Dialog, Communication, Cooperation, and Collaboration: Facets of Human-Computer Interaction

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Abstract
This study is a linguist's attempt to analyze such terms as human-computer interaction, computer-human interaction, human-machine cooperation, machine-human collaboration, and many related terms. The purpose of this analysis is to determine whether and how they represent different shades of meaning, some nuanced, some distinctive. This allows for their further systematization and the identification of terminological synonymy. The discussion shows that terminological choices might be necessary - not only between „man" and „human" or between „dialogue" and „dialog," but also between „cooperation" and „collaboration" as well as „dialog" and „communication." This still leaves a considerable number of terminological options which can be assigned to different facets of human-computer interaction.

Keywords: Human; Machine; Computer; Communication; Cooperation; Dialog; Human-Computer Interaction

Диалог, общение, кооперация и сотрудничество: Грани взаимодействия человека и компьютера

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Аннотация
Данное исследование представляет собой попытку лингвиста проанализировать такие термины, как "human-computer interaction", "computer-human interaction", "human-machine cooperation", "machine-human collaboration", а также многие связанные термины. Цель этого анализа – определить, представляют ли они разные оттенки значения, нюансы отношения, отличия и каким образом. Исследование позволяет провести дальнейшую систематизацию и выявить терминологическую синонимию. Обсуждение показывает, что может потребоваться терминологический выбор не только между "man" и "human" или между "dialogue" и "dialog", но также между "кооперацией" и "сотрудничеством", а также между "диалогом" и "общением". По-прежнему существует значительное количество терминологических вариантов, которые можно отнести к различным аспектам взаимодействия человека и компьютера.

Ключевые слова: Человек; Машина; Компьютер; Коммуникация; Сотрудничество; Диалог; Человеко-компьютерное взаимодействие

INTRODUCTION

Over the centuries, human interaction with technical devices has become more complex in order to achieve certain tasks with the hope of improving living conditions and facilitating labor. Human interaction with technical devices throughout history can be divided into three types: *instrumental*, such as a shovel, axe, scythe, comb, blade, ruler; *mechanical*, such as a vehicle, manual meat grinder, clockwork; *electromechanical*, such as s today's coffee grinders or razors, powered by electricity; and, of course, *electronic*, namely computers and everything controlled by them. At the first stages the interaction between a human being and a technical device was carried out by physical impact on technical devices with the direct participation of a human being or sometimes an animal, for example, a donkey turning a millstone. Today, the interaction between a human being and a technical device that functions on the basis of electronic principles can be carried out without physical contact, for example, by means of a remote control, voice, human biometrics, such as using a fingerprint to unlock a cell phone, or an iris to open doors. With the advent of electronic technical devices, a new type of interaction between human and technical devices appeared – intellectual from the human side and mathematically conditioned from the machine side. Such type of interaction is clearly evident in electronic games or simulators, and any device requiring a person to carry out thinking operations for the functioning of an electronic process and its performance of the tasks for which it was created. Implementation of this interaction can be carried out both nonverbally (slot machines, game consoles) and verbally (speech activated functions, automated phone operators). These forms of human-machine interaction go beyond human-machine interfaces and issues of interface-design. They have led to the appearance of such terms as:

1) *human-computer interaction* (Jaimes & Sebe, 2007)
2) *computer-human interaction* (Masoodian et al., 2004)
3) *man-computer interaction* (Nickerson, 1969; Shackel, 1981; Tainsh, 1985)
4) *human-machine interaction* (Ke et al., 2018)
5) *man-machine-interaction* (Nickerson, 1969; Miller, 1977)
6) *human-machine communication* (Bylieva, 2020; Guzman, 2018)
7) *man-machine communication* (Tadeusiewicz & Demenko, 2009)
8) *man-computer communication* (Sackman, 1968)
9) *human-computer communication* (Mikovec & Klima, 2003; Obrenovic & Starčević, 2004)
10) *man-machine cooperation* (Bouillon & Anquetil, 2014; Guo et al., 2006)
11) *human-machine cooperation* (Hoc, 2000, 2013; Millot & Boy, 2012)
12) *man-machine collaboration* (Bisbey & Martin, 1972)
13) *human-machine collaboration* (Haesevoets et al., 2021)
14) *machine-human collaboration* (Kela & Kela., 2019)
14) *man-machine dialogue* (Landragin, 2013)
15) *human-machine dialogue* (Ramachandran & Canny, 2008)
16) *man-computer dialogue* (Ambrózy, 1971)
17) *human-computer dialog* (Minker, & Bennacef, 2005; Yang & Tao, 2019)

