M = medium, U = up (Barbacci, 2002)

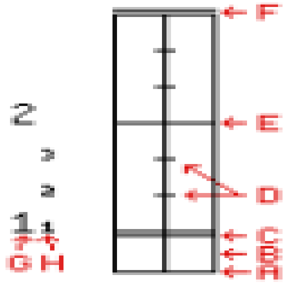

Figure 34. Time indication: A = Line at the beginning of the note, B = Starting position, C = Start of movement (double line), D = Time division indication, E = Start measure, F = End of movement (double line), G, H = Digits indicating time units (large numbers: measures; small numbers: units) (Barbacci, 2002)

The further development of notations was either based on the Laban system or sought to simplify it. Pierre Conté, combined musical notes with simple signs placed on an expanded music staff. Alwin Nikolais used a Laban-style vertical staff but in two parts, with torso and head indications placed separately on the right., created by the dancer and choreographer Eugene Loring with D.J. Canna. In *Kineseography* (1955) they proposed to four categories of movement: emotion, direction, degree, and special. It was used to record Loring's signature ballet, *Billy the Kid* (Guest, 2006).

It should be noted that certain types of dances used specific symbols and forms. For example, simple folk dances used an ancient and archetypal template with a basic three-measure pattern. Thus, in Macedonian *Pravo Oro* (fig. 35) the first two measures travel and the third measure mirrors the second. Another way to describe it is "step, step, step, do something, step, do something." Still another way is `three steps forward (pause), one step back (pause) .'

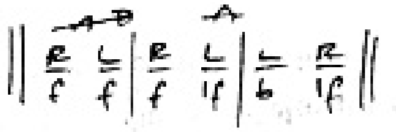

Figure 35. Notation of folk dance Macedonian *Pravo Oro* (Shannon, 1996)

Peculiarities of Recording a Theatrical Production

Theatrical productions usually have a literary original and are based in a text (just as dance performances are based on a musical score). Often, therefore, the director's work involves working with the text, where on the background of the existing verbal sequence appears a system of comments (often again, verbal), which give an idea of what is happening on stage and what the actors are doing, as in this text by Anton Chekhov with notes by Konstantin Stanislavsky:

> HELENA. Frankly, my thoughts were elsewhere. Forgive me! I want to submit you to a little examination, but I am embarrassed and don't know how to begin.
> ASTROFF. An examination? №80
> HELENA. №81 Yes, but quite an innocent one. Sit down. №82 [They sit down] It is about a certain young girl I know. Let us discuss it like honest people, like friends, and then forget №83 what has passed between us, shall we?
> ASTROFF. №84 Very well. №85
> HELENA. It is about my step-daughter, Sonia. №86 Do you like her? №87
> ASTROFF. №88 Yes, I respect her. №89
> HELENA. №90 Do you like her–as a woman? №91
> ASTROFF. [Slowly] No. №92
> HELENA. №93 One more word, and that will be the last. You have not noticed anything? №94
> ASTROFF. No, nothing.
> HELENA. [№95 Taking his hand] You do not love her. I see that in your eyes. №96 She is suffering. You must realise that, and not come here any more. №97
> ASTROFF. My sun has set, yes, and then I haven't the time. №98 [Shrugging his shoulders] Where shall I find time for such things? [№99 He is embarrassed.]»
> *№80 Astrov at the piano; looked around, surprised.*
> *№81 She is even more busy with the socket. Astrov folds cartograms.*
> *№82 Broke away from the socket, decided, points to a chair.*
> *№83 She has made up her mind, she speaks too briskly from nervousness. Astrov sat down in perplexity.*
> *№84 Astrov shrugged his shoulders.*
> *№85 Awkward pause. Elena was confused, lost her resolve, and busied herself with the folds of the wrapped cartogram.*

№86 Awkward pause. Elena leaned even closer to the cartogram. Then she abruptly raised her head and looked up at Astrov. With coquetry, biting his lip, wanting to disguise embarrassment with coquetry.
№87 Astrov looks straight into Elena's face, who realized that coquetry would not help here.
№88 Astrov – resolutely, firmly.
№89 The pause is awkward. Elena lowered her eyes, turned back to the map.
№90 Timidly. Where 0 is a pause. She crumples.
№91 Elena's timid but serious look. Pause. Astrov averted his eyes, hammered on the table, shook his head negatively.
№92 Pause. Elena leaned even more towards the map, Astrov thoughtfully plays with a hammer.
№93 Elena started up, dropped the phrase decisively, taking up the socket. Where f is a pause, it crumples. Elena stares at the socket.
№94 Pause. Astrov turns his eyes to Elena.
№95 Pause. Elena turns her eyes to him without taking her hands off the socket.
№96 Turns his eyes to the socket.
№97 Elena blurted out this phrase, then, as if having dropped a mountain from her shoulders, leaned back and wiped herself with a handkerchief in excitement. Astrov taps the hammer on the table. Then he mumbled, smiled sadly, laughed bitterly through clenched teeth, raised his head, hit the table several times decisively, sighed and nervously shoved the hammer into his pocket.
№98 He waved his head hopelessly, nervously rubbed his hands, or his hands on his knees, or drummed; got up.
№99 Astrov froze, busy with a candle or picking at a cartogram. Pause. Elena gets up quickly, sighs, wipes herself. (Rezhissorskiye ekzemplyary, 1994, p. 78-79)

Nevertheless, sometimes it becomes necessary for the director to visualize movements, which leads to drawings (fig. 36).

Figure 36. Sketch from *Uncle Vanya* (Rezhissorskiye ekzemplyary, 1994)

Even these examples show that, unlike the three pillars of ballet (the dancer's movements, movements on stage and the correspondence to the music), in theatrical recordings it is necessary to record interaction with objects, features of speech and non-verbal communication of the emotional state. Although theater did not lose its connection with music, notes were recorded, and sometimes a musical stanza was used as the basis of the recording, but it could be replaced by a "chessboard" for example.

At the Moscow Art Theatre for about 10 years (1907-1917) a form of recording was practiced recording that was proposed by director Arbatov. In it a special place was given to the interaction with the things. According to this system, all objects on stage were marked with Arabic numerals, actors with Roman numerals, and the direction of their movement with arrows. This record was easy to understand, but included only movements and interactions with objects (fig. 37).

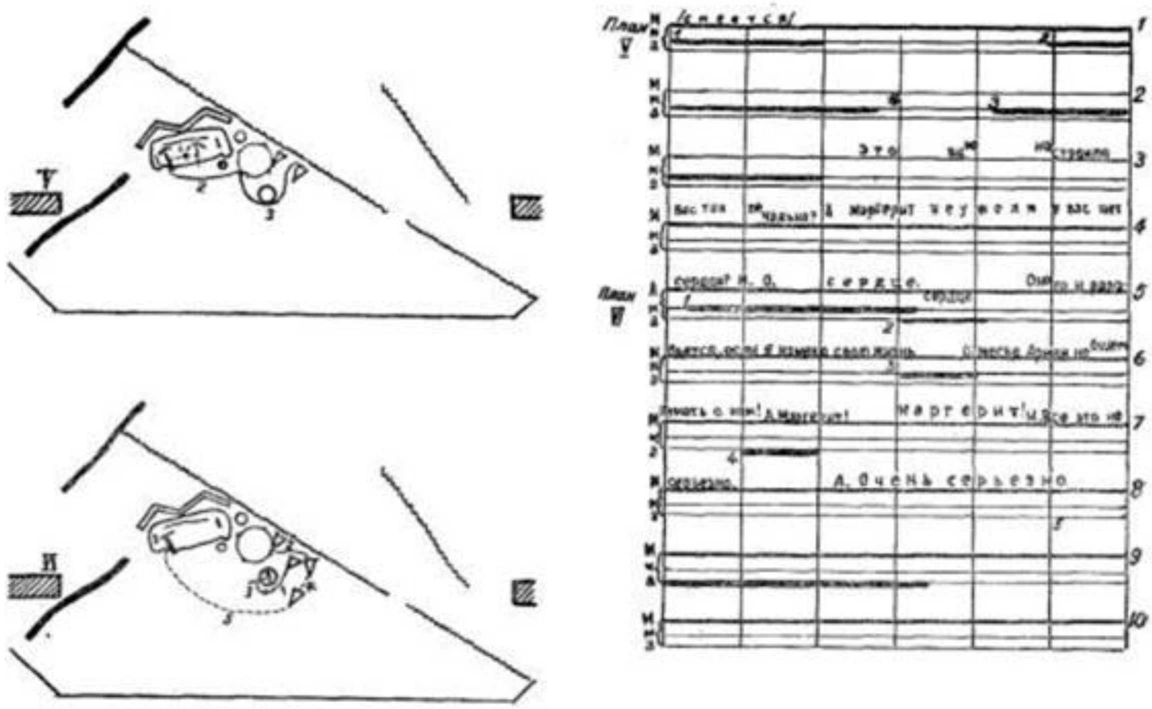

Figure 37. Fragment of the score for *The Lady of the Camellias* by Meyerhold. Excerpt from Act I, Episode 3 (*Meeting*) (Varpakhovsky, 1978).

A similar system was introduced by Ivanov, but unlike Abramov his notation had links to the music playing and the coordinates on the stage: Ivanov divides the stage into chess squares, taking into account the stage floor. The depth of each square is set at one meter; with the close squares corresponding to the bottom and the far ones to the top (Varpakhovsky, 1978). By way of paper, Ivanov was thus able to position the artists on stage more precisely, to set their speed and rhythm (fig. 38).

In the theater, they began to distinguish between "montage notation" and "chess notation." The editing recording is based on drawing the trajectory of the actor's movement around the stage on the floor plan. The notation of chess players indicates only the start and end points of the actor's movement (Gaiduk, 2016). A similar fixation was used in the theater of Bertolt Brecht, where photographs of each change in the position of the actors on the stage were attached to the text of the play.

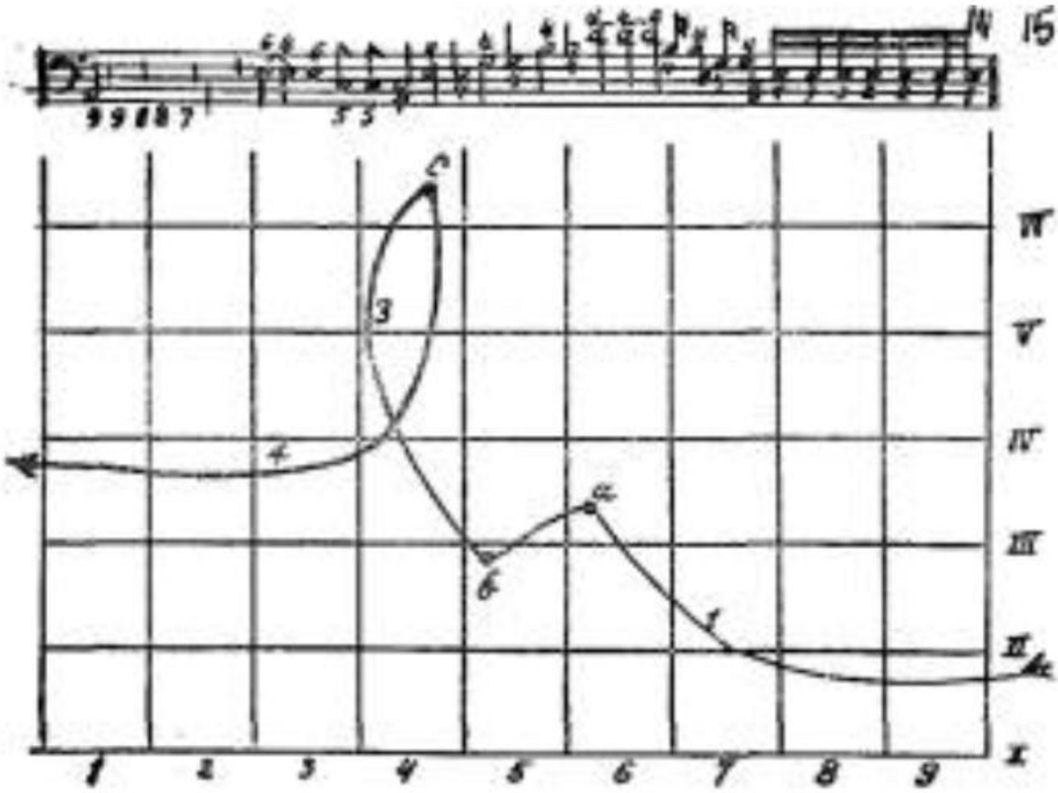

Figure 38. The actor's graph and the location of this movement in Ivanov's system (Varpakhovsky, 1978).

The stage area is divided into a number of squares by lines perpendicular to the lines of the floor. The movement of each actor is recorded on separate lines, so in scenes in which a large number of actors take part, the recording becomes similar to an orchestral score (fig. 39).

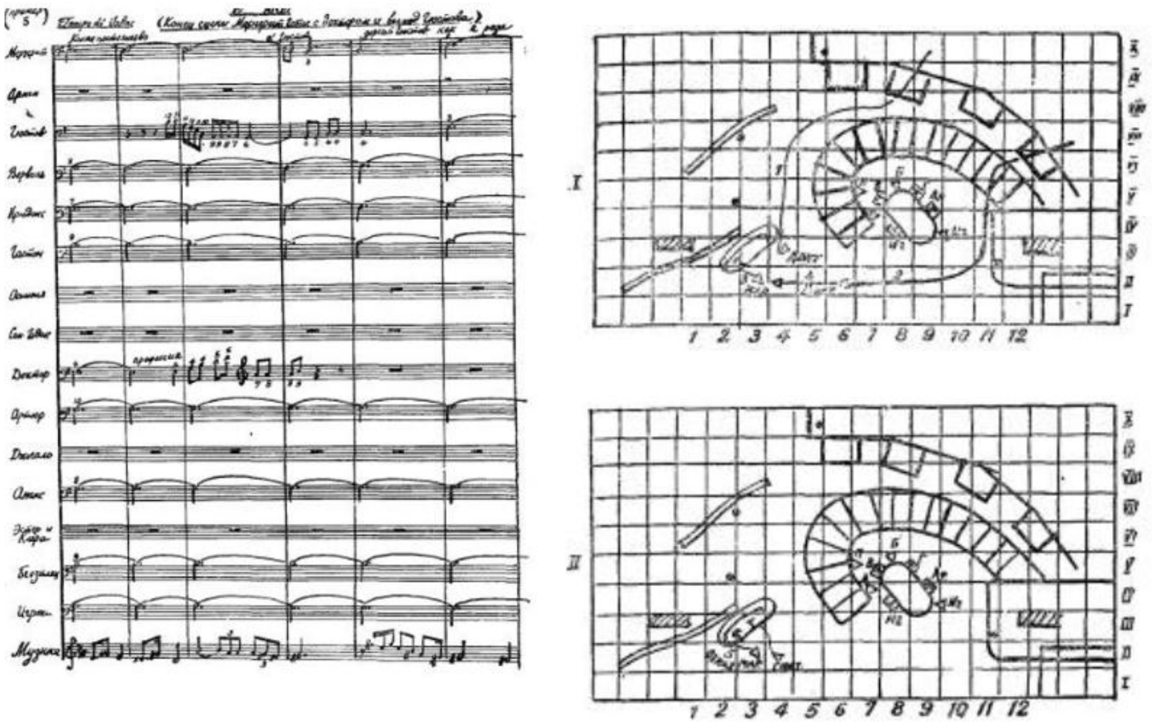

Figure 39. Marguerite Gautier's meeting with Gustave, recorded in Ivanov's system and on the plan. Graphic mise en scène (Varpakhovsky, 1978).

Recording Sound in the Theater

Unlike ballet, the sound notation of theatrical productions did not have its own iconic recording system. Recording the features of speech required its own recording system. A great difficulty was the indication of pitch (melody of speech), style (degree of loudness or accent), and speed (tempo and rhythm of speech).

The Theater of Vsevolod Meyerhold was a real experiment in which among other things, the sound part of the performance is fixed. In 1933 at the Theater named after him, Meyerhold organized a research laboratory. A group of researchers (Varpakhovsky, Sano, Held and other theater workers) studied Meyerhold's rehearsals and performances. Originally, to show a pause in the text, they just wrote "caesura" or “pause.” But it was not clear how long the pause was, whether it lasted one second or five. Later, to show pauses researchers began to double the spaces, and to fix the pause they used a line, its length indicating the time interval. In the copy of the play *The Lady of the Camellias* all the stops were recorded in the speech made by the actors in the performance of April 10, 1934. The arrangement of caesuras indicates the extreme excitement and resentment of the heroine. In the ragged rhythm of speech, not only its internal state is felt, but also the form of expression (fig. 40). Then there were experiments regarding the objective and accurate fixation of the metro-rhythmic structure of the actors' speech.

МАРГЕРИТ. В таком случае, надо любить меня поменьше или понимать получше. Будь я женщина свободная и обеспеченная, я бы не приняла графа. Вам потребовалось узнать каким способом? О, господи, не мудрено догадаться! Ведь я просто могла сказать вам мне надо пятнадцать тысяч франков. Вы молоды, влюблены в меня и, конечно, достали бы эту сумму. Я жалела Вас. Вы не поняли моей деликатности! Со стороны Маргерит Готье, подобное соображение называется деликатностью. Я приносила невестную жертву, я брала известные обязательства. Я думала о, хоть бы чуточку безмятежной жизни где нибудь в деревне, в лесу, вместе с ним я забыла бы о тяжелых днях моей жизни. А через три-четыре месяца мы вернулись бы в Париж, крепко пожали бы друг другу руки и дружба возникла бы там, где вчера была любовь. Нет, не будем говорить об этом. Ты бываешь у меня всего четыре дня, ты ужинал у меня, пришли мне какую нибудь безделушку с твоей визитной карточкой и мы будем квиты.

Figure 40. Margarita is a monologue by Zinaida Reich from the second act of the play *The Lady with the Camellias* on April 10, 1934. censored copy of Neil (Varpakhovsky, 1978).

