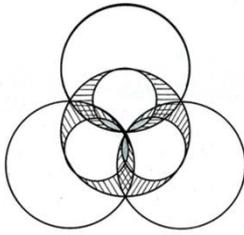


UDC 165



HUMANKIND AS A SYSTEM. PART 1

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Abstract. For an in-depth understanding of the processes underlying the development of mankind as a whole, an approach is proposed in which the opportunities for actions of people and humanity are included in the consideration. The social structures, as well as the impact of mankind on the environment, are excluded from consideration. In the works known to me, this approach is practically absent. The purpose of this study is to develop criteria for the search for components or groups of components of such a system and identify their list. The other purpose is to consider the dynamics of development over time of a system consisting of these groups of components. The search criteria for components or groups of components that may constitute such a system are described. The list of groups of components is given, which, in particular, includes “Man-made materials”, “Mass transport”, etc. The totality of groups of components determines the range of opportunities for the actions of people and humanity as a whole. An analysis was made of the change in time of the proposed set of groups of components. It has been established that the range of these opportunities expands over time and that this expansion is realized with acceleration.

During the search per proposed criteria information was used from various areas of knowledge. Those areas are associated with the development of technologies, means of communication, social activity, globalization, and cognitive abilities.

Keywords: complex systems, humankind, history of mankind, opportunities for human actions, development.

1. INTRODUCTION AND STATEMENT OF THE PROBLEM

Humanity is a complex system. There are various approaches to the description of humanity [2, 9, 14, 18, 22, 24, 25, 30, 31, 50]. What does the system of humanity look like if we include in its description the possibilities for the actions of people and humanity and exclude all individual, social, political, economic differences, as well as the impact of humanity on the environment? I could not find works of this kind. The objective of the present work is to develop a model of this system, to search criteria for components or groups of system components, to identify their list, and also to consider the dynamics of development over time of a system comprising these groups of components.

2. WHEN THE HISTORY OF HUMANITY BEGAN

Our model of the human system should include the most important components or groups of components. Otherwise, the model of the human system will be incomplete.

The commonly accepted definition of the human prehistory is “the period of time until written records appeared” [26]. According to this definition, the history of humanity began in 3200 BC - 3100 BC, when the first written texts appeared. Whatever happens before this time is the prehistory. This definition is understandable, since it is much simpler and more convenient to investigate events and facts for which written records exist. Still, such a periodization of history leaves many important events outside the history of humanity.

With this in mind, it makes sense to count the beginning of human history from the time when Sapiens became behaviourally modern humans. But, this date itself is the subject of debate and may range from 200 to 40 thousand BC [47, 54]. From the point of view of

neurobiology, we will follow the theory presented in [52]. The hypothesis [52] is that the development of behavioural modernity by representatives of the genus *Homo* was associated with the acquisition of prefrontal synthesis (PFS), which is a conscious and focused process of synthesizing new mental images. Accordingly, we named the first group of resources "New Mental Images". For definiteness, we will consider the confirmed date of the first emergence of art with the image of figures of partly people, partly animals [5, 13], i.e. 42000 BC as the date when the human history began.

3. METHODOLOGY

Model. The proposed model consists of abstract discrete components, i.e. resources, or groups of components, i.e. resource groups. Groups of components, resources, and resource groups, the creation of a resource by humanity or the creation of resource groups is the terminology proposed in the paper. The terms "creation of a resource", "the appearance or occurrence of a resource" and "adding a resource to a resource group, as well as to a set or arsenal of resources" are used interchangeably.

Resources. In the context of this paper, the resources are the tools, the things, qualities and methods that can be used to achieve human goals. The resources existing before the beginning of human history will be called prehistoric resources. Resources that have appeared after the beginning of human history, would be called just resources. Prehistoric resources include, in particular, individual resources of people, such as sensory organs, speech, individual mobility, etc. By resources, with rare exceptions, we mean "unlimited resources", which do not decrease over time and as the asset is used. For example, the "Mass Water Transport" resource is not depleted by the fact that someone is using a raft or boat.

When some people first created an object that meets our requirements for finding resources, we tell that humanity has created a new resource. For example, we tell that the new "Mass Water Transport" resource was created, i.e. added to the arsenal of human resources, when someone somewhere in the world built the first boat or raft for two or more people. The date when a particular resource was created, and the content of this resource are determined in accordance with the known literature data that are given in the links.