This list suggests six types of interaction which need to be analyzed: interaction, communication, cooperation, collaboration, dialogue or dialog. The analysis needs to include the features of nomination in each of these types of interaction (Figure 1-5). Not all of these prove to be equally significant:
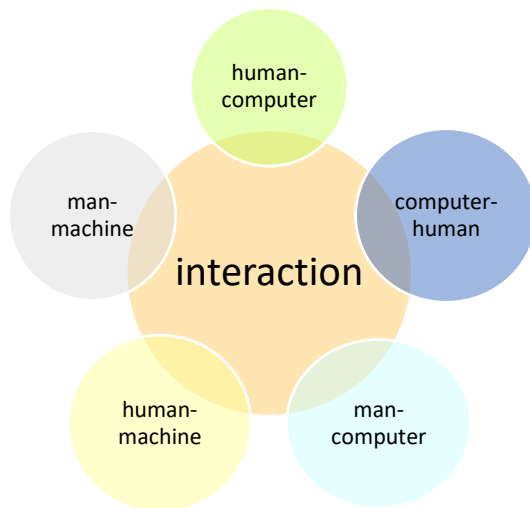
Figure 1. Combinations with the word "interaction"
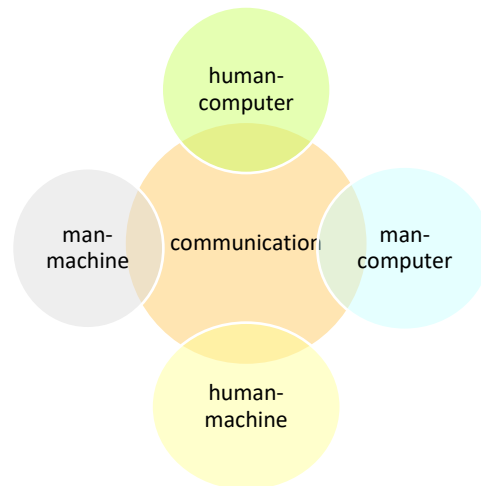
Figure 2. Combinations with the word "communication"
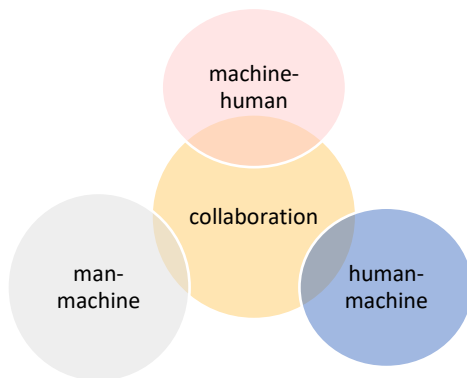
Figure 3. Combinations with the word "collaboration"

Figure 4. Combinations with the word "cooperation"

Figure 5. Combinations with the words "dialogue" and "dialog"

The proposed systematization of terms contributes to the unification of a terminological apparatus which may prevent discrepancies in concepts when creating new terms,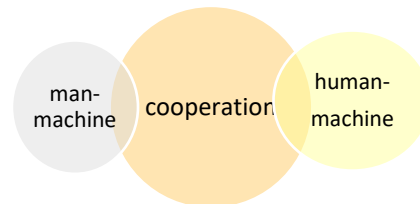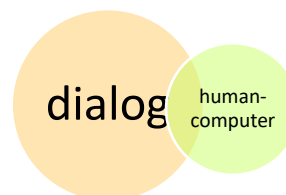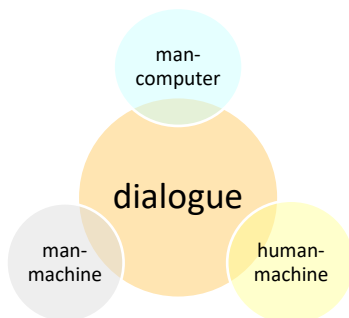 and moreover, helps avoid terminological inaccuracies in interdisciplinary research. The results of this study can be used when placing the terms in terminological databases, for example, the ISO Concept Database, ISO/CDB[1], or Multiterm[2].