An analysis of the phonogram provided a completely objective picture of the rhythmic pattern of the Lomov-Ilyinsky's speech. After the study of the oscillogram – the curve produced by recording speech on tape – began, the Schorin system became very popular. It recorded sounds and then enlarged the phonogram forty times to make sure that each sound had its own imprint (fig. 41) (Smirnov, 2013). By changing the height of the envelope curve, it is possible to determine changes in the volume of the sound, and by the amplitude of the oscillations, changes in height.

The principle of Guido of Arezzo was used in The Meyerhold Theater to record changes in the melody of speech. In this case, only three gradations of pitch were recorded: above the line, on the line, and below the line (high, normal, low). Such three-degree gradation was also applied in relation to the volume of speech (quiet, normal, loud). Graphically it was expressed by changing fonts. In the score, as in any book, there are right and left pages. The right hand was reserved for the recording itself, and the left hand was used for additional reference material consisting of plans (Varpakhovsky, 1978).

Figure 41. The phoneme of the vowel sound A under stress (above). The phoneme of the stressed vowel O (below) (Smirnov, 2013)

Leonid Varpahovsky suggested that each character's speech be recorded on its own lines, indicating the speed and volume of the pronunciation. Varpahovsky's system, like most ballet movement recording systems, is based on a lined score. All characters in such a score have their own row of lines on which their text is marked. Varpakhovsky suggests distinguishing between three speeds of utterance and making appropriate designations: fast speech, normal speech, slow speech. Another important parameter when uttering was the volume of enunciation: quietly, mezzo forte, loudly. Next to the words on which the logical accent of the phrase is placed, there is either a dash mark (–) or an apostrophe mark ('). Varpahovsky takes the montage method of recording actors' movements as the basis for his graphic recording. Each actor is denoted by an isosceles triangle, within which the first letter of the character's name is written in order to distinguish the movement of different characters on stage. A character's movement is indicated by a line. If an actor makes a brief stop during a transition, it is indicated by a dot on the line. Slow actor transitions are drawn with a solid line, and fast ones are drawn with a dotted line (Gaiduk, 2017, p. 309).

German playwright, theater director and the first Master of the stagecraft workshop at the Bauhaus art school Lothar Schreyer created a unique graphic and highly artistic notation of a theatrical performance (fig. 42). It was called the Spielgang notation system from the German words *Spiel* (play) and *Gang* (gait or walking movement) (Buckley & Arbor, 2019). "This notation results in an independent dramatic work, fixed with symbols and words, which Schreyer calls *Spielgang*. A peculiarity of *Spielgang*, which can be conventionally translated as score, is the active integration into the language of the play of signs replacing individual indications in the author's remarks" (Schreyer, 1920). Lothar Schreyer used musical stanza, special symbols, and colors to express the actors' speech. (Schreyer, 2001). Schreyer uses three rows of lines for recording: the upper row records words and sounds, the middle row records the rhythm, pitch and volume of the actors' speech, and the lower row records the actors' movements and gestures. Schreyer suggests using not only different symbols for pitch, loudness and tempo, but he also actively uses colors: for example, yellow color indicates high sounds, and blue color indicates low sounds (Gaiduk, 2016). Speech loudness was recorded in musical notation crescendo (<) dimiduendo (>).

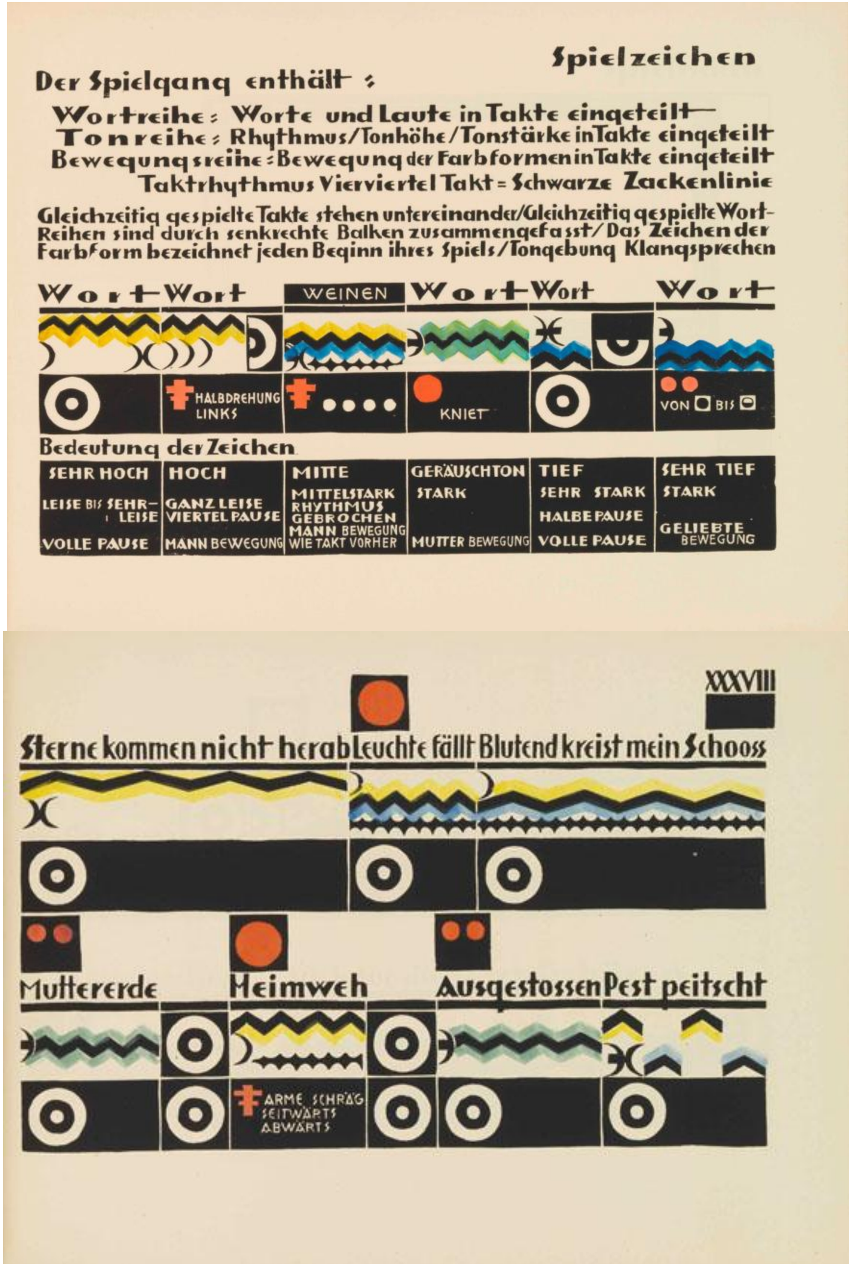

Figure 42. Lothar Schreyer *Kreuzigung Spielgang* Werk VII Hamburg, 1920 (Schreyer, 1920)

Synthetic Recording

The Studio of the Projection Theatre, created by Solomon Nikritin and Sergey Luchishkin in 1922, combined and dissected movements and speech. Projection Theater was adopted by the Central Institute of Labor (CIT) and became a kind of testing ground for the future. The Central Institute of Labor saw the studio as a testing ground for organizing the expression of labor methods on stage, towards creating an objective theater of contemporaneity and, ultimately, a theater of normalized labor which used different forms of notation (fig. 43).

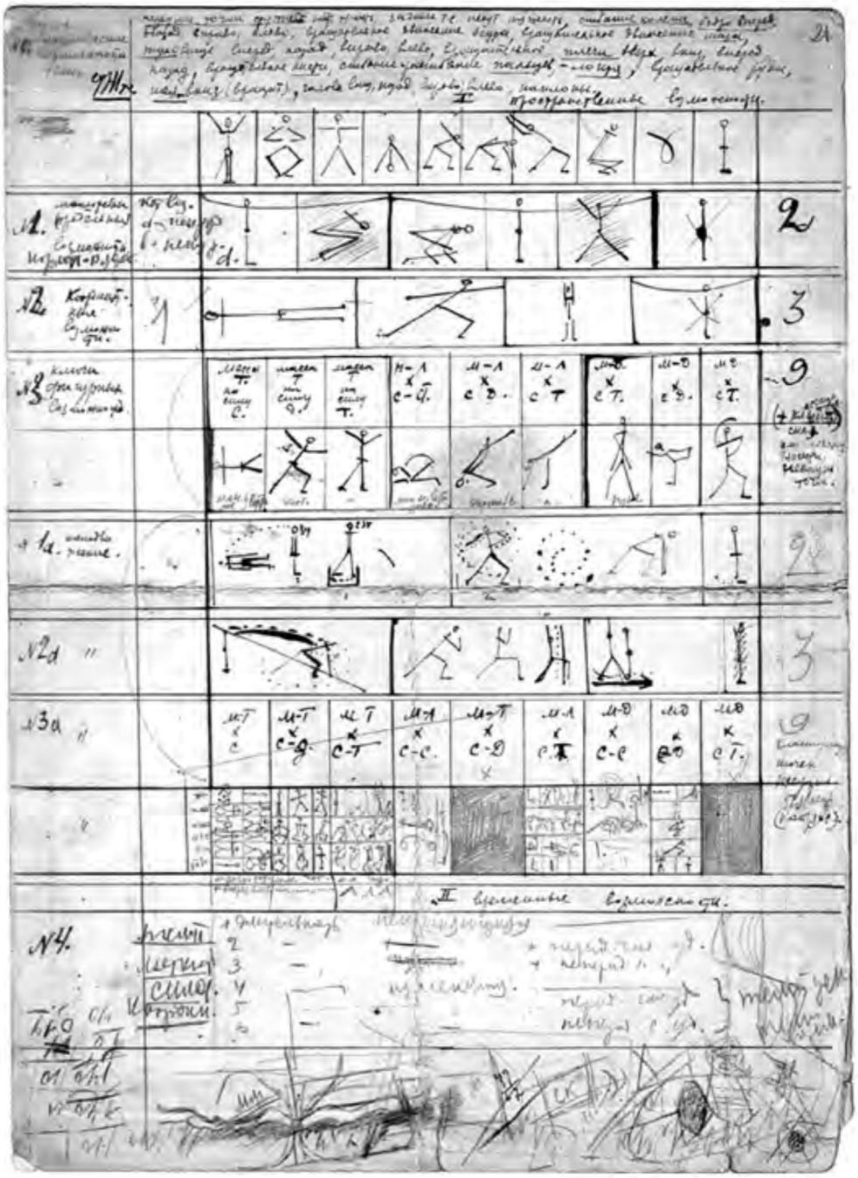

Figure 43. Nikritin's notes (Misler, 2004, p. 364)

Luchishkin wrote:

> We started to implement our experimental concepts by working up action scores by analogy with a piece of music, composing them out of different parts together with different rhythmo-dynamic characteristics. After that, we looked for the form of plastic expression in each part within the movement of the body, for the development of this movement, and for its nuances and transitions, including vocal resonance. All this was tinged by the emotional score which became the basis of the entire action. (Misler, 2004)

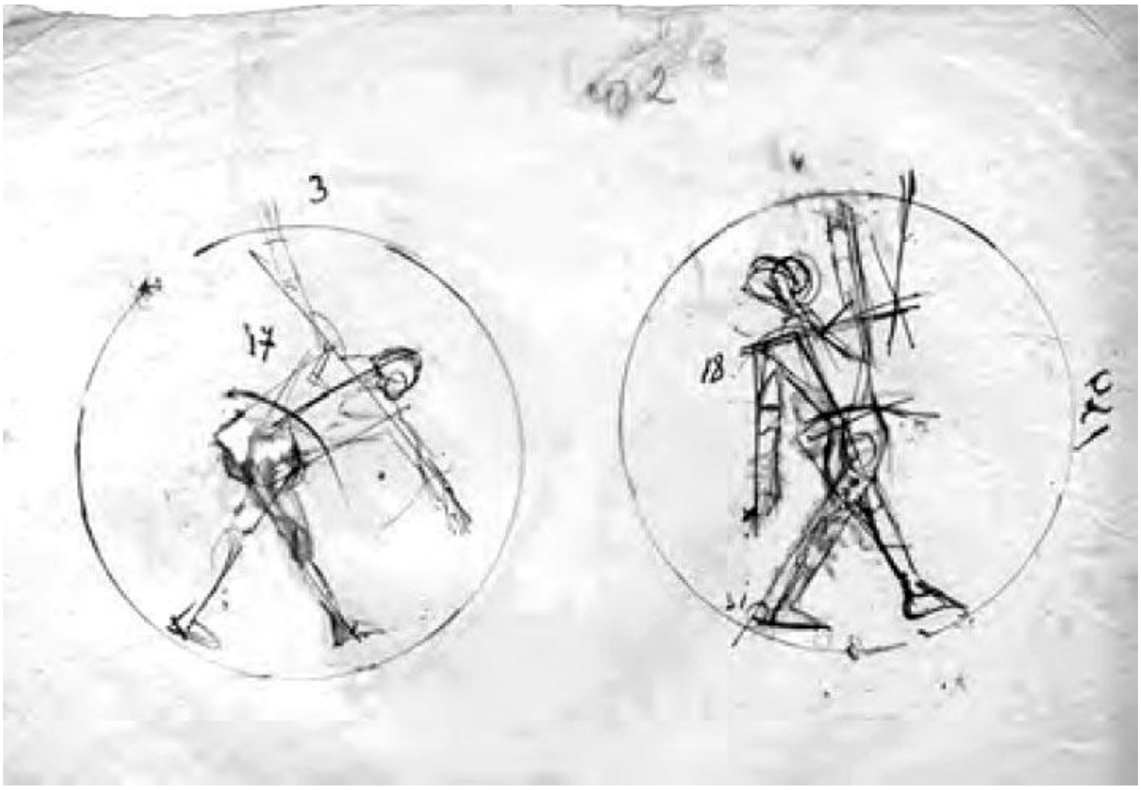

Figure 44. Solomon Nikritin, c. 1922. The notion of the *Octave* – the maximum area mechanically reachable by the dancer with their feet in a fixed position (Misler, 2004).

Nikritin developed, for example, biomechanical temperaments and scales of body movements. He tried to classify human movements, based on the principles of biomechanics and musical harmony. Nikritin introduced the concept of the octave as the basis of metrics. At fig. 44 he defines the maximum area to which a dancer can mechanically reach when his feet are in a fixed position (Smirnov, 2013).

Nikritin's notation was incomprehensible to the common viewer, but quite informative in terms of the staging of movements. He is not interested in the connection with space and time. But the voice plays an important role. In *Program on Sound* of the Projectionist Theater

Sound is a self-sufficient material. The process of sounding itself should be influential. Formation of the sound. Inventory and analysis of the sound material. The attitude to sound material in other theatrical schools. The way the sound material is considered at the Projectionist Theatre. (Smirnov, 2013)

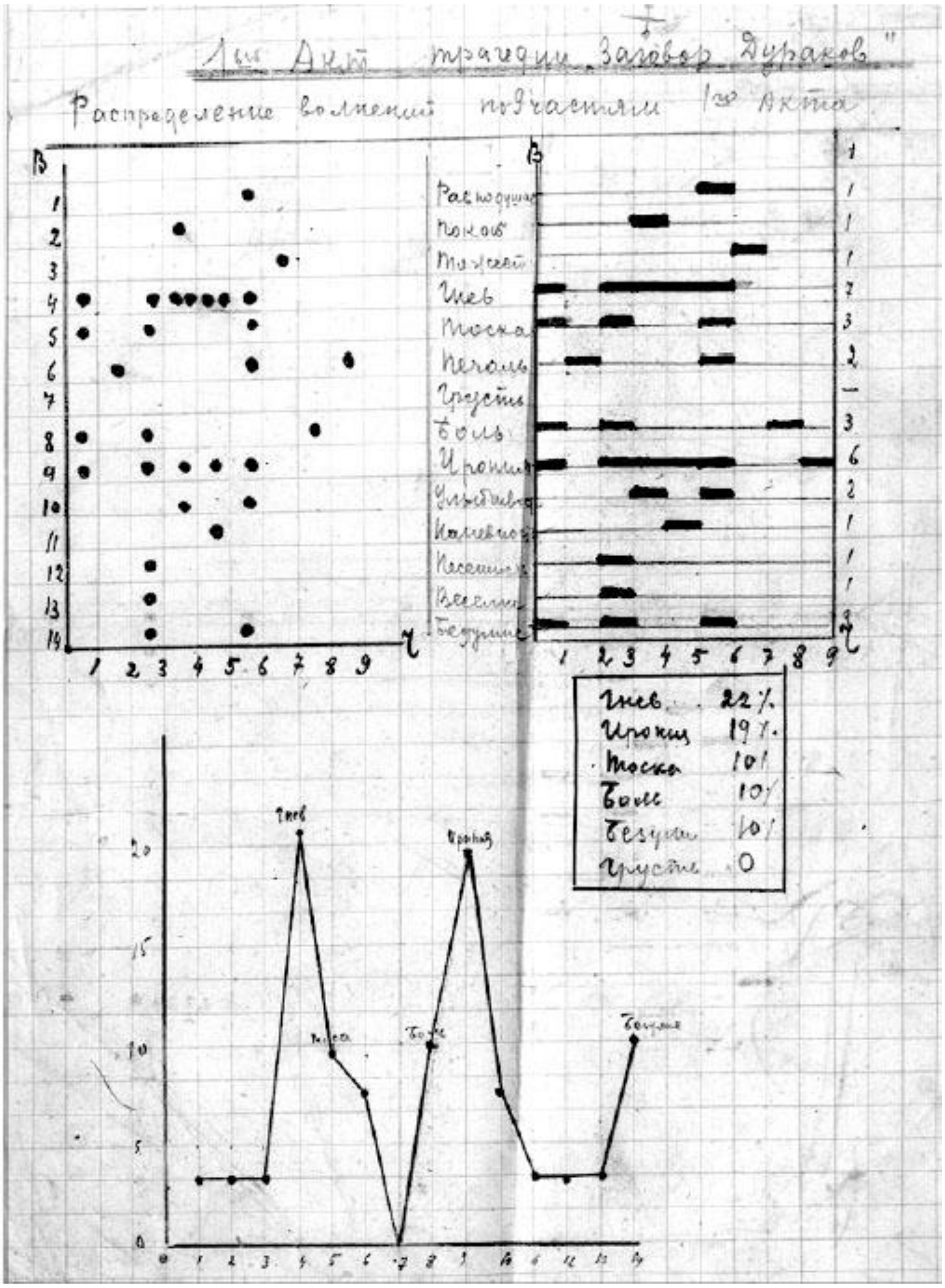

Figure 45. Solomon Nikritin. 1922. Statistical graphs of the distribution of the quantitative and qualitative presence of various emotional states in the first act of *Conspiracy of Fools* at the Projection Theatre (Pchelkina, 2013).