Detailing. Complex systems are often analyzed at the macro- or micro-level, or at both levels. In our model, resource groups and resources are macro components. Resources that specify various aspects of the object described in the name of the resource group belong to the named group. For example, the "Mass transport" resource group includes the resources "Mass water transport", "Mass land transport using animals", "Mass air transport", etc.

A detail of a resource group is a description of the resources included in the group. The resource group has its own dynamics which is determined by the sequence of the creation by the humanity of the resources in the group.

The resources that emerged first in time in the resource group will be called primary resources. Each resource group initially consists of one, namely, primary, resource. All resources in the resource group, except for the primary resource, will be called secondary resources. The sequence of creation of the secondary resources will be considered as an expansion of this group of resources.

The criteria "Durability" and "Mass character of the use" suggest at the search stage for a resource to take into account further detailing the resource. That is, to take into account its development, its widespread use first locally and then in other localities, and in many cases, globally. Thus, when searching for components that meet our requirements, the detailing and distribution of the resource, as well as its use are taken into account. For example, while analyzing the object "Mass Water Transport" we took into account that humanity created boats and rafts. We also acknowledge the creation of ships, at first sailing and later with engines. and the use of ships in search, migration, military, etc. purposes.

At the same time, if a resource is included in our list of resources, then it is considered to be static and indivisible. It is considered to be such from the moment of creation of this resource, regardless of its further development, distribution and use. This static nature and indivisibility ensure that the model is not dependent on social etc. structures and their localization and development. In addition, it is believed that since the creation of the resource it belongs to all of humanity at once. This means that in our model, humanity is considered as a whole .

Dynamics. In the proposed model, the dynamics of the system is studied at two levels. At the least detailed level the dynamics are manifested in the sequence of creating resource groups. It could also be seen in the sequence of creating primary resources in resource groups. At the most detailed level the dynamics of the model corresponds to the sequence of emergence of all resources, including primary ones. Both named above sequences were initially presented in this work in the form of tables with links to the literature data used. With further analysis of the system under study, diagrams and formulas based on tabular data can be used.

Abstraction level and coverage. The abstraction level of the proposed model can be determined as the middle one. The components of our model are more abstract than the components of the human system descriptions, which use individual, social, political, economic, etc. details. The degree of coverage of the human activity spheres in our model is global. We tried to include in the lists of components and component groups all the known “breakthrough” resources and resource groups.

There are studies in which a deeper abstraction level is used. In most cases, these are models that use one man as the smallest “part” of humanity as a component at the micro level. Such models mainly have a low degree of coverage of the human activity spheres. They usually focus on a one-to-one relationship, for example, the impact of population growth on economic indicators, the environment, etc.

Where did the resources come from. The first time resource is the ability to create new mental images. This resource was received by people as a gift from nature.

All other resources were created by specific people. The first big raft, the first school, the first electronic logic gate, etc., were created by specific people in a particular area at a specific time. When people created them, they called these objects with some other words in their language which was local in time and space. They did not think about these objects in terms of the “resources” introduced in this paper. In many cases, we, unfortunately, do not know the names of these people. Summarized, however, we can say that these resources were created by humanity.

Our contribution is as follows. Among the many objects created by humanity, we have selected those matching the criteria we have proposed. We found publications, mainly scientific papers, which provide data on the date of first use of a particular resource. We use information from those articles about the features of a specific version of this resource when it was firstly used. It was determined, to which resource group the specific resource belongs. If a given resource is primary, a name taken from the literature or formulated by us was assigned to a specific resource and a group of resources.

This paper provides information on 26 groups of resources and 26 primary resources. Information about other resources from our list of resources will be published in the future as far as possible.

Summary. Mankind history is rich in a huge number of details being local in space and time. This makes it extremely difficult to build a model of the humankind system if social and other details are used. We were not able to find the models of such a system. We mean the model based on taking into account social structures or alike details for the entire length of history of humanity.

Our model describes the system of humanity at a deeper abstract level than the description based on the use of social, economic or alike parameters. Moreover, the proposed model is global in its covering the mankind activity spheres. In our model we combine the absence of dependence on social and other factors with the consideration of humanity as a whole. That applies to global coverage of human activities. Such a model should allow us to identify the deepest trends in the human development.