MATERIALS AND PROBLEMS

Definitions of the Terms Analyzed

An analysis of the terms necessarily begins with questions of definition in order to identify terminological synonymy and to reveal the functions they denote.

Some authors draw attention to terminological synonymy. One might consider synonymous the terms *computer human interaction*, *man-machine interaction* (Dix, 2009) and *human-machine interaction* (Nardo et al., 2020). And although all the terms that refer to „man" rather than „human," such as *man-machine interaction* can be considered obsolete, they are nevertheless still used in 21st century works (Coiffet, 2004; Gruca et al., 2014; Nardo et al., 2020).

1. *Human-computer interaction* (*HCI*) and its synonym ***computer-human interaction* (*CHI*)** is a field that focuses on simplifying the use of computer technology by the user (Dix, 2009; Wirtz, 2017). In German, *Human-Computer Interaction* (*HCI*) corresponds to the term *Mensch-Computer-Interaktion* (Fach, 1997), and was said to correspond in English to *man-computer interaction* (*MCI*).

2. *Human-machine interaction* (*HMI*) is a scientific field that develops interactive computer systems where these interactions broadly encompass (electronically controlled) machines and their users - including verbal as well as nonverbal signs (Esposito et al., 2008; Ke et al., 2018). Here again, this concerns a focus of Computer Science and Engineering on the development of user-friendly interfaces.[3] Specialists in ***Human-machine interaction* (*HMI*)** - sometimes still called *man-machine interaction* (*MMI*) (Nardo et al., 2020) - implement the practical application of interactive computer systems from the perspective of ease of human use by developing an interface (Ke et al., 2018).

3. The term ***Human-machine communication* (*HMC*)** refers to the creation of a machine intelligence that allows humans to communicate with computer systems that are equipped with special programs to make such communication as close as possible to natural human communication. (Suchman, 1987; Bylieva, 2020). The aim of such communication is to obtain information, as well as to communicate within the social roles assigned to computerized machines, e.g., teacher or caregiver (Patric, 2019).

4. Another definition of ***Human-machine communication*** dates back to an earlier use of the term ***Man-machine communication* (*MMC*)** which was said to aim at developing a sound interface for users with no special technical training (Sharp, 1974).

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[1] http://cdb.iso.org/
[2] http://www.sdl.com/en/language-technology/sdl-openexchange/AppDetails.aspx?appid=134
[3] http://window.edu.ru/catalog/pdf2txt/736/23736/6246

5. *Man-machine dialogue* (*MMD*) (Landragin, 2013) or rather ***human-machine dialogue (HMD)*** (Minker & Bennacef, 2005) foregrounds dialogue, that is verbal and nonverbal communication between humans and the system.

6. *Human-machine cooperation* (*HMC*) involves mutual intervention in human and machine tasks based on human-engineering and cognitive approaches (Hoc, 2013, Millot, 2009). A definition of so-called ***Man-machine cooperation*** even refers to the fusion of human and machine abilities (Goßler, 2016).

7. *Human-computer communication* (*HCC*) refers to the efficient transfer of information between humans and machines (Denning et al., 1988). This definition is a further development of the earlier ***Man-computer communication* (*MCC*)** which was primarily concerned with the interests of users in terms of accessibility and ease of use of computers for various human tasks (Sackman, 1968).

8. *Machine-human collaboration* (*MHC*) and sometimes ***man-machine collaboration*** (*MMC*) (Webb, 1999). do not consider the machine as a tool, but conceive the mutual augmentation of human and machine capabilities (Techtarget, 2017).