For the first act of *Conspiracy of Fools* which consists of nine parts, Nikritin made the first table in which he indicated the distribution in time of various emotions, such as anger, melancholy and sadness, reduced them to percentages and placed them on a graph (Fig. 45) (Misler, 2004, p. 364). Here we can see not only the essence of emotional experiences, but also their degree.

Sergei Luchishkin drew a Diagram of Emotional Excitement (fig. 46). The horizontal axis representing a timeline that is divided in sectors which indicate different situations: street, queue, madhouse, jubilee etc. The vertical axis indicates the state of emotional excitement of three actors. Actors were intended to express particular emotions by means of voice in combination with corresponding body movements (Pchelkina, 2013, p. 154)

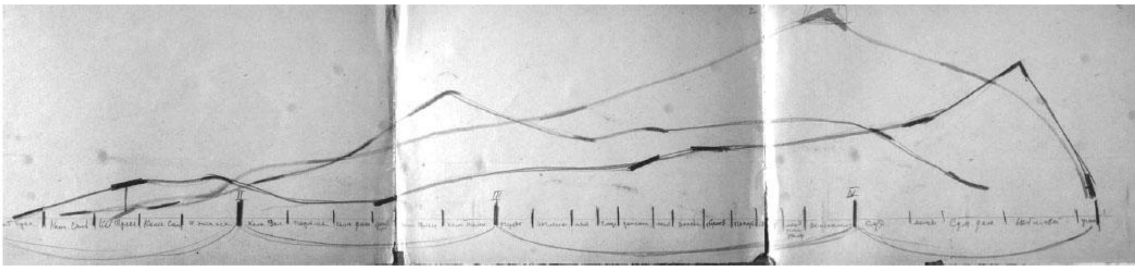

Figure 46. Diagram of the Emotional Excitement. 1920s (Pchelkina, 2013, p. 154).

Nikritin tried to assemble a unversal system for the whole of theatrical action. He writes that the keyboard of scenic movement consists of eight basic *Octaves of Phonetics of Movement*: 1) Octave of the first circle, abnormal stress from motionless point working body, 2) Octave of big horizontals, 3) Octave of verticals (obstacle), 4) Touch Octave, 5) Tragic Octave, 6) Comic Octave, 7) Satirical Octave, 8) The Octave of small contrasts. (Nikritin, 1922). Nikritin developed a system of human movements and gestures, color paletts, sounds (mainly related to the human voice), emotional states (based on the principles and terms of biomechanics), musical harmony and acoustics.

TECHNOLOGY RECORD

In the previous section, we talked about recording a performance primarily by the person who is producing it, who thinks through and records its plan. However, in the twentieth century there was a great interest in the fixation of events – an automatic, technical recording.

In 1921 the State Academy of Arts of Russia established the Laboratory of Dance Composition (since 1923 the Choreographic Section) where photo and video fixation of experiments in the field of body movements was carried out. Experiments on the fixation of movements were also carried out at the Institute of Labor under the direction of Nikolai Bernstein.

Vsevolod Meyerhold used in his productions the original graphical method of fixation on the basis of the chodometer of Varpahosky and Siano, which worked synchronously with the sound recording equipment. The main part of the chodometer was a coupling through which the tape moved from one reel to another. At the top of the sleeve were eight scribes – ink pens – each lowered onto the moving tape by the action of a magnet. Each scribe was controlled outside the device by pressing a special button, and there was a separate button for each scribe. At the moment the recording began, a button was pushed that actuated the mechanism of the electric clock. The mechanism would immediately time the start point on the tape and then every six seconds until the end of the recording. Each member of GosTIM's NIL was assigned to record the mise-en-scene of only one actor. At the moment the actor's movement began on stage, the button corresponding to the actor was pressed, and this button was released at the moment the actor's movement ended. Thus, the paper tape recorded, first, the fact of the actor's movement, second, the time of the beginning and the end of the movement, as the chodomer was equipped with a special clock, and, third, the duration of the movement itself (Haiduk, 2017, p. 309; Varpakhovsky, 1935).

The possibility of videotaping removed many of the issues associated with the ability to record what was happening on stage. It did not solve the problem of recording the performance, but the question has lost its relevance. Valerie Sutton notes,

> For all the machinery that has been developed in this century, no machine can replace the important ability of being able to write a language. The classic example of this is in music, where, though the tape recorder can record symphonies, orchestras of musicians still learn the music from the printed page. (Sutton, 1981)

Sutton here describes the asymmetry of the tape recording as a mere recording device and the written notation which is simultaneously an inscription and a score that instructs the repetition of the performance. It is therefore, that notations as scores play such an important role in philosopher Nelson Goodman‘s (1976) 20th century reflections on *Languages of Art*.

At the same time the attitude to the new technology was different. While Meyerhold hailed the arrival of film and saw in early cinema's techniques, others like Craig, Artaud, and Schreyer recoiled from the new medium, which seemed fully capable of swallowing drama as a whole, stepping into what is specific to stage performance in the era of the "photoplay" (Buckley, 2014). In any case, a two-dimensional image shot from a certain point is not enough for a detailed analysis of the production and it can function as a self-sufficient final product which can be replayed but does not need to be re-eneacted.

Interestingly, with the development of digital technology and robotics, movement notation is becoming relevant again. Once again there is a need to break down the movements into components and compose them into whole compositions, whether for digital training of humans or non-human entities. The 'Web3D dance composer' for ballet e-learning is based on the separation of elementary petit allegro ballet steps that are digitally acquired through 3D motion capture systems, and categorised into families and sub-families. (Umino et al., 2009). The use of notation in motion capture can significantly reduce the cost of technology that is usually only available to major film and game companies (Calvert, 2016).

In addition, the combination of notation and modern technology allows the creation of new art objects (Papadopoulou & Schulte, 2016).

New techniques and notation are also being created for the purposes of digital notation. As early as the late 1960s, Noa Eshkol and her team were invited to the Biological Computer Laboratory at the University of Illinois to create computerized visualizations of the movement paths described by Eshkol-Wachman Movement Notation (EWMN).

The Eshkol-Wachman movement notation is a system to record movement on paper or a computer screen (fig. 47, 48). It was developed by choreographer Noa Eshkol and architect Abraham Wachman. It was originally developed for dance to enable choreographers to write a dance down on paper that dancers could later reconstruct in its entirety, much as composers write a musical score that musicians can later play. Figure 47 shows an example “Stick figure” and “Law of ‘light’ and ‘heavy’ limbs”, basic concepts and rules EWMN.

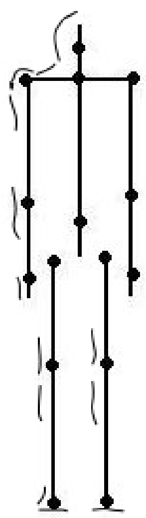

Figure 47. ‘Stick figure’ (Eshkol & Wachmann, 1958, p. 27)

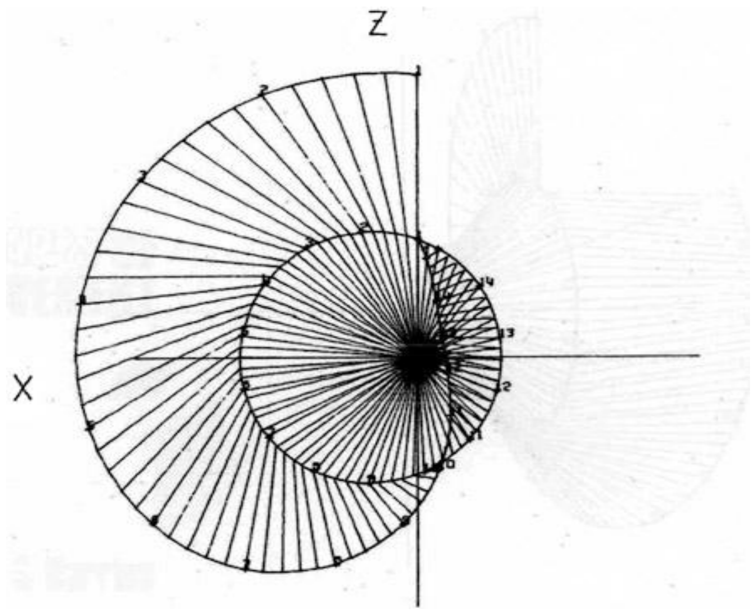

Figure 48. Eshkol's Space-chords of simultaneously moving abstract limbs (Drewes, 2016, p. 93)

The example of an EWMN score in fig. 49 is read from left to right. Horizontal spaces represent the different limbs and their parts which are nominated at the beginning of each space. Positions and movements are analysed along a spherical system of reference, the moving limb being the axis. Numbers and small arrows are used to indicate the coordinates of each position or movement within the circular form drawn by the moving part of the body. Other signs are used for indicating contacts, relationships, flexions/extensions etc. Vertical lines delineate time units and thick lines represent bar lines (Challet-Haas, 2016).

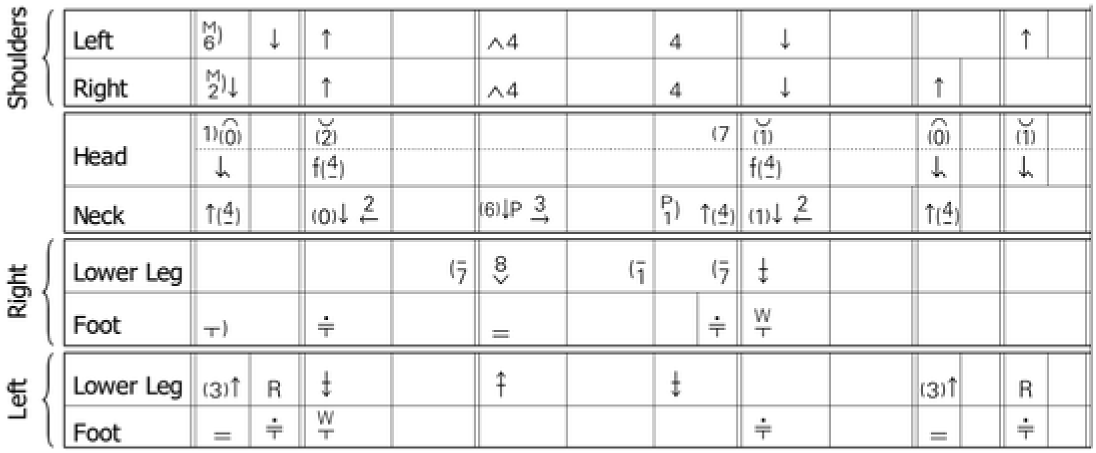

Figure 49. Example of an EWMN score Movement language for 3D visualization and composition of Dance An extract of *Dove* from the composition *Birds* by Tirza Sapir. (Drewes, 2016, p. 98)

In the 1970s, numerous attempts were made to digitally notate dance (Badler & Smoliar, 1979; Smoliar & L. Weber, 1977). Computer programs allow you to speed up the process of transcribing movements and offer neat scores (for example, LINTEL LabanDancer, Labanwriter by Dance Department of Ohio State University, Emote, Nuntius, MacBenesh, Dance-Forms, GenLaban). There are the Eliane Mirzabekiantz Benesh Movement Notation for Humanoid Robots and Henner Drewes: MovEngine-Developping a Movement language for 3D visualization and composition of Dance.

Notations are a convenient basis for representing and analyzing expressive movement, for artificial agents, such as animations, kinetic sculptures and environments, and robots. In particular for characterizing and generating expressive movement (Burton et al., 2016). Combining a dance notation system with a robot programming system allows one to compare and enlighten differences between robot and human movements (Salaris et al., 2017).

CONCLUSION

The possibility of capturing complex representations on paper seems a daunting task because of the sheer number of variables that change their values in space and time.

It is no exaggeration to say that it is a record of a certain quintessence of life in its three-dimensional and temporal dimension. It is not without reason that ancient Chinese notations diagrammatically represented the universe (Strauss et al., 1977, p. 7). Not being able to record everything, the authors of notation fictionalized what they considered to be most important. Most often this was necessary to transmit knowledge to others.

Forms of recording productions are specific languages that appeared, spread in interested circles, faded away, to be revived again in new variants. In the field of dance notation, we can say that there are several of the best known and most used "languages," which does not deny the possibility of using different systems by different authors. At the same time, the type of notation is related to the peculiarities of the dance and cannot always claim to be universal. There is no recognized system of signs in the theatrical environment at all.

Rich variability, the use of letters, numbers, notes, arrows, specific iconic, symbolic signs associated with body movements, various ways of indicating spatial and temporal location, notation of voice features, and the interaction with things makes the study of performance records a rich research material not only from the perspective of theater history, but also from the perspective of semiotic systems. Unlike letters and notes, motion recording conveys what can be visually clear, so the desire to use iconic signs that can be easily read by anyone without special knowledge is understandable. However, a developed symbol system can convey more information (including, for example, movement time, which cannot be recorded iconically), but requires special training in the meaning of symbols. As Murphy (2021) notes, this form of notation is complex and can only be used and understood by small numbers of people. The system of notation of voice can also be intuitively clear or with specific notations. Thus, depending on the code, the semiotic systems used can be either publicly available or privileged. For example, Schreyer sought to keep his handcrafted book-cum-performance score *Kreuzigung* (crucifixion) restricted to the “spiritually select” (Buckley & Arbor, 2019).

The great advantage of notation over videotaping is the intellectual work behind it, the analysis and synthesis of the elements that make up the essence of what is happening on stage. A person does not need to look through a video file, which can be quite large, to understand the essence of what is happening. This is why the notation is in demand today for motion analysis and to generate 3D character animation, motion capture, digital learning of humans or non-human entities. This is why it is nowadays used in many areas of both art and digital technology.

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Research article

Visualizing the Composition: A Method for Mapping Inscription and Instruction

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Abstract

How are instructions mediated by technical artifacts? What role does technology play? From a Latourian perspective, these questions have to do with composition. The purpose of this article is to review Latour's approach to Science and Technology Studies (STS) and, more specifically, to review and assess his visualization practices. According to Latour, science and technology are not two separated domains. Scientific facts are obtained through cascades of mediation of heterogenous components, and the manufacture and use of technical artifacts is a co-action by humans and non-humans. Latour's STS approach contributed toward the development of Actor-Network-Theory (ANT), which seeks to provide performative narratives of things by tracking their traces and transformations. These analyses reveal a key concern of the composition of things. For Latour, everything that occurs in the world is a hybrid assembly composed by humans and non-humans; we therefore need proper methods to map out the associations clearly and gain a better understanding. Along with attempts to develop theoretical analyses, Latour has also conducted visualization practices to perform the interwoven nature of things. I argue that visualization practices, which are endowed with performative power, can be treated as a supplement to STS research, functioning as a practical method of ANT to show how things are composed and, conversely, providing more cases for theoretical analysis.

Keywords: STS; Bruno Latour; Inscription; Script analysis; Composition; Visualization; Controversy mapping

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Научная статья

Визуализация композиции: Метод отображения надписей и инструкций

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Аннотация

Каким образом инструкции опосредованы техническими артефактами? Какую роль играют технологии? С точки зрения Латура эти вопросы связаны с композицией. Цель этой статьи — рассмотреть подход Латура к исследованиям в области науки и технологий (STS) и, в частности, рассмотреть и оценить его методы визуализации. Согласно Латуру, наука и технология не являются двумя отдельными областями. Научные факты получаются посредством каскадного посредничества разнородных компонентов, а производство и использование технических артефактов — это совместное действие людей и не-людей. Подход Латура к STS способствовал развитию акторно-сетевой теории (ANT), которая стремится обеспечить перформативное повествование о вещах, отслеживая их следы и трансформации. Данный анализ раскрывает ключевую проблему состава вещей. Для Латура все, что происходит в мире, представляет собой гибридное объединение, состоящее из людей и не-людей; поэтому нужны надлежащие методы для лучшего понимания. Наряду с попытками развития теоретического анализа Латур также проводил практики визуализации, чтобы показать переплетенную природу вещей. Я утверждаю, что практики визуализации, наделенные перформативной силой, можно рассматривать как дополнение к исследованиям науки и технологий (STS), функционируя как практический метод акторно-сетевой теории (ANT), чтобы показать, как устроены вещи, и, наоборот, предоставляя больше случаев для теоретического анализа.

Ключевые слова: STS; Исследование науки и техники; Бруно Латур; Надпись; Анализ сценария; Композиция; Визуализация; Картографирование

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INTRODUCTION

The term "instruction" usually refers to a statement about what and how something is to be done. The most common scenario in which we encounter instructions is when we buy a new product and find inside the package an instruction manual which tells us how to use it. However, sometimes we simply don't need to read the manual: from the product itself it is obvious how to use it.

A design philosophy known as "Without Thought" has been prevalent in industrial design. It was introduced by well-known Japanese product designer Naoto Fukasawa. Fukasawa (2016) holds the view that "the impetus for design is found in people´s unconscious behavior"[1]: he believes that a good design is one that enables users to work with their intuition. One example of this is a rice cooker, which looks elegant simple and has a small protrusion on the top of the lid. Usually, looking for a clean place for the used scoop disrupts the action of serving rice. With this small protrusion, users can now lay the scoop on it naturally and the action is not disrupted. It is an action performed out of intuition, so there is no need to read the instruction manual. In this case, "instructions" are not "given" to users literally; rather, they are conveyed by the material shape of the product alone. Another famous product designed by Fukasawa is a CD player. It looks like a ventilation fan equipped with a rope attached beneath it. To turn on the device, users need to pull the rope, just as they would turn on a fan. The shape of the product prompts its users to do so. Fukasawa (2016) calls this "a shape with the operation included" (p. 19). Here, things not only bear and convey messages, they also have the power to change and guide action, and this power derives directly from their materiality. To put this in terms used by Akrich and Latour (Akrich & Latour, 1992; Latour, 1994), the instruction is translated into concrete shapes and the product itself contains a "script", such as "please place the scoop on the protrusion" and "please pull the rope."