The use of the resources and group of resources made it possible to build a model of mankind system with clearly defined components and a reasonable number of such components.

With each new resource created, humanity is expanding its ability to act. Accordingly, our model allows us to analyze the history of humanity as the history of the emergence of possibilities for action. This is a detailed story on a global scale that has been unfolding over the past 44 thousand years. We are not aware of work on such a history of humanity.

4. CRITERIA FOR SEARCHING RESOURCE GROUPS AND INDIVIDUAL RESOURCES

The key criteria for finding resource groups are as follows.

1. Importance. The difference in the quality of the resource group compared to the old resource in the same area should be very significant.

2. Durability: Starting from the date of a resource group creation, the resource group should not be limited in time.

3. Mass character of use. Use by the humanity of the group of resources must have mass character and be preferably global over time.

4. Possibility of expansion: in many cases, the expansion of a group of resources into new fields of application over time should be carried out.

The same criteria are used in a search for individual resources, with the exception of criterion 4.

Sometimes the mass character of using a resource decreases due to the appearance of a similar and more efficient resource. For example, the resource “Mass ground transport with the use of animals” became less used with the emergence of the resource “Mass ground transport with an engine”.

Each specific criterion in this list is of great importance. Tables 1 and 2 have a list of 26 resource groups and 26 primary resources. Note that there are no revolutions, long-lasting kingdoms or the like in this list. Such things cannot be considered resources under the criterion of longevity. You simply could not repeat any revolution again and again. This is true for all revolutions, be it the French Revolution or the agricultural revolution.

5. SYSTEM WITH RESOURCE GROUPS.

Let us consider table 1 which presents a set of resource groups identified by the search criteria. The date of emergence of the resource group is taken as the first known date for the use of the primary resource in this group by scientists.

Table 1 presents the resource groups identified by the search criteria and emerged during the history of humanity. In the column "Resource Group" there are the proposed names of such resource groups in bold. The “Emergence Time” column shows the first known date when the primary resource from this particular resource group was used. This date is extracted from the research work which is named in the link mentioned in the "References".

Table 1. Chronicle of the emergence of resource groups in the history of humanity

	Resource Group	Emergence Time	References
1	Novel Mental Images	42000 BC	5, 13
2	Art and music	42000 BC	5, 13
3	Man-made materials, substances and organisms	34000 BC	7, 29
4	Domesticated Plants and Animals	10500 BC	10
5	Mass transport	8040-2345 BC.	6, 37
6	People as resource on a massive scale	4000 BC	8
7	Text	3200 - 3100 BC	21
8	Tools, devices, machines from man-made materials	3400-3100 BC	48
9	Trade with an intermediary	3300-3000 BC	16, 38
10	War	2700 BC	33
11	External information storage and processing	2500 BC	28
12	Transnational organizations	2250 BC	49
13	People and societies as objects of study	2100 BC	17
14	Mass education	1950-1900 BC.	40, 45
15	Independent communication channels	550 BC	11
16	Forces of nature and quantum physics	280 BC	20, 53, 55
17	Weapon of mass damage	660 AD	12, 39
18	Mass production	1320 AD	19
19	Mass media	1439 AD	34
20	Technology beyond limitations of human senses	1590 AD	15, 51
21	Scientific method and information technology	1642, 1687 AD	23, 32, 36, 44
22	Natural resources on a massive scale	1750 AD	43
23	Involvement of women in mankind activity	1893 AD	3
24	Life expectancy growth	1900 AD	4, 41, 56
25	Digital technology	1924 AD	42
26	Artificial Intelligence (AI)	1956 AD	27, 35, 46

The resource groups listed in Table 1 represent such areas of activity as communication, art, music, cognition, technology, social activity, globalization, the study of people, methodology, and life expectancy.

Table 1 provides information about the 26 resource groups created by humanity for 44,000 years of history. For 44 thousand years, humanity has been able to expand this set of resource groups from one group to 26 resource groups. We can use table 1 and related charts in the next chapter to understand the dynamics of humankind development.

6. DYNAMICS OF THE SYSTEM WITH RESOURCE GROUPS

Dynamics of mankind development is presented in figures 1-3 as a change in the set of resource groups over time.