Peculiarities of the Dialogue and Dialog Concepts

One of the things that strikes the eye when looking at the list of the analyzed concepts is the different spelling of *dialogue and dialog* in the same terms:

1) *Man-machine dialogue* and *man-machine dialog* (Landragin, 2013; Beroule, 1983)

2) *human-machine dialogue* and *human-machine dialog*

3) *man-computer dialogue* and *man-computer dialog*

4) *human-computer dialogue* and *human-computer dialog*

Since the purpose of this article is to unify the concepts under consideration, it makes sense to attend also to the ever-so nuanced difference between *dialog* and *dialogue*. The word *dialogue* is used in British English, as evidenced by Oxford Learner's Dictionaries (Oxford University Press, n.d.c) and Cambridge Dictionary (Cambridge University Press, n.d.d), while there is no *dialog* variant in these dictionaries. According to surveys, *dialog* is quite rare in British English (Writing explained, n.d.). In American English, *dialog* has been used in addition to *dialogue* since the 1980s and its popularity peaked in 2000 (Writing explained, n.d.). In the context of computer technology the word *dialog* is mostly used in American English , while in British English it is rarely used both in the language of everyday communication and in the field of computer technology (Writing explained, n.d.). American use would indicate that the more resonant *dialogue* is preferred in human communication and *dialog* is considered more suitable for technical communication.

Peculiarities of the Human and Man Concepts

All of the analyzed terms appear in the two variants containing *human* and *man*. In dictionaries on computer science and computer technology (Heinrich et al., 2004, p. 423, p. 797), as well as in scientific articles (Tadeusiewicz & Demenko, 2009; Suchman, 1987) *human* and *man* occur in the same meaning, despite the fact that some

authors rightly note that "man" as a synonym for "human" is outdated (Dix, 2009). The language of everyday communication is quite susceptible to changes due to various reasons. In some cases, we are talking about simplifying language constructions, in other cases, these changes reflect culturally and politically conditioned changes in people's mentality. However, such changes in the language are noticeable primarily for native speakers. In contrast, the language of Computer Science and Engineering is international and unites native speakers of different languages. The professional sphere is evidently not subject to such rapid language changes. "Man" is still actively used in computer science and programming dictionaries as a synonym for "human. " Given the trend restrict the meaning of the word "man" to males as opposed to females, this trend will perhaps take hold in dictionaries as well. The influence of "language fashion" on terminology sometimes makes it difficult to understand scientific texts. In this study, linguistic phenomena are considered at various levels, identifying the most vulnerable places. Initially, specialists in the field of computer technology either did not pay close attention to terminology, or implied some differences that were later erased. This entails the appearance of a large number of synonymous words, which makes it difficult for both native speakers and foreigners to understand professional texts and presents difficulties for translators.

Peculiarities of the Cooperation and Collaboration Concepts

Despite similarities in meaning, *collaboration* and *cooperation* have some differences:

Collaboration is understood as working together toward a common goal in which ideas are generated by a team and tasks are set and solved together (Cambridge University Press, n.d.a; Oxford University Press, n.d.a).

Cooperation is understood as the individual work of each project participant toward a common goal (Cambridge University Press, n.d.c; Oxford University Press, n.d.b).

Peculiarities of the Interaction and Communication Concepts

On the one hand, *interaction* is broader than *communication*. *Communication* implies the transmission or exchange of information (Cambridge University Press, n.d.b), *interaction* refers to any type of interaction, including the interaction of acids in a chemical reaction. On the other hand, we should not forget that *communication* as the exchange of information is also a rather broad concept. We can assume that by interacting with a cat the moment we stroke it, information is also exchanged. The person who strokes the cat in this way expresses their love for it, and the cat's behavior at the moment of stroking shows the person how much it is pleased.

Peculiarities of the Machine and Computer Concepts

According to the dictionary (Oxford University Press, n.d.d), *machine* is a broad term that can include the computer. *Machine* denotes:

1) Hardware with many parts working together to accomplish a specific task. The power used to run a machine can be electricity, gas, human power;

2) Computer.