The world in which we live is full of material artifacts. After many years of neglect, artifacts are making a comeback among scholars of the philosophy of technology, post-phenomenology and STS (e.g. Ihde, 1979; Latour & Woolgar, 1979/1986; Latour, 1994, 2007; Verbeek, 2005). As a participant in this discourse, Latour proclaims resolutely that we should give material artifacts their due, that we should treat both humans and non-humans symmetrically (e.g. Latour 1994, 2005a, 2007). Since their early book *Laboratory Life*, Latour and Woolgar (1986) have consistently focused attention on what they termed "literature inscription" and the inscription devices that most sociologists of science had hitherto ignored (Schmidgen, 2012). Along with their appeal for symmetrical relations are a return to materiality, Latour's studies focus on performativity: they are about tracking chains of mediation in order to show the geneses of science, technology, society and many other "fixed" domains. This approach also gives rise to the crucial inquiry into the composition of things, and for Latour the philosophy of science and technology is related precisely to this. In addition to his theoretical analyses, Latour is involved in several practical visualization projects. In this article, we will review both his theoretical analyses and

[11] See the introduction page of the website of Naoto Fukasawa, https://naotofukasawa.com/about/

practical visualization practices and discuss how visualization practices can contribute towards future STS work.

CONSTRUCTED SCIENTIFIC FACTS

Latour distinguishes between ready-made-science – an already settled scientific controversy – and science-in-the-making – an open dispute on which scientists are still working. The focus of his science studies lies on the latter, namely, on the history and genesis of science, on the process of how scientific knowledge is made. Latour describes his research as “opening Pandora’s black box” (Latour, 1987, p. 1). He points out that every fact has its history. A fact is neither isolated nor “bald”, rather it is “hairy”, historically situated. Before a statement is perceived as an undisputed one, the question that prompted it was still an unsettled controversy. Not until a statement has been accepted by others is the open dispute settled and a corresponding scientific fact constructed. Science in action thus turns into ready-made science. Accordingly, the uncertainties, controversies, manipulations, instruments, chemicals and people involved in its generation will be enclosed inside a “black box”, with all processes and prior traces erased; no matter how and why this controversy was settled, the scientific statement stands as “fact”, as if it had been there from the outset. What Latour attempts to do is reopen these “boxes” and to take us back to study the controversies before the boxes were closed (Latour, 1987).

Observing the daily work of scientists, Latour sees the laboratory as “a system of literature inscription” (Latour & Woolgar, 1986, p. 52). Inscription is a term borrowed from Derrida, but here it has a broader meaning than just writing. It designates “all traces, spots, points, histograms, recorded numbers, spectra, peaks, and so on” (Latour & Woolgar, 1986, p. 88). It is the end product of a succession of experiments, visually displaying the content and context of a series of experiments. Inscription is also an “immutable mobile” (Latour 1986, 1987). It is readable, superimposable, combinable with other immutable mobiles, and can be easily brought to one place, modified, recombined, superimposed, integrated and printed as figures in a scientific article. Even after very many years, when laboratory samples or conversations between scientists are unlikely to have been preserved, inscriptions and articles can last for long. Different times, spaces and disciplines are linked together by accumulation of these immutable mobiles – they provide a ready glimpse into what scientist did even in distant lands or long ago.

Inscriptions are obtained from a certain arrangement of inscription devices. An inscription device is an instrument, “any set-up, no matter what its size, nature and cost, that provides a visual display of any sort in a scientific text” (Latour, 1987, p. 68); the NMR spectrometer in Roger Guillenmin’s laboratory (Latour & Woolgar, 1986) is such an example. Experimental materials taken from nature are transformed into a fixed inscription in a scientific paper. In the laboratory, scientists breed experimental rats, they classify, cut, mix, mark, record, handle them with various items of apparatus; they process numerous data, comparing and merging them to generate images. In this process, all three-dimensional materials are gradually abstracted into two-dimensional diagrams, tables, charts and curves. This abstraction is ultimately all that counts. From a real rat to a chart, from a chart to a simpler chart, forms become less and less material and more and more abstract through cascades of visualization performed by inscription devices. Successive transformations make up a chain of references, and continuous chains that turn tangible materials into abstract forms give rise to the final conclusion (Latour 1986, 1987, 1999a; Latour & Woolgar, 1986).

These chains are obtained through mediation. Mediation is a modification of the meanings and elements transported in chains of references and networks. It is not just transportation, its synonyms are translation, transformation and manipulation (Latour, 2005a), which means that each segment in the chain needs to be obtained by mediating the former one, its meaning is transformed or modified on its way to the next stage in the chain. Therefore, to visualize something or to make an image is to mediate, transform, translate, and manipulate. Scientific images are not simply re-presentations of nature; instead, they are mediations to reality. What really matters is not any isolated inscription per se, but rather the chains of transformation behind the visual (Latour, 1986, 1998). One single image or diagram without any connection with other visuals or materials cannot provide any credible knowledge; it is the chain of references indicating how this visual is transformed step by step to this stage that achieves this (Latour, 2005b, 2014). Statements are regarded as reliable due to the existence of these chains of references which can be traced back. The traceability of chains endows them with truth value. If any section of the chain breaks, no truth can be gained, because the truth value cannot be transported and translated into the next section. The length of these chains of references has no limit: both ends could be extended and attached to other forms. Moreover, different chains can intersect, forming crossing points through which form is transformed and truth value can flow. Scientific facts are constructed in this way (Latour 2008b).

Further, it is not only the effort of scientists that counts. Inscription devices, chemicals, financial support from other institutes and even laboratory architecture all play a role as well. All components and actions are involved. Subjects and objects and all natural and social components should be taken into account. Latour introduced the term “actant” to cover all humans and non-humans that play a role in such processes (Latour, 1987, 1999a, 2005). Both subjects and objects are mobilized and connected in the network. They adapt each other mutually and cannot be separated clearly from one another (Latour, 1999a; Wieser, 2012). Thus, Latour rejects the so-called Great Divide: there is no such thing as a world of human entities and another world of non-human entities, and thus no absolutely strict divide between what we call natural and what we call social. What happen in the world are rather hybrid, heterogeneous, entangled and interactional associations of human and non-human components (Latour, 1987, 1993, 1999a). In this sense, things are no longer conceived of as solid, unitary, isolated, prematurely naturalized matters of fact, but rather as complex, entangled, attached, historically situated, multi-faceted matters of concern (Latour, 2004).

Science is thus a consequence of networks that mobilize and gather all human and non-human elements from all places and times using innovative inscription devices. It is advanced by drawing things together through cycles of accumulation. The history of science is the history of mobilization and of the innovations introduced by new visualization devices. It is by means of these mobile and immutable inscriptions that relevant allies can be assembled in one place, enabling scientists to solve scientific problems and to propose and prove their theories. The innovations embodied in new visualization tools along with the ability to manipulate inscriptions have contributed towards settling controversies, and have thus become one of the main forces promoting the tremendous progress of science and technology (Latour, 1986, 1987). Thus, to know something is not a process that happens only in the mind; it is “thinking with eyes and hands”, a praxis of “drawing things together” (Latour, 1986). The emergence of modern science and technology is a result of scientists being able to invent more inscription devices, working on papers and inscriptions, and being able to gather more and more immutable mobiles together. Now, then, we have a performative definition of scientific practice: it is an accumulation of inscription, a network of assembled hybrid components. Only through a cascade of mediation and displacement that draws all things together can scientific knowledge be constructed. The word “construction” here does not imply any opposition to realism (Latour, 2003). It does not mean that science is non-credible or unreliable; what it means instead is that it is only after step-by-step manipulation that we can obtain facts and objectivity. In order to get close to reality, much must be mobilized, gathered and manipulated (Latour, 2014).

TECHNICAL MEDIATION

There is a widespread view that technology is the application of science. However, as discussed above, inscription devices, i.e., technical artifacts, themselves contribute towards the development of modern science. For Latour, science and technology are not two separated domains; they are connected to and exert an influence on each other. He uses the term “technoscience” to cover “all the elements tied to the scientific contents” (Latour, 1987, p.174). Along with science studies, Latour also observes engineers in order to study chains of reference and analyze mediation in the making and use of technology. His script analysis with Akrich (Akrich & Latour, 1992) and technical mediation theory (Latour 1994) provide a glimpse into how technology influences our actions and the relations between humans and technology. Even today they continue to contribute much to the development of new theories in the philosophy of technology and design research, serving as background theories (e.g. Verbeek, 2011, 2016; Eggink & Dorrestijn, 2018; Fallan, 2008).

Akrich and Latour (1992) drew up a list of terms to describe the interaction between humans and technology in the manufacture and employment of technical artifacts. Akrich (1992) refers to the concept of “script”, which she defines as a scenario, “a program of action” that is pre-scribed in(to) technical artifacts. That is to say, designers or manufacturers predefine the circumstances regarding what users are supposed to do and what the results are expected to be. Latour points out that “Each artifact has its script, its ‘affordance’, its potential to take hold of passersby and force them to play roles in its story” (Latour,1994, p. 31). In other words, an artifact is not a mere tool or a neutral medium, but rather a mediator – it has the ability to influence the actions of users. To take two examples provided by Latour, a speed bump contains the script "Please slow down," while a hotel key with a heavy pendant attached implies the script "Do not forget to bring the keys back to the front desk."

Three other terms associated with the etyma of "script" are also worth explaining at this point:

Antiprogram: Since new technical innovations begin with controversies and conflicts, every program has its antiprogram and it is exactly the problem the designers want to solve. The "front line" is where a program and its antiprogram are confronted.

In-scription: Unlike the same term used in science studies, inscription here designates an act of translation. Through in-scription, the message is translated in order to "struggle with" antiprograms.

De-scription: This is the opposite movement to in-scription, a translation by analysts from things to signs.

Let's take the hotel key as an example to explain these terms better. It is a story Latour has told in many articles. A hotel manager wants his clients to return their key to the front desk every time they leave the hotel. This is the program of action through which he defines the clients, and the antiprogram is that many clients neglect or forget to return their key. In order to make the clients follow this program of action, the hotel manager devises many methods successively, such as making a verbal appeal, adding a written notice, and finally adding a heavy metal pendant onto each key. Each time the hotel manager makes a change, the front line between program and antiprogram shifts accordingly, as more clients return their key. After the heavy metal pendant is added, the majority of clients does what the manager defines in the script. Each change is designed to inscribe the message "do not forget to bring the keys back to the front desk" into different countermeasures. Finally, the message is translated by attaching a heavy pendant to the keys: the inscription is inscribed in a concrete tangible stuff. The hotel's clients do not wish to carry such a heavy object in their pocket all the time, and in this way they are forced "to be reminded to bring back the keys to the front desk." Each translation is a mediation. In this mediation, human (i.e. the hotel manager) and non-human (i.e. the heavy keys) co-act; they both play a role. Without the heavy metal pendant or with another material, the front line would move to a different place.

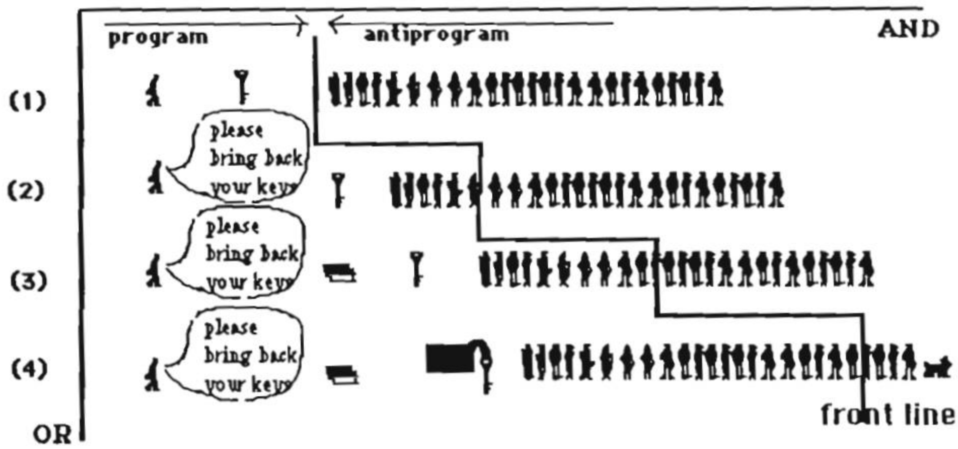

Figure 1. How the program and antiprogram look like in the case of a hotel key (Akrich & Latour 1992, p. 263)

In addition to the meaning of “mediation” discussed in relation to his science studies, Latour (1994, 1999a) develops four meanings of “mediation” while analyzing technology. The first of these is translation. As explained above, a technical artifact can translate goals, actions, and the competences of other agents. To take the example of shooting, the goal or intention of an angry man to hurt someone could be modified by the existence of a gun into the goal to kill. This modification is completely symmetrical regarding the man and the gun. While the man is modified by the gun from a regular citizen to a criminal, at the same time the gun is modified by the person: “a silent gun becomes a fired gun, a new gun becomes a used gun, a sporting gun becomes a weapon” (Latour, 1994, p.33). This symmetry then leads to the second meaning of mediation, namely, composition. “Action is a property of associated entities”, writes Latour (1994, p. 35). The shooting action cannot be accomplished without either the person or the gun. The one who performs the action is neither the person nor the gun themselves, but the hybrid of person and gun. Human and non-human co-act. The program of action is thus composed. However, the joint action always turns into a “black box” after composition. The relation inside the box becomes opaque to us, so that the non-human actants are regarded merely as a tool used by humans. Latour wants to open the black box to go back and observe the heterogenous assemblies that have occurred throughout the process. This, then, is the third meaning of mediation: reversible blackboxing. The last meaning of mediation is what Latour identifies as the most important one: delegation. According to Latour, technology does not produce meanings in the same way we humans do, but rather “via a special type of articulation that crosses the commonsense boundary between signs and things” (Latour, 1994, p. 38). In the case of the hotel key, the program of action which the manager pre-defines is inscribed and translated into a heavy metal pendant. It is neither a shift from one language to another, nor a shift from discourse to matter. The original message is transformed into a new one. Meaning is thus modified: the heavy weight makes the key impractical to carry so that the clients who return their key are not just responding to the message “do not forget to bring the keys back to the front desk" but are also reacting to their unwillingness to carry such a heavy object around with them. The shifts involved in this delegation are simultaneously spatial ("displacement from here to there and back"), temporal ("displacement from now to then and back"), and "actorial" (displacement from one actant to another actant and back), while in the case of setting there is also a material shift (displacement from signs to things and back) (Akrich & Latour, 1992, p. 260). For example, in order to force drivers to slow down, a speed bump is installed on the road (spatial) to serve as a "sleeping policeman" ("actorial") all day long (temporal), modifying the sign "Please slow down" to the actual hump in the road (material). These four "mediations" are connected to each other and occur together. The occurrence of "delegation" depends on the previous three (Latour, 1994).

The list of a "convenient vocabulary" is explicitly intended for a *Semiotics of Human and Nonhuman Assemblies* (Akrich & Latour, 1992). For Akrich and Latour, semiotics is not limited to signs; rather, it refers to the materiality of things as well: "it is the study of order building or path building and may be applied to settings, machines, bodies and programming languages as well as texts" (Akrich & Latour, 1992, p. 259). We exist neither in a world made up only of words nor in a world of objects alone. We are always in the Middle Kingdom, in a non-modern world (Latour, 1993) full of heterogenous assemblies composed by human and non-human actants. Latour seeks to develop a philosophy of technology that attends to the entire process (Latour 1994) in order to study order and path building (Akrich & Latour, 1992). This philosophy is a study of how technology (non-humans) and humans co-act in the fabrication and employment of technical artifacts, that is, a study of traces and associations, of network-like composition.

Even though the objects of the above-mentioned science studies and technology studies are different, it is possible to identify similarities in their terms, methods and conclusions. Starting from laboratory studies, Latour directs our attention to the genesis of scientific facts. Science, technology, society and every field we take for granted is the consequence of settling a dispute, not a starting point; it is constructed through chains of mediation. After the associations are made, traces and connections are closed off inside a "black box", becoming invisible. What STS researchers do is reopen the box to make the traces visible again. This approach can be extended further for studying other objects. In this perspective, "almost anything can be STS, from literature and politics, to art and engineering" (Mazanderani & Latour 2018, p. 299). Actor-Network-Theory (ANT) could be seen as a summary of this STS approach. This idea stems from a joint paper on the Leviathan by Callon and Latour (1981). ANT is not a complete theory of the "social" but a guide on how to provide a performative narrative of it. Latour compares ANT with perspective drawing (Latour, 1999b), because it is an approach intended to trace and "draw" connections. Like all things, society is not a pre-existing domain but a consequence of hybrid associations composed of humans and non-humans. From the ANT perspective, we should learn to view things from a trajectory of transformation and draw out the associated invisible networks. By following traces and trajectories, the associations among things can become clear and performative definitions emerge.

A KEY CONCERN OF HETEROGENEOUS COMPOSITION

When we study the genesis of things using ANT, the divides between human and non-human and those among domains gradually fade away. ANT shows that the world we live in is heterogeneous and that all its components have mutual effects on one another. Apparently fixed domains are the consequence of cascades of mediation. In effect, Latour attempts to blur all apparently clear boundaries; in his view there is no neat line between human and non-human, nature and social, or between academic disciplines. This means that each technology, product, issue or problem we encounter is an assembly of heterogeneous actants co-acting together and irreducible to a single factor. The world in which we live is always a sphere of hybrid assemblies.

Latour’s statements challenge traditional ideas of epistemology and modernism. He regards epistemology in western philosophy as “the discipline that tries to understand how we manage to bridge the gap between representations and reality” (Latour 2008b, p. 94). For him, however, there is no such gap in the first place, and knowledge should not be understood in this way. Science studies provide another scheme: to know something is to mobilize more allies to deploy in a continuous chain so that truth value can flow forward and we become more “experienced” and cognizant of the knowledge thus produced. The separation of one world of nature from another of the social never existed. Latour seeks to dissolve the archaic dichotomous doctrines of subject-object, natural-social etc., which are deeply rooted in the mind of the public, in order that they might be liberated from the irrationality of prematurely naturalized “objective” facts.