The facts known to scientists about the date and content of certain primary resources are used in the analysis of the proposed model in this paper. The names of the primary resources and the corresponding group of resources are not used in the quantitative analysis. Figures 1-3 show the nonlinear dynamics of the system consisting of the resource groups.

The data in these figures indicate three time periods in the number of resource groups with different rates of growth. The first period, with the diagram in Figure 1 and the time period from 42000 BC until 10500 BC, is characterized by very slow growth. One group of

resources has been added once every 21,000 years on average. The growth was much faster than linear during the second period, with the diagram in Figure 2 and the time period from 10,500 BC to 1600 AD. 16 resource groups have been added for the period over 11,600 years. During the third period, which is part of the diagram in Fig. 3, and lasted in the second half of the second millennium AD, another faster growth in the number of resource groups began. 8 resource groups have been added for over 400 years.

The number of resource groups

(from 42000 BC until 10500 BC.)

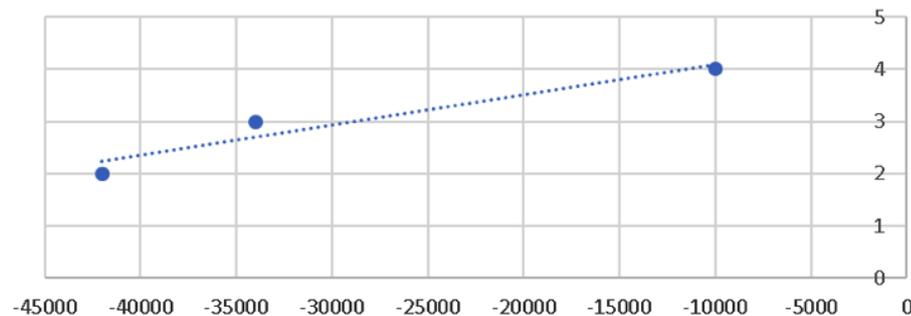


Fig. 1. The number of resource groups created in the period from 42000 BC to 10500 BC. The data from table 1 are used. Horizontally shown are years; vertically shown are the quantity of created resource groups. Dotted line reflects linear growth.

The number of resource groups

(from 10000 BC until 1600 AD.)

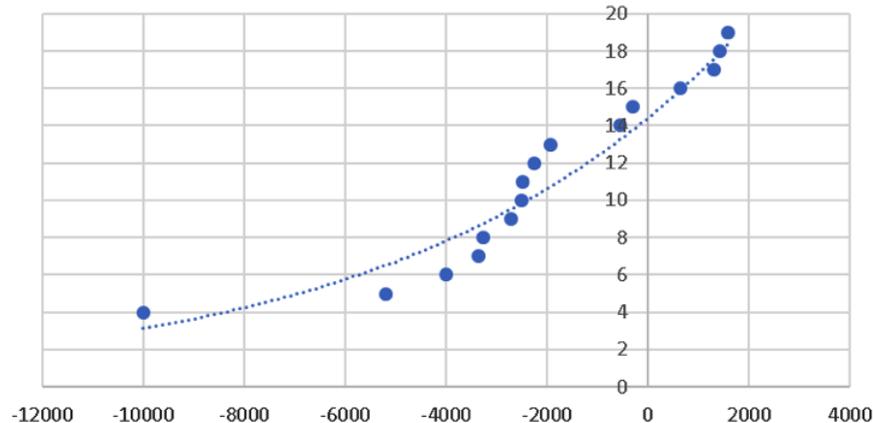


Fig. 2. The number of resource groups created in the period from 10,500 BC to 1600 AD. The data from table 1 were used. Horizontal are years; vertical are the quantity of resource groups created.

A detailed analysis concerning the dynamics of the development of the human system which consists of resource groups will be carried out in the next paper.

It is known that the accumulation of diversity in a complex system leads to an increase in its adaptability [1]. Our model of a system shows that over time the number of resource groups increases, which leads to the accumulation of diversity in this system. We also note that the resource groups themselves are very different from each other.