The large number of academic papers and vocabulary entries on the issue under study, terminological synonymy and homonymy of the concepts under consideration, the peculiarities of the translation of terms in Russian, English, and German required this initial survey of meanings as they can be found in the literature.


RESULTS

Classification of the Analyzed Terms by Function

A literature review showed that the terms analyzed have a large number of equivalents, both synonymous and differing in the functions they perform.

Furthermore, the translation of the analyzed terms into Russian or German show the impossibility to differentiate them in many cases. For example, *man-machine cooperation* and *human-machine cooperation, human-machine collaboration, human-machine interaction* have only one variant of translation into Russian – "*человеко-машинное взаимодействие*". Likewise, when translated into German, one cannot distinguish between *man-machine cooperation* and *human-machine cooperation*, since there is only *die Mensch-Maschine-Kooperation*. To identify synonymous terms, it is necessary to classify them according to the functions they perform. In order to accomplish this task, I have chosen the faceted classification method. Based on a review and an analysis of the literature on the problem under study, I have identified four facets:

- Development of a user-friendly interface,
- Bringing machine communication closer to natural one,
- Combining the human and machine abilities,
- Exchange of information between humans and machines. The distribution of the analyzed terms by the selected facets is shown in figure 6.
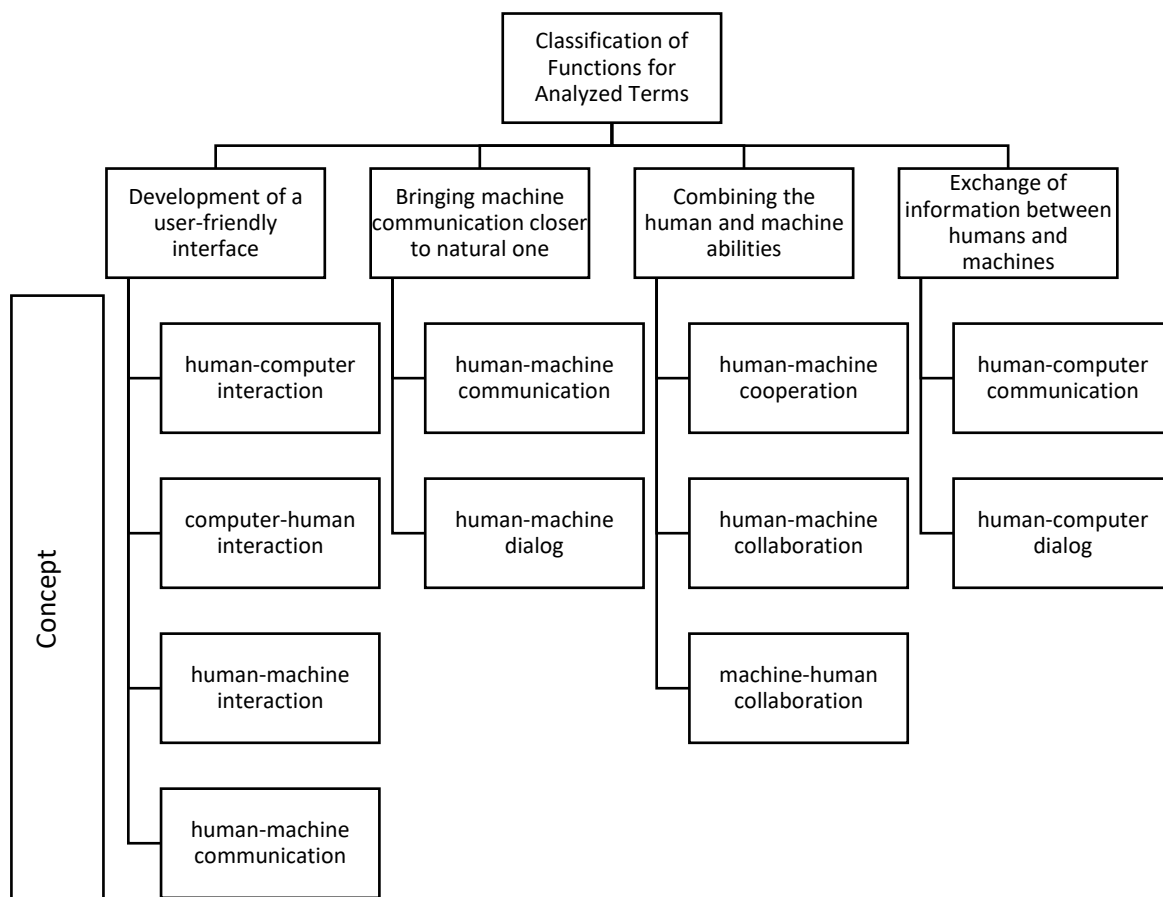
Figure 6. Classification of functions for analyzed terms