Although one of the goals of STS is to critique the traditional epistemology is, it is not the ultimate goal. If the complex chains and associations contained within a thing are usually hidden, as in a “black box”, the task of philosophers is to reopen the box to sort out the complex chains involved. If we want to go one step further in the philosophy of science and technology, we are confronted with the crucial task of understanding how things are “constructed”, such as the question of how humans and technology interact during the operation of a machine. To date, STS and ANT have completed only some of the work of de-construction with their guide to observing the actants in things. They do not provide an accurate theory of how everything is composed, but rather constitute a preparatory framework for establishing a new epistemology. For Latour, ANT is a necessary thinking method. It provides us with an adequate way to understand science, technology, society and indeed all things in the world. After “de-constructing” an obsolete narrative we need to develop alternative narratives about world-building using the ANT approach (Mazanderani & Latour 2018): we need to follow the traces and trajectories of actants in order to identify the “associations” and “networks” that comprise things. We need to ask: How are things composed? Despite the general argument that humans and non-humans co-act, we still need to know exactly which humans and non-humans are involved. How do they co-act? How are actants transported and how is meaning transformed? What does an entangled connection look like? How can we make those connections visible? ……

Here, "things" is merely a blank that could be filled with any number of issues or artifacts.

It is worth pointing out here that the word "construction" has brought about some misunderstanding. In order to avoid any further misunderstanding of ANT, many other terms such as "constitution", "composition", "performance", "enactment" and even "design" have been introduced to substitute "construction" (Latour, 2003, 2008a, Mazanderani & Latour, 2018). Among these, the term "design" seems worthy of note. Nowadays, "design" not only contains the meanings of verbs such as plan, arrange, package, project and so on, but can also be used for a wide range of things or even issues. In one lecture on design philosophy, Latour (2008a) argues that the expansion of the term design as well as five connotations of design (modesty, attentiveness to details, symbolic interpretation, to design is always to redesign, normative dimension) is powerful proof of the shift from matters of fact to matters of concern. It indicates that things are not "made" or "fabricated", but designed in a precautionary way. In such a narrative, our world is a product of collaborative design and provides us with life supports. More important is the normative dimension. It provides a helpful link between the question of design and that of politics, because we are allowed to tell whether something is well or badly designed, while solid matters of fact are regarded as free from goodness or badness. Latour's new political concept is "Dingpolitik" ("Ding" is a German word meaning "thing" and "politik" means politics) or an "object-oriented democracy". Both humans and non-humans are involved and all entities are viewed as things, not as one-sided objects (Latour, 2005c). Therefore, how political issues should be addressed depends exactly on the composition contained within these "things". This is also true for issues such as ethics. In the case of a shooting, who or what should take responsibility is up to the question of who or what performs the shooting action. Thus, Latour asserts that "[i]t is neither people nor guns that kill. Responsibility for action must be shared among the various actants" (Latour 1994, p.34). Since the question of how a thing is composed is not merely an issue of ontology but has something to do with epistemology, ethics and politics as well, it is of significant importance. Indeed, this question of composition has become a major concern in STS (Mazanderani & Latour, 2018) and many scholars are working on it.

Since societies are always faced with various controversies regarding matters of concern, it is not possible to resolve them by stating so-called "indisputable" facts. Such matters are highly complex and are dependent upon and entangled with one another. Latour's aim is to find an appropriate method to display this complexity, so that the public can understand what is happening and make better decisions. A "what" question, i.e., the composition of things, then moves one step further to a "how" question, i.e., how to map out the composition inherent in the issue at hand. These questions should be taken into account: How can suitable descriptions of the world be obtained? How can we give a more accurate and useful depiction of the entangled world, so that people are enabled to become aware and get a clearer understanding of a particular controversial state of affairs? In order to render ANT – the appropriate thinking method according to Latour – tacit in people's minds, he is earnestly calling on scholars from different backgrounds to work together to develop suitable visualization tools on the theoretical foundations of ANT.

VISUALIZATION PRACTICES FOR DRAWING THINGS TOGETHER

Latour proposes a visualization method called controversy mapping to map out the entangled characteristics of things. He has devoted himself to the collaborative project of controversy mapping for more than 30 years (Latour & Yaneva, 2008). Just as the practice of mapping is to depict roads and trails, controversy mapping is used to reveal the traces of actants and highlight connections and transformations. According to the etymological meaning of design as “drawing” or “drawing together” in French, this mapping is also a way of “drawing things together” (Latour, 2008a). Taking ANT as a theoretical basis, the object of this kind of mapping is controversies, the final version of a map being unknown in advance. It studies transformations and associations before a controversy has been settled. Using visualization techniques, a controversy “datascape” is created (Latour & Yaneva, 2008), showing the contradictory and controversial nature of the issues, including all the humans and non-humans involved. It can make visible those things that were previously invisible and provide a certain degree of traceability. This helps in dealing with the complexity of the issues involved, so that people are able to understand the situation in more detail and more comprehensively. This should enable them to make better decisions in relation to the issue concerned.

In addition to introducing the links between the concept of design and his theories, Latour calls on designers to take advantage of their drawing skills to invent another tool for matters of concern. “How can we draw together matters of concern so as to offer to political disputes an overview, or at least a view, of the difficulties that will entangle us every time we must modify the practical details of our material existence?” (Latour 2008a, p.12). In the same year, Latour co-wrote an article with Albena Yaneva (Latour & Yaneva, 2008) aimed at generating interest among architects in this challenge of drawing a living project of instead of drawing a building – after all, architects are those who view buildings as projects, and “a building is always a ‘thing’ that is, etymologically, a contested gathering of many conflicting demands” (Latour & Yaneva, 2008, p. 108). Thus, it might be interesting for them to map out and understand the controversial situations associated with their architectural designs.

Before turning to designers, Latour himself first designed a chart. It is obvious that he is keen on employing various types of visuals in his articles and monographs. This turn towards the visual is already apparent in *Science in Action* (Latour 1987), where the theoretical concept of mapping associations and an early form of controversy mapping appear (see Figure 2). In 1991 and 1992, together with Philip Mauguin and Genevieve Teil, Latour proposed a method called Socio-technical Graphs (STG) (Latour, Mauguin, & Teil, 1991, 1992). This was an attempt to develop a new tool to map scientific controversies and technological innovations. It was a collaborative project for de-constructing the technology/social divide by revealing entangled matters of concern, which could be usable for pedagogical as well as analytical purposes. STG was supposed to provide performative narratives by listing all the transformations and traces involved in a given situation so that users are enabled to grasp it clearly. Figure 3 shows their preliminary design of how to describe the case of the hotel key using STG. The graph appears rather static, however, and is not able to illustrate the entangled (network-like) nature of things.

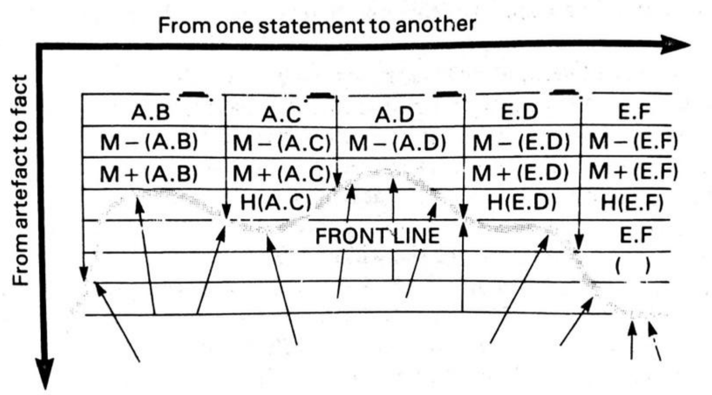

Figure 2. A graph to show transformations of a statement in *Science in Action* (Latour 1987, p. 60)

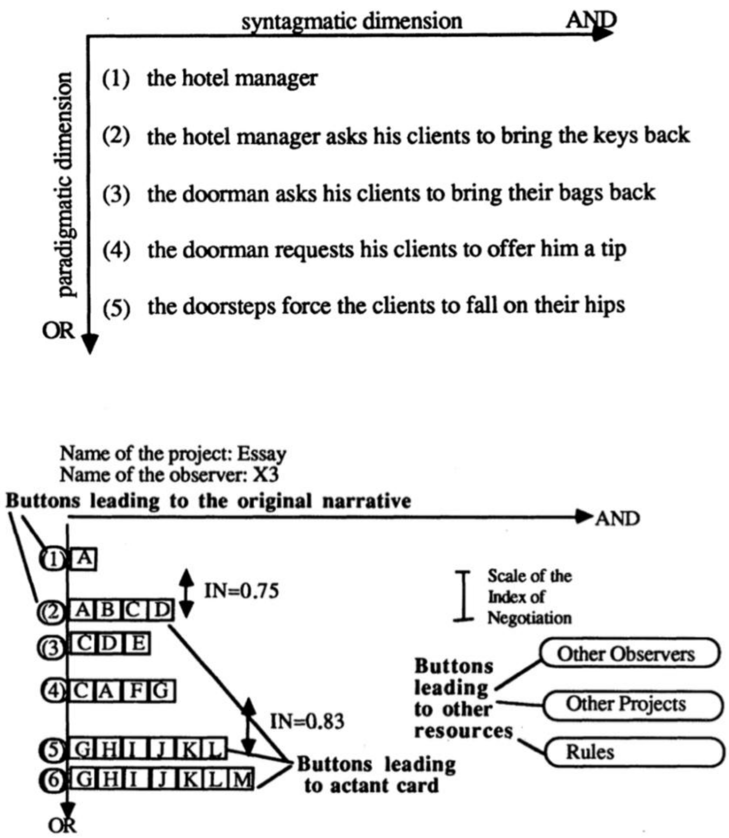

Figure 3. Socio-Technical Graph (Latour, Mauguin, & Teil, 1992, p. 35, 50)

With the development of new technologies, the appearance and function of mapping changed correspondingly. New media technology was able to draw things in greater detail and even to visualize processes dynamically. From 2008 to 2009, Latour facilitated a collaborative project called “Mapping Controversies on Science for Politics (MACOSPOL)”, involving groups working in risk cartography, digital methods, architecture and design, geography, journalism, policy making, and so on. The project was aimed at devising a collaborative tool to map out controversies to help European citizens participate in decision-making and make better judgments. Unlike the mapping techniques mentioned above, this mapping became a form of network mapping. It provided a dynamic interface that enabled processes of association and transformation to be continuously traced and illustrated, so that users are able to appreciate the “constituency of a network and the fluency of the social” (Yaneva, 2014, p.234). With this kind of mapping, the complexity of things is drawn together, various relationships between different actants can be observed in detail, and the ensuring illustration is no longer static in character. What is really novel and important is that the process of genesis can be performed, so that users gain a better understanding of the world to some extent. Yaneva (2014), who participated in this project, asserts the performative force of this mapping. It does not just describe the issues, it is a way of generating knowledge, possessing its own epistemological power. However, since there is no final documentation or other information about this project and the showcase website[2] is no longer active, the actual effect of this mapping is not exactly known.

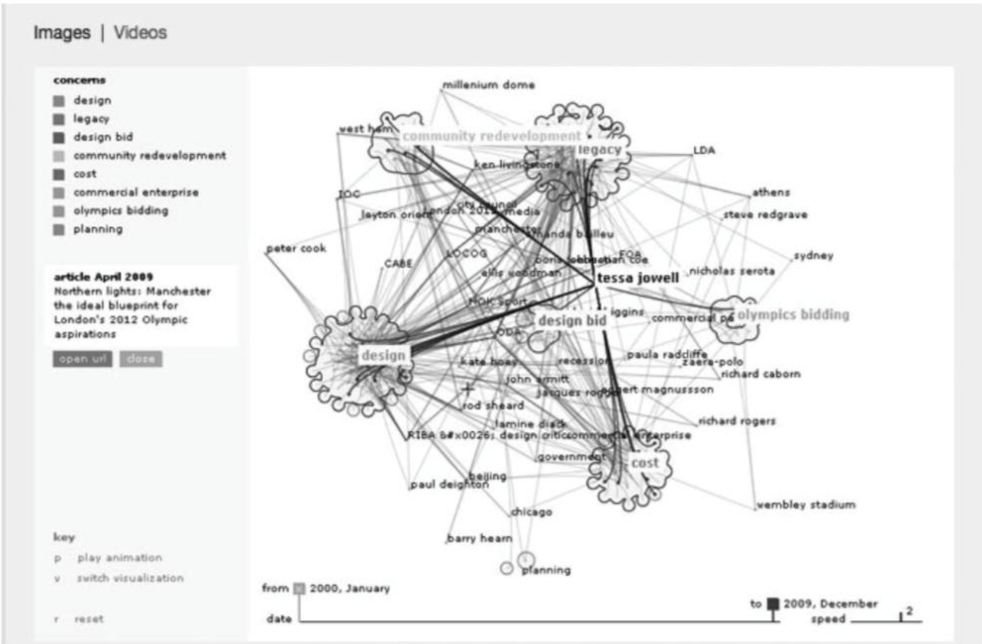

Figure 4. The dynamic network mapping of the process of design and construction of the 2012 London Olympic Stadium (Yaneva, 2014, p. 235)

[2] See https://www.mappingcontroversies.net/.

Latour's visualization practice is not limited to 2D depictions. Since 2005, he has been collaborating with artists and curating four exhibitions at the Zentrum für Kunst und Medien (ZKM, Center for Art and Media) in Karlsruhe: *Iconoclash. Beyond the image wars in science, religion and art; Making things public: Atmospheres of democracy; Reset Modernity!;* and *Critical Zones – Observatories for Earthly Politics* (Weibel & Latour, 2007, Mersmann, 2019). Since "to exhibit" means "to submit or expose to view" or "to show", and an exhibition is a place where various things as well as visual displays and technologies for the topics are gathered together, an exhibition itself is a visualization tool. From this perspective, an exhibition is not a place where ready-made knowledge is simply represented and disseminated, but rather one where knowledge is produced, as stated by Basu and Macdonald: "[V]arious 'actants' (visitors, curators, objects, technologies, institutional and architectural spaces, and so forth) are brought into relation with each other with no sure sense of what the result will be" (Basu & Macdonald 2008, pp. 2-3). Unlike other media, exhibitions also assemble things made of different materials, from two-dimensional to three-dimensional, from real to virtual, displaying images, audio tracks and videos as well as interactive technology in a small enclosed place. Everything is dictated by the theme and conditions of the exhibition. It is an ideal place to carry out thought experiments and "an exploration into the techniques of representation" (Weibel & Latour, 2007, p. 98). What is special about this exhibition is that, on the one hand, it displays not just flat images but also three-dimensional materials; while on the other hand, visitors can also become part of what is on view, rather than merely standing in front of and looking at it. In other words, this kind of exhibition is performative democracy itself: it is complex, interactive, visitor-dependent and object-oriented, a place where viewers and objects all act and new media and new technologies will play a crucial role. It is "a parliament of parliaments, an assembly of assemblies" (Weibel & Latour, 2007, p. 98). In addition to which, Weibel and Latour (2007) argue that as a thought experiment, this kind of exhibition is falsifiable, so it is a good method for testing new political ideas. For example, the aim of the second exhibition *Making things public* is to visualize the concept of Dingpolitik, such that, if after visiting the exhibition someone still regarded the modernist political solution as a good one, the experiment has failed. Conversely, if a visitor begins to hesitate and think that Dingpolitik might be worth a try, it has succeeded (Weibel & Latour, 2007). This idea sounds good in theory; however, there appears to be no feedback on the exhibitions and therefore no way of knowing whether these effects were achieved.

According to research on images in intellectual and cognitive activities, the role of vision in thinking has long been ignored (Mitchell, 1995; Reed, 2013). Put briefly, in addition to words, images also play a central role in intellectual practice, but they do not share the same logic as words do. Images possess non-propositional cognitive power, so they do not explain explicitly what they show. In this sense knowledge is obtained by acquaintance rather than by description. When images and words are combined, they help us to understand texts better (Boehm, 2007; Schlechtriemen, 2019). Since visual representations in science have been studied from divers aspects in STS for many years, it is time to explore the power of visualization more thoroughly and take advantage of it. In fact, Latour’s practices are not unique among STS scholars. More and more scholars have started to take advantage of visual descriptions (Burri & Dumit 2008). Galison (2014) uses the name “Visual STS (VSTS)” to register this spectrum, which contains two stages: first-order VSTS studies the role of visuals in scientific and technological research, while second-order VSTS uses visuals in turn as one method of inquiry for STS. In addition, there is a growing trend of debate and hybridization between STS scholars and art and design practitioners (Basu & Macdonald, 2008; Burri & Dumit, 2008; Salter, Burri, & Dumit, 2017; Yaneva, 2014).

Since STS studies are quite empirical, I would argue that developing visualization tools could be seen as a suitable approach to supplement these theoretical analyses. Visualization can serve as a practical method of ANT to show how things work and in turn provide more cases for analysis. Following Latour’s path, if we want to have a better understanding of science, technology, society and all the issues that we are confronted with in today’s Anthropocene, we need to solve the question of composition and to trace the complex associations among humans and non-humans. If the associations inside things can be performed by more and more advanced media technologies, then the issue of heterogenous composition could be rendered more workable and we might gain a clearer insight into the relations among humans, technology and the world more generally. Clearly Latour has made many effective and meaningful attempts to explore the power of visualization. However, such practices should be more deliberately designed and planned for a long period of time, so that more useful results can be obtained.

CONCLUSION

In this article, we review Latour’s STS studies and visualization practices. Latour blurs neat lines among different disciplines and rejects the traditional dichotomous epistemology in western philosophy. Everything that occurs in the world involves complex, entangled issues and assemblies. His STS studies are thus aimed at offering performative narratives of things by following traces and trajectories in order to draw together the connections between heterogenous components. This concern about the composition of things is a key task in understanding science, technology, society and many other spheres, and thus also relates to ethical and political questions. In order to render the invisible associations and connections clearly, Latour has also devoted himself to several projects of controversy mapping. Equipped with increasingly advanced media technologies, the process of genesis can be now dynamically visualized. Controversy mappings are supposed to possess performative power. When such visualization tools can provide better performative narratives of composition, they can serve as practical methods to complement theoretical STS analyses. In turn, through visualizing actual issues, more cases can be studied for future STS work.

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Research article

The Grammars of AI: Towards a Structuralist and Transcendental Hermeneutics of Digital Technologies

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Abstract

After its rejection of the linguistic turn, influential strands in empirically-oriented philosophy of technology tend to neglect or are even hostile towards structuralist and transcendental approaches to technology. Drawing on Cassirer, Bourdieu, Wittgenstein, and Ricoeur, this article offers an account of the meaning of technologies that theorizes precisely those aspects of technology and shows what this hermeneutics means for understanding digital technologies such as AI and algorithmic data processing. It argues that a transcendental and structuralist approach helps us to reveal and evaluate the linguistic, social-political, bodily, and material preconditions for AI and, more generally, of digital technologies. Considering some issues raised by AI and robotics, the article shows that these transcendental structures or "grammars" make possible the meaning and use of AI, but at the same time constrain it. The proposed framework and research program therefore enables not only a better understanding of digital and other technologies but also their critique, leading to nothing less than the philosophical task of questioning our ways of being in the world.

Keywords: Philosophy of technology; Hermeneutics; Structuralism; Transcendental; Wittgenstein; Ricoeur; Boudieu, Cassirer

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Научная статья

Грамматика ИИ: к структуралистской и трансцендентальной герменевтике цифровых технологий

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Аннотация
После отказа от лингвистического поворота влиятельные направления эмпирически ориентированной философии технологии склонны пренебрегать или даже враждебно относиться к структуралистским и трансцендентальным подходам к технологии. Опираясь на Кассирера, Бурдье, Витгенштейна и Рикёра, в данной статье предлагается описание значения технологий, которое теоретизирует именно эти аспекты, и показывается, что герменевтика означает для понимания цифровых технологий, таких как ИИ и алгоритмическая обработка данных. В ней утверждается, что трансцендентальный и структуралистский подход помогает нам выявить и оценить лингвистические, социально-политические, телесные и материальные предпосылки ИИ и, в более широком смысле, цифровых технологий. Рассматривая некоторые вопросы, поднятые ИИ и робототехникой, статья показывает, что эти трансцендентальные структуры или “грамматики” делают возможным значение и использование ИИ, но в то же время ограничивают его. Таким образом, предлагаемая система позволяет не только лучше понять цифровые технологии, но и критиковать их, что ведет не к чему иному, как к философской задаче поставить под сомнение наши способы существования в мире.

Ключевые слова: Философия Техники; Герменевтика; Структурализм; Трансцендентализм; Витгенштейн; Рикёр; Будье; Кассирер

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INTRODUCTION

Empirically oriented philosophy of technology conceptualizes technologies as material artefacts that have more-than-instrumental effects: they shape our experience and action. For example, postphenomenology and posthermeneutics see technological artefacts as mediators that constitute subjects and help to shape human interpretations of the world (Ihde, 1990; Verbeek, 2005; Kudina, 2021). In order to conceptualize what we do with digital technologies such as artificial intelligence (AI) that are not easily described in terms of “things” and to move beyond the hermeneutics of individual human-technology relations, however, we need an account of the meaning of technologies that is holistic and relates to the social context of technologies in a more internal and systematic way. Furthermore, we need a framework that accounts for the many ways in which language and technology are interwoven: we need to analyse what things do but also what words do (Coeckelbergh, 2017). This is especially important in the case of AI and data science, which through machine learning gain impressive linguistic capacities.

Taking inspiration from Wittgenstein, Ricoeur, Bourdieu, and Cassirer, this article proposes a structuralist and transcendental approach to the meaning of what we do with technology, according to which (1) language, (2) social relations, norms, and institutions, (3) human bodies, and (4) material (infra)structures pre-structure, shape, and render possible, our technological experience, meaning-making, and action. As such it uses and helps to further develop and systematize work on Wittgenstein and technology (Coeckelbergh, 2018; Coeckelbergh & Funk, 2018), ongoing work on a Ricoeurian hermeneutics of technology (Reijers and Coeckelbergh, 2020; Reijers, Romele, and Coeckelbergh, 2021; Romele, 2020a; Wolff, 2021; Gransche, 2021), and Smith’s (2015) critique of postphenomenology and his argument for transcendental empiricism. It also uses Bourdieu and Cassirer. It thus connects to other traditions in philosophy (transcendental epistemology) and the humanities and social sciences (structuralism) that are not often used in contemporary philosophy of technology, and also responds to postphenomenology and to work by Floridi (2011) in order to distinguish itself from non-critical and non-transcendental approaches to technology that also could be developed in a structuralist direction. The paper then distinguishes between, and describes, four conditions of possibility of technology, and shows what the proposed transcendental and structuralist hermeneutics means for understanding and evaluating AI/data science and other digital technologies. In particular, it argues that such an approach helps us to reveal and evaluate the linguistic, social-political, and material preconditions for AI and algorithmic data processing – with implications for understanding and evaluating digital technologies and technologies in general.

First, I will explain how transcendental and structuralist approaches differ from some influential ways in which contemporary philosophy of technology conceptualizes what technology is and does. I will refer to Cassirer and Bourdieu and also mention process philosophy. Second, I will invite the reader to consider a set of structures or conditions of possibility that make technological experience and action possible and pre-shape (that is, before the actual (inter)action with the technology) what we say about technology and what we do with technology: language, social relations, human bodies, and material infrastructures. On the way, I will show what recognizing and revealing this "grammar of technology" means for understanding and evaluating AI and other digital technologies.

THE GRAMMAR OF TECHNOLOGY: ASKING THE QUESTION CONCERNING TECHNOLOGY IN A STRUCTURALIST AND TRANSCENDENTAL WAY

In contemporary empirically-oriented philosophy of technology, questions regarding AI and other digital technologies are asked in a way that focuses on the object and its relation to the subject, without considering the wider structures in which the technology is embedded. For example, postphenomenology (Ihde, 1990; Verbeek, 2005) theorizes human-technology relations in a way that concerns how technologies mediate between the "I" and the world. While this approach has delivered valuable insights into the phenomenology and hermeneutics of technology use, it misses out on the structural aspects of technology and on the conditions that must be presupposed for these human-technology relations to form in that way. For example, it does not conceptualize how language shapes how we relate to technologies and how technologies are part of larger social institutions. Similarly, Floridi's metaphysics of technology in terms of information remains on the 'ontic' level and misses the structural, 'ontological' dimension. It is "flat", so to speak. It is a description of the world in terms of information but it misses an account of *formation* processes and of the transcendental conditions that make possible our use, experience, and knowledge of information. Furthermore, both types of theories do not offer a substantial account of the social and cultural dimension of technology use: Ihde because he focuses on individual human-technology relations, and Floridi because his metaphysics of information does mainly consider human beings as what he calls conscious 'inforgs' (informational organisms (Floridi, 2011, p. xiii)) and not as social beings.

In order to conceptualize the ontological and social dimension of technology use, we need what Smith (2015) and I (Coeckelbergh, 2012) have called a 'transcendental' approach. One could also call it a structural or grammatical (Coeckelbergh, 2018) approach. The point is not that technology is somehow transcendent and abstract (this would be Technology with the big 'T' Ihde and Verbeek argue against) but that there are *transcendental* conditions involved: the use and meaning of technology are *made possible* by, and structured by, some other elements that are not themselves necessarily technological and material. These structures or conditions pre-shape the meaning of, and our performances with, technology. For example, as I will argue below, language pre-structures and pre-conditions how we deal with machines. The semantics of technology is made possible by what I will call the "grammars" of technology. Let me unpack this approach and to show what it means with regard to digital technologies such as AI.

Inspired by Gransche (2021), we can find further support for a transcendental approach by drawing on Cassirer – without however borrowing the latter's idealism and while keeping an empirical orientation, broadly understood. Cassirer writes:

> 'If philosophy wants to remain loyal to its mission . . . it must inquire into the 'conditions of the possibility' of technological efficacy and technological formation, just as it enquires into the 'conditions of the possibility' of theoretical knowledge, language and art. . . . However, this clarification cannot succeed so long as one's observations are limited to the circle of technological works, to the region of the effected and created. The world of technology remains mute as long as philosophers look at it and investigate it from this single point of view.' (Cassirer, 1930, p. 18)

To inquire into the conditions of possibility of technology is thus, according to Cassirer, a key task for philosophers. And it is in tune with contemporary phenomenology and hermeneutics that see technology in a more-than-instrumental way. Cassirer (1930/2012) compares this way of seeing technology with what philosophers of language have said about the use of language: language is not just a tool for representation, but a means of making reality (p. 23): the form of the world is 'built' by humans (p. 24) through language, which in turn is related to other elements. Similarly, Cassirer argues, material tools create realities and are not just things with properties but are the expression of 'a particular activity to be performed' (p. 23) and in the end also create the human. Technology participates in 'anthropogeny' (p. 36): we do not only create technology, but technology also creates us. It forms the world. It is part of formation and – to use Cassirer's process philosophy vocabulary – it is part of becoming.

In previous work I have started to conceptualize the transcendental dimension of the use and meaning of technology by using Wittgenstein and Ricoeur. First, what Wittgenstein (1953/2009) says about language in the *Investigations* – that language use is related to activities, games, and a form of life – can also be said about the use and meaning of technology: technologies are embedded in games, which have rules but also require a tacit understanding of them, and all this provides a grammar for technology use and meaning (Coeckelbergh, 2018; Coeckelbergh and Funk, 2018). The point is not only that language shapes how we deal with technology, but that the transcendental structure of language is similar to the transcendental structure of technology. Both are deeply embedded in the social-cultural world. The meaning of words and the meaning of things is not a matter of word-objects or of things-objects alone; what words and things mean and do depends on larger structures such as games and a form of life, which render use and meaning possible. Just as linguistic grammar provides a structure that renders possible and constrains our use of language, there is language and other transcendental grammars that make possible and govern the use of (other) technologies. Moreover, technology can change the game. It is phenomenologically and hermeneutically "active", so to speak. Culture is not a matter of a kind of (virtual?) things but is performed and enacted. There is no form of life separate from *how we do things*. What culture becomes depends on our uses of language and our uses of technologies. By changing those uses and performances, we can change the larger cultural whole – albeit slowly.

Second, using Ricoeur's view that human experience has a narrative structure, one can also construct a hermeneutics of technology use that shows how technologies are embedded in narratives and even shape those narratives (Reijers and Coeckelbergh, 2020). In *Time and Narrative*, Ricoeur (1984) argued that, based on a pre-understanding, the plot of a story configures characters, motivations, and events into a meaningful whole; in the end, the narrative as a whole makes sense and leads to a new understanding. Reijes and I argued that technologies have a hermeneutic function that is similar to narrative and text: they also help us make sense of the world and organize characters and events. We do not only tell stories about technologies; technologies also co-write our stories. Again thinking about language – here narrative theory – offers a model for thinking about technology and makes even a direct link between technology and language, this time in the form of narrative. Technologies themselves, or rather, technologies other than text *also* narrate. And again the non-instrumental aspect of technology is stressed. In line with Cassirer (1930/2012), who as we have seen writes about formation (p. 18), I propose to call technology a *formator*. It is not just object and substance, not just a thing. It forms worlds. But it is not the only formator; humans, for example, also form. There is no technological determinism but co-formation. To put it in process philosophy language: like humans, technology participates in the becoming of the world.

This approach can also be framed as structuralist. In the social sciences, Bourdieu is known for his further development of structuralism. We develop and are situated within a social environment and Bourdieu (1984; 1990) famously argued that this happens via the creation of *habits*: we develop a particular way of thinking, feeling, and acting. As such we and our acts are always embedded in social relations. Bourdieu explained how the social grammar becomes habitual and incorporated. But this happens in an implicit, tacit way. There are rules, there is an order, but the social organization and orchestration happens without a conductor (Bourdieu 1990, 53). This becomes also clear when we consider how Bourdieu was influenced by both Cassirer *and* Wittgenstein: as Calhoun (2002) points out, as an ex-rugby player and a reader of the later Wittgenstein, Boudrieu used the metaphor of games to argue that when we play we are also aware of being part of something larger. Like Wittgenstein, Bourdieu thought that this was not just a matter of following rules but also getting a sense of how to play. It is also about implicit knowledge, and is especially a *social* matter: 'it requires a constant awareness of and responsiveness to the play of one's opponent (and in some cases one's teammates' (3). Applied to technology use, one could say that technology use is also a matter of habitus: technology use is embedded in habitus, and technologies also form our habitus and thus shape our link to the social. We are habituated by technology. As Romele (2020b) puts it: 'digital media and technologies are just the continuations of social and cultural habituations by others means'; these media and technologies are 'habitus machines'. This happens largely in an tacit way. We are usually not aware of it. We are not aware of the social as a transcendental structure, and we are not aware of what technology – as pre-structured by the social – does to us.

Four transcendental structures and the implications for understanding and evaluating AI and other digital technologies

Let me now analyse these conditions of possibility in a more systematic way. If technology can and must be approached at least *also* in a transcendental way, *what* are conditions of possibility of technology use and meaning? What are the structures and grammars of technology?

There are at least the following four *conditions of possibility* or transcendental *structures* of technology:

1) Language
2) Social Relations
3) Human Bodies
4) Material Infrastructures

Let me elucidate these different structures and on the way apply the framework to AI and algorithmic data processing and, more generally, to digital technologies.

Language is a transcendental structure of technology since the way we experience, use, and talk about and *to* technology is shaped by the *milieu* of our language – a specific language and language in general. Hermeneutically and epistemologically speaking, we do not have direct, unmediated access to our own tools; the way we use them and what they mean to us is mediated by language and by a specific language. This includes grammar and narratives. For example, the meaning of what a specific AI or robot "is", is co-constructed by the way we talk about them grammatically speaking. It matters, for instance, if we say "it" and "the machine" to a robot or if we use "she" or "he". (Coeckelbergh, 2011) Here the expression "grammar" of technology needs to be taken literally: the grammar pre-conditions how we perceive and engage with the robot. Consider also how bias in AI may be created by a specific language, for example English. Caliskan, Bryson, and Narayanan (2017) have shown that the English language itself contains imprints of historic biases. An AI-based search engine that uses the English language will likely adopt those biases – for example gender biases; this may lead to unintentional discrimination. AI, and more generally algorithmic data processing, is thus always already also an intervention in social relations and is made possible by social relations.

Moreover, if we entertain a narrative about AI that sees current AI as a step towards general artificial intelligence and superintelligence, as transhumanists do (see for example Bostrom, 2014), then that narrative shapes the actual use and development of the technologies: investments and efforts will then go into trying to create that kind of AI, and people will experiment with technologies for the purpose of so-called "human enhancement." A specific narrative and discourse then make possible particular developments and governs them. For example, tech companies like OpenAI, DeepMind, Google Brain, and Facebook A.I. Research are trying to develop artificial general intelligence (AGI). The technology is still an idea, it is all hypothetical. But the narratives about AGI and superintelligence nevertheless drive these developments; they provide the transcendental support. Without presupposing these narratives and discourses, it is impossible to make sense of what these companies do and to support the use of these technologies.

More generally, the meaning and use of digital technologies is made possible by the grammars and narratives of language and specific languages. One of these languages is of course a specific coding language, but also natural language use pre-structures the meaning and use of digital technologies. The way we talk about AI and digital technologies is not neutral in relation to what these technologies "are". Even the very word "artificial intelligence" is not hermeneutically neutral: it *already* compares the machine's cognitive capacities to those of humans and ascribes "intelligence" to machines, *before* we even discuss the matter (for example as philosophers) or develop and use the technology. It already suggests that such a comparison between humans and machines even makes sense. This use of language about AI thus pre-structures most discussions about AI, unless the precondition is revealed, in which case a critical discussion can take place.

Social relations also pre-structure and make possible technology use and meaning. As I already suggested, the habits we develop in and while using digital technologies such as AI are embedded in a wider social-cultural context. For example, the development of AI is often embedded in games of competition, say between big tech firms but also between countries and governments (e.g., between the West and China). But also closer to home, social relations make possible particular meanings and uses. Consider "intelligent" assistive devices such as Alexa: what Alexa says makes only sense if what is said is related to a specific social context, for example relations with a family. It is only within such a context that it makes sense when for example someone treats Alexa as a member of the family. The sense-making process related to the technology presupposes an entire social world, which often remains implicit and is not articulated. If AI, or any digital technology for that matter, fails to establish this social lifeworld embedding, it fails as a social device, for example as a social robot or as a social assistive device. The use and development of such technologies is in this sense parasitic on the social structures that already exist. It cannot function in isolation from the social relations, social structures, and social institutions that are already there and make possible the meaning and use of the technology. This "making possible" is always also at the same time a *constraining* and a governing. Again the problem of bias in AI offers an excellent example: if AI is used in a society that is pervaded by a particular kind of bias or set of biases (e.g. gender bias, racial bias) and the social relations formed by it, then these biases and social relations will pre-structure the use of the AI, and for example lead to discrimination on the basis of race when AI is used in juridical systems. What AI then does and means depends on the existence, nature, and history of these social structures and institutions. Consider for instance the famous case of COMPAS in the U.S.: the software, used by a US court for risk assessment concerning prisoners, was said to be more prone to mistakenly label black defendants as likely to reoffend[1]. Both

[1] Buranyi, Stephen. 2017. 'Rise of the Racist Robots – How AI is Learning All our Worst Impulses.' Guardian, 8 August 2017. https://www.theguardian.com/inequality/2017/aug/08/rise-of-the-racist-robots-how-ai-is-learning-all-our-worst-impulses

the use of this technology and the meanings that surround the case can only be fully understood within the specific social context and history of the U.S., which made and makes possible such uses of AI and such discussions about AI. Other societies and cultures may or may not have similar social contexts and hence may or may not have similar cases.

There is nothing deterministic about this influence of the social as a transcendental structure, however: we can change social relations and we can change our technologies. We can change the social games we play and the 'technology games' (Coeckelbergh, 2018) we play. But in order to do that, we first have to be aware of the reality and persistence of these pre-structures and conditions of possibility. If we fail to develop this awareness, stick with a flat ontology that focuses on technologies as mere things and tools, and falsely think that technology is hermeneutically and normatively neutral, we will continue to be governed by our technologies in ways that are not always morally and politically acceptable. If, however, we manage to reveal the social preconditions of the meaning and use of AI and other technologies, and understand that and how technologies are very much entangled with the social and its structures, formations, and institutions, we open up the possibility of social-technological change.