The Main Problems of the Analyzed Terms

The review of the scientific and reference literature highlighted the main problems in the use of the terms that were identified and analyzed:

1) The use of *dialogue* and *dialog* in the context of computer technology

2) The meaning of *human* and *man* in the analyzed concepts

3) The differentiation of the terminology from the points of view of human-machine interaction, communication, and dialogue.

For all of these problems suggestions are needed about how to deal with them.

Dialogue or Dialog?

Since the form *dialog* is mostly used in American English especially in the field of computer technology, and since the American version of English tends to simplify it, it would be reasonable to use the form *dialog* and, accordingly, the following terms: *man-machine dialog, human-machine dialog, man-computer dialog, human-computer*

dialog, from the point of view of the ease of its use by users, computer scientists and engineers. This choice in favor of *dialog* takes into account the fact that in American English *dialog* has a more technical use compared to *dialogue* which makes it especially suitable in the context of computer technology.

Man or Human?

A valuable feature of any term is its unambiguity, especially within the same sphere. In everyday language *man* is used in a gendered way and also in the general meaning of *human*. As an adjective, *human* is used in the meaning of *user* and denotes a person as a living being, as opposed to machines and computers. Therefore, the use of *human* as a part of computer terms is preferable to *man*: *human-computer interaction, human-machine interaction, human-machine communication.* In addition, the tradition of using the lexical unit „man" mainly in relation to men has practically formed in English-language discourse. Based on the frequency of their use, we should choose to adopt the term „human": *human-computer interaction*, *human-machine interaction, human-machine communication, human-machine dialog, human-machine cooperation, machine-human collaboration, human-computer communication, human-computer dialog*. The choice in favor of *human* takes into account not only a trend in modern language but also the fact that in computer terminology, *man* is found to mean "manual; a Unix command designed to format and output reference pages" (Multitran, n.d.b), and also the abbreviation MAN to mean city or regional network (Multitran, n.d.b). *Human* in computer terminology as an adjective means "user" (Multitran, n.d.a). In this way, as well, it is possible to avoid excessive ambiguity.

The literature search for the keyword *computer-human interaction* caused difficulties, as the predominant combination is *human-computer interaction,* and "Human-Computer Interaction" (Dix, 2009) considers these two terms as synonyms.

Machine or Computer?

Since „machine" is a general concept, which includes the concept of „computer," it is in our case appropriate to use the broader term „machine" as in *human-machine interaction, human-machine communication, human-machine dialog, human-machine cooperation, machine-human collaboration.* In this use, however, human-machine communication requires a specific type of machine, machinery or mechanical system of that is controlled by electronics. This is accounted for by the analyzed uses of *human-computer communication* and *human-computer dialog*.

Cooperation or Collaboration?

Since humans and machines are not yet able to work as equals, putting forward ideas and tasks, it is at this point more likely to be a case of *cooperation*: *human-machine cooperation.*

Interaction or Communication?

Interaction with technical means, which includes machines and computers, can be carried out both with and without the transfer or exchange of information. *Interaction* is

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a fairly broad concept, including the concept of *communication*. While *communication* is usually understood as the transmission or exchange of information, the pure form of *interaction* can be clearly seen in simpler technical means or tools, such as a razor blade. When a man shaves, he acts on the razor blade, the razor blade removes excess hair by acting on it. The transmission, reception and exchange of information can take place through both verbal and nonverbal signs. The more primitive the mechanism, the less information is exchanged. If we consider a mechanical meat grinder, then the exchange of information between the person and this machine is reduced to zero, there is only the transfer of information by the person: its preparation for operation, filling with meat are nonverbal signals transmitting information to this technical device. In a meat grinder with electronic elements, communication goes from one-way to two-way communication, that is, from transmitting, perceiving information, to responding to it, as electronic sensing becomes more complex. The meat grinder can work by receiving information and beginning to grind the meat as it receives the signal of its feeding. As part of two-way communication, it can also signal the degree of readiness of the minced meat. Thus, the implementation of *interaction* and *communication* depends on the complexity of the technical device. Therefore, it is advisable to use the two seemingly similar, but nevertheless different terms *interaction* and *communication*. As for the development of a user-friendly interface, in this case, we are talking about complex technical devices equipped with electronics, which is most accurately reflected in the concept of *communication*. But, nevertheless, it is most appropriate to use a more concise concept of *interaction*: *human-machine interaction*.

Human-Machine Dialog

The use of the concepts "*human-machine dialog*", "*operator-computer dialog*", "*operator-computer dialogue*" allows us to assume that there is a dialog between a human and a machine. To answer the question whether a dialog between humans and machines is possible, we must first analyze the concept of dialog.

Dialog is undoubtedly a part of communication, but it is usually seen as communication between people or a group of people (Collins, n.d.). It can exist in the form of an oral dialog between several persons, as a written text such as dialogues in fiction, as communication between several persons recorded on paper, or communication by fixing statements in writing in the case of hearing-impaired people. To determine the legitimacy of using the term "human-machine dialog", it is necessary to find out whether human-machine dialog has the same attributes, properties and characteristics as communication between people, to what extent they correspond to verbal communication between a human and a machine.

Any communication implies (face-to-face to a greater extent, remote to a lesser extent) the use of nonverbal signals of the sign system in addition to verbal signs. The spectrum of nonverbal signs in face-to-face communication is wide: gestures, facial expressions, intonation.

In the absence of visualization of the interlocutor, the number of nonverbal signals affecting the course of the dialog also decreases, that is, the number of signals given may remain the same, but they will not all be perceived by the interlocutor and the

desired pragmatic effect will be absent. Moreover, the phonetic means of nonverbal communication (tempo, timbre, speech volume, pause fillers, speech melody) can interfere with the perception and interpretation of human speech by a machine.

And the programs themselves with their voice phrases are as much as possible deprived of nonverbal speech signs. Statements in such programs are built in accordance with the norms of literary language.

Another important feature of dialog between people is the emergence of not only a verbal dialog, but also a dialog of worldviews inherent in each interlocutor. The machine asking and answering questions is not the bearer of a certain worldview. Its questions and answers depend on the software installed, and its moral and spiritual values are determined by the programmers' worldview. At the same time, the questions asked and answered by the machine may not reflect the programmer's position on the issue, it is more likely to act as a definition of basic human values.

Communication between humans and machines can proceed through nonverbal signs, which reduces it to maximum functionality, strict sequence of actions, complete absence of emotional coloring, and excludes the exchange of worldviews.

Thus, the concept of *human-machine dialog* does not absorb the main properties and characteristics of the term *dialog*, but corresponds to the concept of *communication*. Communication is a general concept, a subspecies of which is dialog. Since the concepts of *dialogue* and *communication* are not synonymous, i.e. are not equal to each other, it is logical to assume that dialog is one of the components of communication, while the second part is assigned to other forms of communication, for example, the interaction of a person with a machine or machines with each other. Thus, as the second and third parts of the concept of *communication*, we can distinguish human-machine and machine-machine interaction.