Furthermore, while this article remains agnostic regarding the potential existence of transcendental forms as proposed by the idealist philosophical tradition, the mentioned social transcendental structures are not to be understood in an idealist way: they are not abstract forms that pre-structure cognition and shape our intuition of objects, as in Kant (1781/1996), or purely symbolical forms. Instead, they are part of the world and part of the way we are in the world. They are related to concrete uses and performances within a social and cultural context, and they have material and bodily aspects. They are not transcendent. Yet often remaining inexplicit and hidden from view, they pre-structure and shape how we relate to technology and what technology does to us. This leads us to the next two transcendental structures: the human body and material infrastructures.

The human body is a transcendental structure of the meaning and use of technology for at least two reasons. First, as contemporary "enactivist" cognitive science and philosophy has convincingly shown (see for example Varela, Thomson and Rosch, 1991), the way we experience and think about *anything* is embodied. When we think, we do not leave our body behind. We are bodies-minds interacting with our environment, and as such we make sense of the world. We enactively and embodied bring forth a world of meaning and significance. Embodied cognition theory reacts against what it takes to be the dualism of Descartes and other modern thinkers and against the idea that cognition is about re-presenting. Instead, cognition is seen as an active relationship to the world 'anchored in the living body' (Di et al., 2017, p. 20).

For AI, this means that making meaning of AI is pre-structured by our embodied way of being and knowing. Thus, when we think about AI, we may for example project a human body onto the artificial agent. This way of approaching AI is understandable and helps us to make sense. But as in the cases mentioned so far, it is also constraining: it means that it becomes difficult for us to think about AI in a way that does not imagine it as, say, a humanoid robot. Second, our body and our bodily way of being in the world pre-structures and makes possible our experience and use of digital technologies. Even if we immerse ourselves in an AI-based virtual world in which we move with an avatar (perhaps a kind of 'metaverse' as proposed by Zuckerberg[2] or indeed many already existing multi-player online games) or engage with AI-based digital technologies in ways that do not involve a representation of a human body at all, we do not leave our body behind but instead move through that virtual world in a bodily manner, in a way that is similar to how we move our biological body through the offline world. We can only make sense of the virtual world and move within it because we have a human body. Offline forms online. Thus, while phenomenologically and ontically it might appear that when I enter a virtual world, I transcend my body, I do not leave my biological body behind in the sense that it remains what Husserl (1952/1989) called the 'zero point' (German: *nullpunkt*) of perception (p. 61) and what Merleau-Ponty (1945) considered the condition for having a world. It is the point from which I move into the world and make sense of the world – virtual or not. The living and moving body is therefore also part of the grammar of technology.

Note that through *habituation* (as mentioned above in relation to Bourdieu), the body is also already involved in our socially situated use and experience of digital technologies: our habits are not abstract social and cultural "things" but are incorporated, embodied, and performed. The social is transcendental but not transcendent: it is only present in what we do, what we tell, what we write, how we move, etc. It is embodied, moving, and changing. It is living. Similarly, language use is connected to what we do with our voice, our hands, and so on. The transcendental structures that precondition the meaning and use of technology are inter-related; they meet in the nexus of technology meaning and use, where all transcendental structures are at play.

Finally, in spite of the perception that AI and other digital technologies have to do with an immaterial world, the preconditions for using and making sense of these technologies are very material: *material infrastructures* and other material technologies related to the technology in question. In line with the empirical turn in philosophy of technology (Achterhuis, 2001) and with much work in social studies of science and technology, it must be emphasized that our current digital technologies, including AI and data science process, are only possible because the material infrastructures, physical processes, and material devices that support their use and without which our sense-making of and with technologies is not possible. For example, if I use an AI-based search engine or an intelligent assistive device, these technologies are not only embedded in material devices such as computers and mobile phones (and hence these technologies are always more than "virtual" code) on which they totally depend for their functioning and use. These material devices and physical processes are in turn extremely dependent on, and made possible by, other material technologies and processes such as the infrastructure of data centres and (mobile) data transmission

[2] The term refers to a form of online virtual reality, see for example https://www.theverge.com/22588022/mark-zuckerberg-facebook-ceo-metaverse-interview

technologies, electricity production, and the production of the devices. AI and other algorithmic and data processes are thus not very immaterial at all once we relate them to their material structures and infrastructures. As critical studies of technology and for example Crawford (2021) have shown, these material processes are in turn related to often exploitative and dehumanizing labor processes and have environmental consequences, threatening a sustainable future. Ultimately, planet earth and its vulnerable ecosystems and climates make possible our use of digital technologies. They are the "zero point" of our so-called digital lives. AI is nothing without these artificial and non-artificial bodies, ecologies, and supporting infrastructures, which must be presupposed even when we believe that we play around in a different, digital or virtual world. Technology ultimately depends on life.[3]

CONCLUSION

This article has argued that the use of digital technologies and the making of meaning of and with these technologies is only possible on the basis of a number of conditions of possibility or transcendental structures. These "grammars" or preconditions make possible the meaning and use of the technologies, but also at the same time constrain it. This transcendental and structuralist approach has enabled me to conceptualize some issues regarding AI and digital technologies as pertaining to the conditions of possibility or "grammars" of AI.

Yet this "detour" through technology's transcendental conditions does not only promise a more adequate understanding of AI and digital technologies; it also (1) suggests a broader research program about the grammars of technology and (2) invites us to consider some normative implications – both ethical and political.

First, as already became clear in the course of this article, the proposed structuralist and transcendental conceptual framework is applicable to technology in general, and not only to AI and other digital technologies. It also enables us to further discuss the relations between technology and language. More work needs to be done to elaborate this approach to the hermeneutics of technology. I suggest further investigations into the ways in which the various grammars of technology operate, but also into their interconnections and their other relations to technology. For example, language is a structure and condition of possibility of technology use, but language is also related to the social, and language use and its meaning are in turn themselves conditioned by technologies and media, for example when digital social media (pre-)structure how we talk to each another. This opens up interesting directions for further developing the "grammars of technology" approach in ways that reveal rich and complex worlds of technology.

Second, given the influence of these grammars on how we use technologies and on the meanings we co-create, revealing the grammars of digital and other technologies

[3] As I already suggested previously (Coeckelbergh, 2022), earth is a condition of possibility that makes possible our form of life, and that includes technology.

is also a critical task or at least a precondition for a critical task. Evaluating technologies does then not only need the "ontic", flat description and analysis of our tools and media, but also and especially the revealing and questioning of the transcendental structures of technological experience, meaning-making, use, and performance. Evaluating technologies is then also about questioning our language use, our social relations, the way we bodily and kinetically relate to our environment, and our material infrastructures and production processes (and the related labour processes). In other words, if we adopt this structuralist and transcendental approach, the challenge of understanding and questioning technology means nothing less than the challenge of understanding and questioning our ways of being in the world – indeed our form of life – and its relevant processes of formation and becoming. This is not only a task for philosophers of technology but for all philosophers who – to use Cassirer's words – wish to remain loyal to philosophy's mission.

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Research article

Global-local Cultural Interactions in a Hyperconnected World[1]

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Abstract

The article dwells upon the development and organization of new information relations and global-local cultural interactions. New social environment processes that encompass real and virtual life are being controlled by a complex set of digital instruments or interactive systems. The novel notion of a "hyperconnected" world is being discussed with its characteristics that lead to the transparency of human relations and the hyperopenness of society. There is a description of the growing importance of social networks as a universal field of communication. The issues of transforming the environment for information exchange and communication into networked communication platforms are raised. These platforms are easy to use for a variety of purposes, which at the same time renders them unpredictable. The conditions for the existence of such networks transform into an "anthropo-space" and it is shown how this produces a shift in social relations.

Keywords: Culture; "Hyperconnected" world; Digital culture; Social networks; Digital; Communication platform; Digital environment

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Научная статья

Глобально-локальные культурные взаимодействия в гиперсвязанном мире[2]

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Аннотация
Статья раскрывает развитие и организацию новых информационных связей и глобального-локального культурного взаимодействия. Сложный набор цифровых инструментов, а скорее интерактивных систем, регулирует процессы в новой социальной среде, сочетающей реальность и виртуальность. Рассматривается новое понятие "гиперсвязанный" мир и его характеристики, ведущие к "прозрачности" человеческих взаимодействий и гипероткрытости общества. Дано описание возросшей культурной значимости социальных сетей как универсального коммуникационного поля. Поднимаются вопросы, связанные с ходом преобразования среды для обмена информацией и общения в сетевые коммуникационные платформы, которые легко использовать в различных целях, что предполагает определенную степень их непредсказуемости. Поясняется как условия существования, где сеть превратилась в "антропопространство", порождают определенные социальные сдвиги.

Ключевые слова: Культура; "Гиперсвязанный" мир; Цифровая культура; Социальные сети; "Цифра"; Коммуникационная платформа; Цифровая среда

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[2] Эта статья развивает и дополняет исследование " 'Гиперсвязанный' мир как фактор формирования нового типа социума", представленное на конференции на конференции "Коммуникативные стратегии информационного общества " (2021)

ВВЕДЕНИЕ

Модернизация и технологические усовершенствования вносят изменения в общественную и частную жизнь в любом обществе. Эти изменения могут быть резкими или незаметными в зависимости от скорости, с которой приходят технологические новшества. В XXI веке мы переживаем резкий переход от массовой культуры к цифровой, где возрастные и экономические факторы играют определяющую роль в фазе адаптации. Изменения в формах общения в рамках цифровой культуры и формируют новый тип социума.

Цель статьи — понять культурные изменения в социуме и общественном сознании, вызванные быстрым распространением новых коммуникационных технологий. Основной уклон – с социологической точки зрения, но он неизбежно является и междисциплинарным из-за общего объекта с философией, культурологией и психологией (Тайлор 1989; Кастельс. 2000). Анализ призван дать некоторые представления о том, как понимать нынешние и будущие изменения, вызванные влиянием цифровой среды, воздействующей на различные социальные аспекты виртуального пространства и реальную сферу жизни. Стратегические последствия таких изменений крайне важны.

Рассмотрение начинается с краткого описания причин, по которым культура, являясь информационной основой человеческого общества, играет важную роль в понимании цифровой революции, активно меняющей нашу повседневную жизнь. Модель цифровой культуры находит свои собственные ответы на внутренние импульсы, возникающие в течение небольшого периода времени ее существования, но прежде всего на те, которые порождены изменениями в социуме (Levin & Tsybulsky, 2017).

Следующий шаг сделан по осознанию того, как цифровая среда, цифровая культура формирует наш опыт об окружающем мире, предоставляя сложный набор цифровых инструментов для организации новых информационных связей и глобального-локального культурного взаимодействия (Acerbi, 2016). Речь пойдет о наблюдаемом “скоростном” культурном внегенетическом накоплении, и как следствии, “гибридизацией онлайн и оффлайн полей”, формировании гиперсвязанного мира, который серьезно влияет на наше самовосприятие.

Поднимаются вопросы, связанные с процессом преобразования идентичности человека в реальной жизни созданной им цифровой идентичностью в системе социальных отношений, что генерирует появление новых моделей поведения в рамках цифровой культуры, обусловленных особенностями сетевого общества. Человек уже не ощущает себя вне “цифры”. На него всегда оказывает влияние цифровое сообщество – гигантская сеть, сверхорганизм с коллективным разумом, где обмен информацией происходит со скоростью света, человеческий интеллект сливается воедино с машинным, и где даже мысли способны передаваться через расстояние в тысячи километров за доли секунды.

Гиперсвязанный мир имеет одну из важнейших характеристик, выраженную в формировании “сетевого” общественного сознания. В свое время новаторское исследование Стэнли Милгрэма (2022) социальной взаимосвязанности удивляло и интриговало, потому как предполагало, что, несмотря на огромные размеры нашего социума, в нем легко ориентироваться, следуя социальным связям от одного человека к другому. Сейчас подобный эффект наблюдается в разрастании различных социальных сетей. Эффект микромира имеет значение для динамических процессов, происходящих в реальных взаимодействиях, для нас, в первую очередь для происходящих в пространстве виртуальном (например, скорость распространения информации по сети и т. д.), а именно в создании гипер- или метавселенной (Holton, 2020, Jensen, 2020).

Мир, приобретая черты гипероткрытости, также становится сквозным в своей связанности, приобретая общую тенденцию постоянно делиться всем. При этом эффект суперактивного влияния представляет собой очень удобное поле для формирования изменений в социуме, демонстрируя определенную степень непредсказуемости. На конкретных примерах мы наблюдаем отличительные черты мира сетевого общения, в котором межличностные сообщения и “узкие” информационные кампании могут мгновенно превратиться в массовые. Вследствие чего цифровые сети могут стать полем битвы, так как коммуникационные платформы общего пользования, сейчас являются “центрами силы” значительно больше, чем мы могли представить когда-либо.

При рассмотрении коммуникационных технологий аргументирована целесообразность ни в коей мере не забывать о значительности и мощи их воздействия (Shhwarz, 2019), поскольку способ их использования может повлиять на изменения наших коммуникативных и культурных моделей. Таким образом, технологии, связанные с информацией и коммуникацией, работающие в цифровой среде, создающие “гиперсвязанность” нельзя рассматривать как пассивные инструменты, а скорее, как интерактивные системы, регулирующие процессы внутри цифровых сред, тем самым порождая определенные социальные сдвиги.

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ КАК АДАПТИВНЫЙ МЕХАНИЗМ

Рассматривая культуру как некую информационную оболочку, являющуюся творением человека, стоит, опираясь на ее информационную сущность, выявить выстроенные и еще зарождающиеся культурные особенности цифрового общества. Культура неотделима от информации, являющейся основой человеческого общества, жизненно важным условием его существования. Судя по всему, в цифровом обществе социальное бытие культуры представляет особый интерес. В киберпространстве у нее появляются две новых характеристики. С одной стороны происходит сжатие пространства-времени, с другой – мир разрастается до параметров глобальной деревни, но при этом возникает нехватка реальных ощущений.

Одно из устоявшихся представлений о человеческой культуре — это форма “трехмерного пространства культуры”, показанная на Рисунке 1.

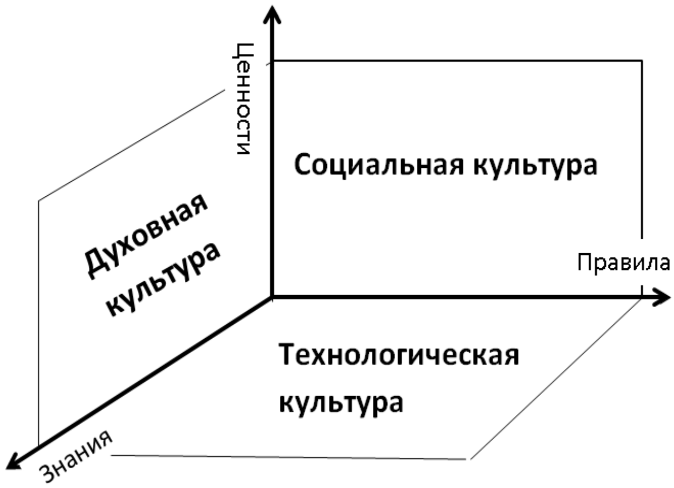

Рисунок 1. Культурное пространство (Levin et al., 2013, с. 17)

Культурное пространство (рис. 1) образовано тремя осями – знаниями, ценностями и правилами. Каждая пара осей образует плоскость, соответствующую одной из граней человеческой культуры. Духовная образована плоскостным соответствием осей “знаний и ценностей”; оси “ценностей и правил” образуют поле соответствия социальной культуре; технологическая представлена между осями “норм и знаний” (Levin, 2014).

В 2013 году вышеупомянутая трехмерная модель была впервые применена для представления цифровой культуры (Levin et al, 2013, с. 17). Духовная составляющая цифрового общества – явление уникальное. Прежде всего, этому способствует его внутренняя связь с виртуальным миром. Очевидно, что по мере того, как Интернет стал неотъемлемым компонентом жизни, присутствие в сети влияет на духовную культуру. Появление виртуальной сетевой жизни как существенной части реальной имеет большое значение для формирования личности. Самое интимное, что может быть, – собственная личность, собственное “я” – в значительной степени подвержено влиянию цифровых технологий (Левин, 2013).

Если традиционная среда строилась по законам природы, то и в технологическом смысле природа была источником энергии как основы жизни. Нынешний развивающийся континуум определяется технологиями машинного обучения, основанными на анализе Big Data, заменяя энергию информацией как “основным источником” жизни человека. Познаваемая среда “оцифровывает” человеческие взаимодействия, естественным путем встраиваясь в них. Таким образом, все составляющие современной культуры, тесным образом взаимодействуя, образуют целостный ландшафт цифровой эпохи.

В человеческом обществе культура выстроила принципиально новую и удивительно разнообразную по своим возможностям модель информационного процесса, отсутствующую у животных, в которой кодировка знаний происходит не генами, а знаковыми системами. Идеи и образы, выраженные в этих системах, отделены от индивидуума, приобретая независимое, неличностное существование. Они становятся социальной информацией, носителем которой является не отдельный человек, а социум, бытующая в нем культура. В отличие от биологической, социальная знаковая информация не исчезает со смертью человека, образуя внутри культуры специфический в негенетический “механизм” своей наследственности – социальную наследственность (Кармин, 2003).

Параллель между культурной и биологической эволюцией восходит к Хаксли (Huxley, 1874), Поппер и Экклс (Popper & Eccles, 1977) и Джеймсу (James, 1879), а идея рассматривать культуру как форму эпигенетической передачи впервые была выдвинута Р. Докинзом (1993), который ввел термин “мем” в книге “Эгоистичный ген” для обозначения целостной единицы информации. Она может передаваться фенотипически, что дало основание для представления о том, что культура, как и гены, может развиваться посредством репликации (передачи между поколениями), мутации и отбора.

Отношения между окружающей средой, генами и культурой довольно сложны и требуют глубокого изучения процесса адаптации человека к новым условиям, всегда представляющим собой уникально сложное взаимодействие между культурными и генетическими изменениями. Потенциал наблюдаемой “скоростной” культурной эволюции по сравнению с генетическими изменениями выявляет важную особенность нынешнего социума: у современных людей приспособляемость к новой среде часто объясняется уникально развитой способностью быстро накапливать большой адаптивный культурный “репертуар”. Подобно биологическим адаптациям, культура приспосабливает нас к окружающей среде настолько удобно, насколько это возможно при существующих условиях. Но каждое новое поколение не является клоном предыдущего, культура всегда находится в движении.

Изменение алгоритмов человеческого поведения, по большей части вытекающих из модификации социума, опирается на перестройку условий существования, где мировоззрение формируется как в непосредственном (физическом), так и в виртуальном пространстве. У И. Левина и Д. Мамлока появляется понятие “гиперсвязанный” мир и его влияние на человеческий опыт. Это мир, в котором активно проявляется феномен цифровой культуры, усиленный “гибридизацией онлайн и оффлайн полей, где сеть превратилась в пространство человеческой коммуникации, повседневной деятельности и развлечения, в “антропопространство”. К. Бэссет, говоря о необходимости построения социальной теории, учитывающей эти изменения, описывает новый этап развития цифровых технологий и их влияние на социум как этап “посткиберпространства” (Соколова, 2012, с. 9).

Самые важные метаморфозы в “оцифрованном” социуме связаны с заменой традиционной концепции человека как отдельной сущности новым онтологическим самовосприятием человека как информационного организма, взаимосвязанного со всем миром. Легкость доступа к бесчисленным видам информации меняет природу человеческого опыта – возможность любого человека (имеющего доступ в Интернет) выбирать желаемый контент дает новые способы конструирования своего мировоззрения, своих отношений с другими и своего понимания того, что есть человеческая сущность. Духовная культура в гиперсвязанном мире индивидуализирована и, можно утверждать, деконтекстуализирована.

СЕТЕВОЕ СОЗНАНИЕ В СВЕРХСВЯЗАННОМ МИРЕ

Информационная революция не ограничивается более совершенным технологическим решением для получения знаний или выполнения различных повседневных задач. Скорее, она сигнализирует о сдвиге в способах, которыми мы, как люди – члены социума, понимаем саму суть того, кем “должно быть”.

До появления Интернета энциклопедическая утопия олицетворяла всемогущество знания, предполагая, что именно знание служит нормативным компасом, который направляет людей и общество. Чем больше мы знаем, тем лучше действуем. И наоборот, ошибки и проступки, согласно этой рациональности, связывались с недостатком знаний. В новой цифровой реальности важнейшим условием существования являются не знания, а наша способность захватить внимание, зафиксировать его, продемонстрировать себя, удивить любым способом, чтобы не быть незамеченным.

Информации становится все больше. Наше ощущение безграничности мира сместилось с природных ресурсов на нее. Это существенное изменение является прямым следствием цифрового поворота. Одним из примеров таких изменений является возросшая культурная значимость социальных сетей

В материале, посвященном молодежи в современном белорусском обществе, четко просматривается почти абсолютная погруженность молодого поколения в мир социальных сетей (рисунок 2).

Рисунок 2. Посещаемость интернет-сайтов молодежью (Сухотский, 2020)

Социальные сети принципиально отличаются от традиционных СМИ. Они быстрые, динамичные и, что самое главное, персонализированные. Это связано с тем, что каждый член сети связан со "своим" сообществом, которое соответствует ему и которому он доверяет.

Важной особенностью сетевого общества является его "деятельностный" характер и способность людей быть как потребителями, так и производителями контента. Эффективное общение между людьми требует быстрой реакции на любое сетевое событие. Жизнь в гиперинтенсивном обществе делает запоздалые ответы или реакции на контент неуместными. Рациональность сетевого общества выражает идею о том, что результативное общение не может быть достигнуто без постоянной активности по всей сети. В этом отношении процесс социализации кардинально изменился и приобрел новые характеристики. Социальный характер сети противоречит иерархическим моделям коммуникации, в которых доминируют принципы вертикального статуса и подавления. Сеть превращает взаимодействие между пользователями в обычное социальное общение и выводит его на более высокий уровень развития цифрового общества.

"Коллективизм" и специфика социальной культуры наиболее ярко выражается в цифровом обществе в новой динамике формирования "сетевого" общественного сознания. Поскольку цифровая передача культурных ценностей характеризуется такими особенностями как скорость, возможность комбинировать письменный и аудиовизуальный компоненты и многим другим, возникает серьезный вопрос, как взаимодействие этих новых функций будет влиять на то, какой содержательный контент станет распространяться в социуме с большей вероятностью и какого будет его влияние (Acerbi & Bentley, 2016).

ЧЕРЕЗ СОЗДАНИЕ ЦИФРОВОГО "Я" К "ГИПЕРОТКРЫТОСТИ"

Новые интерактивные области представляют собой очень удобное поле для формирования изменений в социуме. Диалоговый характер новых медиа, в частности, подготавливает среду для реализации стратегий, которые облегчают работу массового производства. Люди могут легко создавать в цифровом формате те типы социальных отношений, которые не могут создать в реальной жизни. Именно так индивид вступает в процесс реконструкции цифровой идентичности, трансформируя реальную, добавляя новые качества. Однако в случае платформ социальных сетей человек воссоздает не только свое поведение, а и визуальные коды. У современного человека достаточно времени и свободы в социальных сетях, чтобы создавать цифровое "Я", которое он не может создать в реальном мире.

Социальные сети вышли за рамки цифровой социализации и стали витриной цифровой идентичности. Многие социологические и социально-психологические подходы предполагают, что социальный характер человека возникает и формируется в соответствии с разнообразием социальных отношений, которые у него есть. Цифровые идентификаторы, которые отличаются от личности индивида, трансформируются в дискурсивные индикаторы, отрываясь от реального времени и пространства, а также усиливают друг друга демонстрацией, присущей цифровому миру.

Люди хотят продемонстрировать свое присутствие в цифровом мире, поделиться своим реальным опытом, размещая сообщения в социальных сетях. "Гиперсвязанный" мир поддерживает у публики, в том числе, и экзистенциальную потребность в одобрении. Пока человек продолжает присутствовать в социальных сетях, делясь и получая "лайки", его действия записываются и сохраняются, создается новая цифровая идентичность.

При этом генерируются и иные модели поведения в рамках цифровой культуры. Появляется мировоззрение, которое представляет собой новую кодировку и привычки как фрагментированные, отредактированные, связанные и подключенные к Интернету, к "гиперсреде". Сопричастность и создание анонимной идентичности значительно проще в "цифре", а разница в статусах полностью исчезает или уменьшается до минимума, что позволяет говорить о новом формате аккультурации. Так с помощью новых технологий в цифровой среде реконструируется социальная, культурная и повседневная жизнь.

Интеллектуальная, творческая деятельность человека требует исключительного авторского права на контент в традиционном обществе, где люди привыкли делиться с другими главным образом результатами своей работы. В современной "цифре" люди начали делиться практически всем, не только результатами, а и процессами творчества. Этот принцип становится все более универсальным, регулярным и желательным, выступая в качестве рутинной практики. Частные лица уже сейчас могут влиять на основных производителей в сети, прилагая совместные усилия по формированию социальных норм и структур. Прогнозируется, что в будущем все большее число профессионалов будет устанавливать тесные связи с любителями, то есть "мешапы" профессионально составленных сообщений средств массовой информации и сообщений граждан, вероятно, будут расти.

В своей работе Дж. Херинг называет общую тенденцию постоянно делиться всем "транспаризацией", определяя ее как процесс перехода к "прозрачности" человеческих взаимодействий и гипероткрытости общества. Изучение взаимодействия и совместной динамики индивидуализации и транспаризации тесно связано с такими существенными понятиями, как "я в отношениях", (Herring, 2019) и аспектами самооценки человека. Не следует забывать, что цифровая культура может освободить нас как личностей, но она также может и "заключить" нас в тюрьму.

У.Митчелл предполагает, что всеобъемлющие виртуальные сети практически сливаются с человеком на биологическом уровне, приводя к осознанию – я как киборг, рассеянный в пространстве, то есть разделение между человеком и машиной больше не действует. Гиперподключение в сочетании с эффективными технологиями привело к ускорению множества действий, что предполагает определенную степень непредсказуемости (Mitchell, 1999).

Возникает серьезный вопрос. Какое значение имеет для общества то, что сетевые коммуникационные платформы могут сделать кого угодно массовым коммуникатором? Один из ответов состоит в том, что именно так сейчас и рождается невероятный потенциал социальных изменений. Потому что общество, как считает М. Доуз, не просто строится посредством коммуникации, оно существует в ней (Deuze, 2006, p. 70). Это означает, что любой человек с компьютером или смартфоном может распространять какие угодно сообщения, которые могут серьезно повлиять на общество в целом. Теперь отдельные лица и небольшие группы имеют возможность координировать свои действия и взаимодействовать, возглавив социальные движения, используя сетевые коммуникационные технологии.

Цифровые технологии Б. Стиглер определил как "фармакон" – φάρμακον (греч.) – термин, который в философии и критической теории представляет собой смесь двух: лекарство и яд, а то и трех значений (Stiegler, 2019). Здесь речь идет о внутреннем напряжении цифрового мира и технологий, которые с одной стороны обещают предоставить больше возможностей для человеческой культуры, а с другой обладают и разрушительной силой. С его точки зрения такой посыл ставит под угрозу герменевтические знания, лишает человека способности размышлять о переживаниях и разрушает социальную солидарность. Распространение дезинформации и рост разногласий в политических сферах являются воплощением предупреждения Б. Стиглера о возможностях и умении или неумении жить в эпоху разрушения.

"ГИПЕРПОДКЛЮЧЕНИЕ" КАК НОВЫЙ ФОРМАТ АКТИВНОГО ОСВОЕНИЯ РЕАЛЬНОСТИ

Гражданская идентичность имеет тенденцию переходить от пассивного к активному гражданству. Б. Веллман рассматривая отношения в XX веке, вводит понятие "глокализация", "сочетание глобальной и локальной взаимосвязанности" (Wellman, 2001), взаимодействия на рабочих местах и в группах сообществ. Интернет и его социально-сетевая структура работает на участие максимально большего числа отдельных людей, объединенных в глобальную коммуникацию. Это изменение с середины XX века до начала XXI проявило понятие гражданина, который становится все активнее стремящимся озвучивать свои опасения и требовать своего места в обществе.

Постоянная связь друг с другом с помощью цифровых сетей создает возможность для относительно быстрых массовых социальных действий. Люди начинают использовать эту силу, чтобы тянуть общество в разные стороны. "Гиперсвязанный" мир, в котором виртуальная толпа, порой небольшими усилиями превращается в реальную, демонстрирует, что социальные сдвиги и разногласия развиваются, ускоряются значительно быстрее, благодаря интернет-платформам.

Факторы, символизирующие перемены, такие как диверсификация средств массовой информации и "обретение" ими власти над обществом и правительством, технический прогресс, социальная свобода или новые тенденции в мыслях о правах человека и социальных движениях, поступенно формируют новый тип социума.

События, происходящие в публичной медиа сфере, интересны для большинства граждан, а мобильные устройства превратились в вещательные СМИ, интегрируясь в социальные сети. В этом смысле социальные сети функционируют практически как посредническая виртуальная публичная сфера. Трансляции обычных людей в социальных сетях, особенно прямые, по количеству просмотров иногда успешнее, чем у знаменитостей. В настоящее время существует множество учетных записей в социальных сетях, со временем значительно увеличивающих число своих подписчиков. А в остроактуальные моменты эта тенденция разрастается в геометрической прогрессии. Примером может служить август 2020 года в Беларуси, где “телеграмм-революция” разворачивалась, благодаря неустанному вбросу информации с экстремистскими призывами на канале Nexta, число подписчиков которого в считанные дни выросло почти в семь раз, с 317,4 тыс. до 2,165 млн. (рисунок 3).

Рисунок 3. Статистика посещения канала с экстремистскими призывами (Статистика канала с сайта TGStat.com)

Социальные сети создали универсальное коммуникационное поле, которое традиционные средства массовой коммуникации не могут предоставить своим пользователям, в виде среды для обмена информацией и общения, гиперпространство, которою также легко использовать в различных целях, что становится серьезной проблемой и для изучения, в том числе.

Параллельно с аудиторией, сформированной средствами массовой информации, социальные сети “порождают” свою публику (сетевое сознание), где каждый человек может поделиться собственным, особым, личным мнением. На этом этапе важно понимать, что общественные социальные сети, значительно более успешны, чем традиционные СМИ, в плане участия граждан и с точки зрения привлекательности, в чем проявляется один из принципов демократизации.

В то время как традиционные средства массовой информации состоят из институционализированных вещательных групп и институционализированной информации, новые медиа — это поле, которое допускает независимое участие граждан. Социальные сети работают как структура, которая имеет характеристики газет, радио и телевидения. С развитием интернет-технологий со времен Web 2.0 и социальных сетей, которые позволяли пользователям общаться в чате, идея публичного пространства вступила в новую фазу.

В XXI веке, в отличие от одностороннего и искусственного потока информации, редактируемой и цензурируемой, распространяемой традиционными СМИ, информация, циркулирующая в "гирерсвязанном" мире, позволяет пользователю чувствовать себя свободнее. Интернет с его демократическими условиями и структурой превращается в дискуссионную площадку / витрину. Современное телевидение также уходит в "цифру", пытаясь не потеряться на фоне различных интегрированных приложений в сети (Lindegaard, 2012). Спрос на Интернет и его безграничность "повредили" структуру традиционной повествовательной структуры телевидения, учитывая, что на протяжении многих лет оно использовалось как инструмент формирования пассивного зрителя, не имеющего возможности вмешаться в процесс.

Наши представления об информации и знаниях меняются. Люди стремятся выжить в море информации. Однако мы должны помнить, что это море не "чистое" – в частности, оно включает в себя различные типы манипулируемых данных, информации и знаний из ненадежных источников, предлагаемых с разными целями.

Концепция цифровой культуры – сложная конструкция, которая включает глобализационные процессы, популяризацию культуры, сетевые сообщества, новые медиа, игровые практики, цифровую рекламу, потребление, надзор и еще многие составляющие. Она многослойна и отличается от любого предыдущего типа культуры в плане структуры и распространения. В частности, давление, создаваемое новыми медиа в форме аккультурации, важно с точки зрения быстрого и эффективного влияния, невероятно скоростного выхода на большие массы. Цифра "требует", чтобы у человека было с технической точки зрения недорогое и совместимое устройство (телефон или компьютер), предлагая пользователям возможность построить новый мир, включающий в себя реальность внутри общественного виртуального социума, охватывая все конкретные социальные практики, начиная с политики и заканчивая любыми самыми экзотическими интересами.

ЗАКЛЮЧЕНИЕ

В заключение вышеизложенного было бы полезно спросить себя, какие выводы мы можем сделать, чтобы лучше понимать настоящее и наступающее будущее в разрезе стремительно расширяющейся гипервселенной. С этой целью я хотела бы выделить некоторые культурные особенности, которые, на мой взгляд, играют важную роль.

Самая глубокая трансформация — это то, что люди теперь не отделены друг от друга. Поскольку жизнь в “гиперсвязанном” мире – относительно новое явление, история нашей новой киберсреды или уже посткиберсреды обитания лаконична. Теоретические исследования цифровой революции как культурного феномена отражают известные цифровые преобразования общества и открывают путь к будущему изучению социума путем анализа ожидаемых возникающих антропологических, социальных и технологических явлений. Любое исследование, пытающееся понять общество и предвидеть его изменения в будущем, должно проводиться в культурно-антропологическом контексте.

Многомиллиардная эволюция и формирование жизни на нашей планете регулировалась естественным отбором, смешением генов и мутациями. Впервые в человеческой истории именно наука и культура предложили совершенно новый инструментарий для вмешательства в собственный эволюционный процесс. В биологической карте мы заменяем и ремонтируем “бракованные” части, в социальной – формируем новое мироощущение. С точки зрения включенности в технологическую вселенную “рассеянный в пространстве киборг” – это уже реальность. Что же позволяет нам оставаться людьми в этой гибридной среде? Дают ли эти навыки человеку больше свободы?

Новая цифровая среда, сочетающая реальность и виртуальность, сильно отличается от нашей обычной естественной реальности. Переосмысливая то, как люди рассматривают свой переход в цифровой мир, мы понимаем, что в определенном смысле культура, которую можно охарактеризовать как вторую природу человека, вышла на другой уровень и образует новый пласт в виде интерактивного виртуального пространства. В цифровом обществе человек не только создает новый объективный мир, как это происходит во “второй” природе (культуре), но также создает объекты другой природы (например, сетевые, коммуникативные и мультимедийные). По этой причине некоторые ученые склонны рассматривать культуру цифрового общества как “третью” сущность (Kelly, 2016, p. 292–293).

Второе большое достижение “гиперсвязанного” мира состоит в том, что бывшие зрители превратились из потребителей в производителей. Когда новый потребитель приобщается к информационному ландшафту, он одновременно становится и производителем

Третий очень важный момент – то, что средства коммуникации перестали быть просто источником информации. А стали местом управления. Поскольку группы, которые имели возможность видеть и слышать, смотреть и слушать, теперь могут собираться и общаться друг с другом. Следовательно, последствия перехода от пассивного приема информации к активному восприятию – сети, Интернет – поднимают важный вопрос: как меняется коммуникационное поле, кто и как наполняет его новым содержанием, как информация в цифровой среде меняет и будет в дальнейшем трансформировать процессы в социуме. На самом деле это изменение всей экосистемы в целом, влияющей на формирование нового типа социума.

Человек оказывается в своеобразном личностном культурном микромире, сформированном в соответствии с его склонностями и приоритетами. Создание микромиров сопровождается, усиливается и активно поддерживается цифровой средой, посредством взаимопроникновения онлайн и оффлайн полей через "антропопространство" выстраивается новая вселенная, "гиперсвязанный" мир. Как будет дальше меняться "оцифрованный" социум, какова будет культурная трансмиссия – темы весьма актуальные для любого общества и подходят для теоретического и методологического осмысления.

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