CONCLUSION

This study is a linguist's attempt to systematize the terminological basis of the so-called "man-machine interaction" from the perspective of dialogue, interaction, communication, related *computer* and *machine* terms, as well as the problem of translating the terms containing *human* and *man* from English into Russian and German. As a result of this study, we can offer table 1 reflecting the four functions of the analyzed terms and the concept that, from my point of view, is the most relevant:

Table 1. Terms reflecting the main functions of the analyzed concepts

No.	Function	Concept
1.	***Development of a user-friendly interface***	*human-machine interaction*
2.	***Bringing machine communication closer to natural one***	*human-machine communication*

3.	*Combining the human and machine abilities*	human-machine cooperation
4.	*Exchange of information between humans and machines*	human-computer communication

This identification of separate strands does not put them all on the same level. The definitions of these concepts also revealed an aspirational dimension which assigns special meaning and rank to some of them over other. Most ambitious and perhaps unrealistically ambitious proved to be „computer-human collaboration" which seeks to overcome the notion of the computer as a tool but posits the collaboration of equals. In contrast, „human-machine communication" designates almost neutrally a general area of study. This suggests, finally, a landscape which reveals the standing in respect to each other of the central claims and central terms (fig. 7).
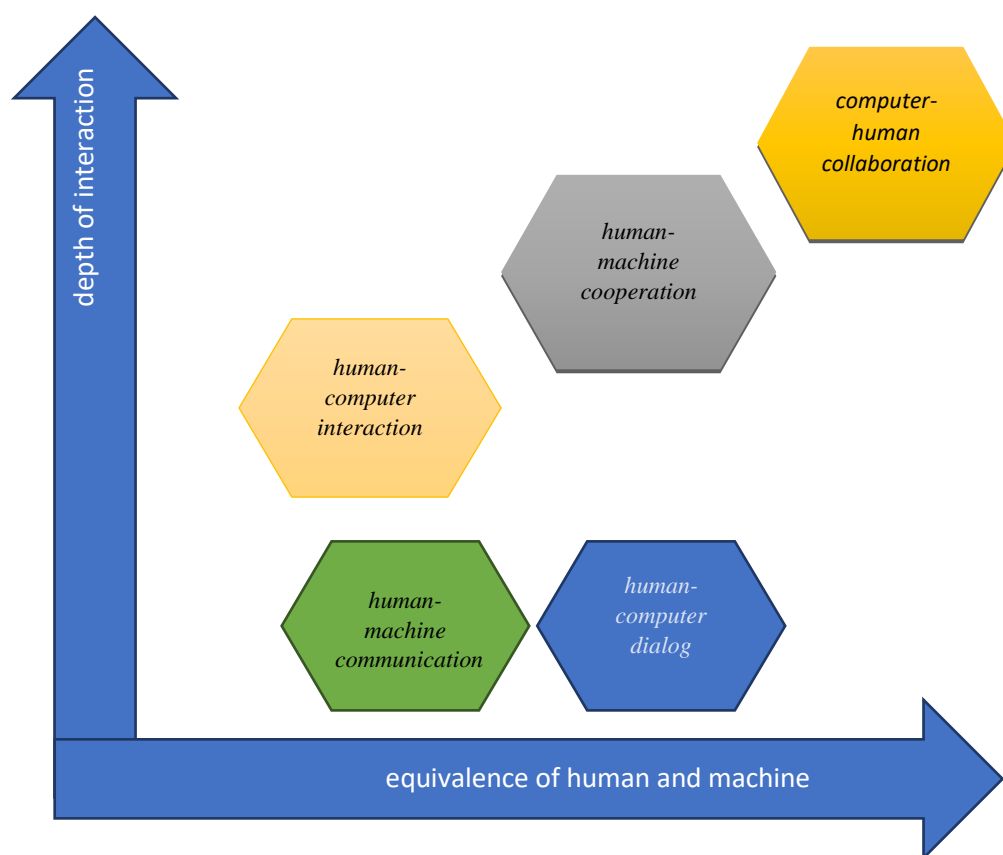
Figure 7. Aspirational facets of terms

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