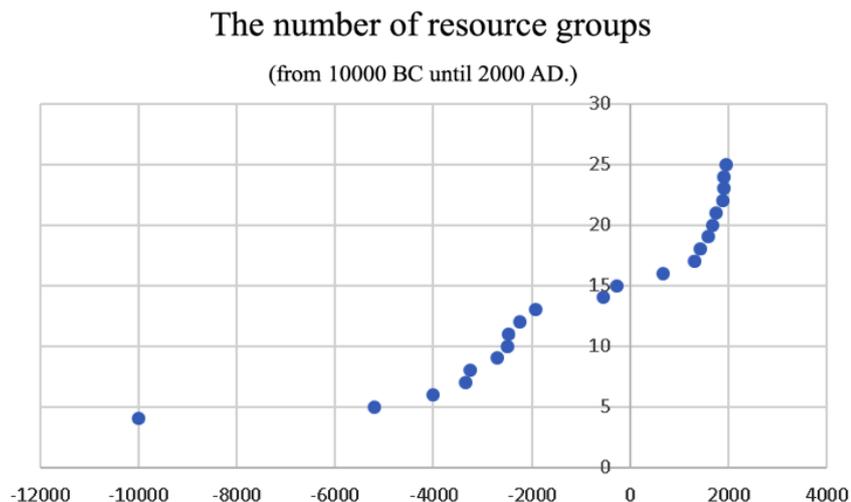


Fig. 3. *The quantity of resource groups created in the period from 10,500 BC to 2000 AD. The data from table 1 were used. Horizontally shown are years, vertically shown are the quantity of resource groups created.*

7. SYSTEM WITH RESOURCES

We consider table 2, which presents information known to scientists on resources at the times of emergence of resource groups, i.e. information on primary resources. Tables 1 and 2 complement each other.

Table 2. Chronicle of emergence of primary resources in the history of humanity

	Primary resource (How and Where implemented)	Resource group	Emergence time	References
1	A presented (by means of art) image of non-existent on Earth object from a group of hybrids (partially human and partially animal, Indonesia)	Novel Mental Images	42000 BC	5, 13
2	Symbolic art depicting hybrids (partly human and partly animal, rock art, Indonesia)	Art and music	42000 BC	5, 13
3	Textiles (first material used in textiles, Republic of Georgia)	Man-made materials, substances, organisms	34000 BC	7, 29
4	Domesticated animals (Cows, Mesopotamia)	Domesticated Plants and Animals	10500 BC	10
5	Mass transport with watercraft (raft, Egypt, or boat, Europe)	Mass transport	8040-2345 BC	6, 37
6	Forced labour of prisoners (first drawing with working prisoners, Sumer)	People as a resource on a massive scale	4000 BC	8
7	Writing (first letters, Sumer)	Text	3200 - 3100 BC	21
8	Tool (copper axe, Italy)	Tools, devices, machines from man-made materials	3400-3100 BC	48

9	Commodity money (cowry shells in China, shekel in Sumer)	Trade with an intermediary	3300-3000 BC	16, 39
10	War with a use of weapons (The war between Sumer and Elam)	War	2700 BC	33
11	Library (Temple library with clay tablets, Iraq)	External information storage and processing	2500 BC	28
12	Empire (Akkadian Empire, Mesopotamia)	Transnational organizations	2250 BC	49
13	Epic Poem ("Gilgamesh", Mesopotamia)	People and societies as objects of study	2100 BC	17
14	School (School for scribes, Egypt)	Mass education	1950-1900 BC	40, 45
15	Post (Post system with horse changing posts, Persian Empire)	Independent communication channels	550 BC	11
16	Gravity (water mills, Turkey, North Africa)	Forces of nature and quantum physics	280 BC	20, 53, 55
17	Means of destruction of ships at sea (Greek Fire, Greece)	Weapon of mass damage	660	12, 39
18	Standardized parts in mass production (Mass production of ships, Venice, Italy)	Mass production	1320	19
19	Mass printing technology (European type of printing press, Guttenberg, Germany)	Mass media	1439	34
20	Tool to see the details not visible with naked eye (microscope, the Netherlands)	Technology beyond limitations of human senses	1590	15, 51
21	Mechanical calculator (Blaise Pascal, France) and the scientific method in physics (Isaac Newton, England)	Scientific method and information technology	1642 and 1687	23, 32, 36, 44
22	Increase in coal production (75% since since 1700 - world production)	Natural resources on a massive scale	1750	43
23	Recognition of women's right to vote (New Zealand)	Involvement of women in mankind activity	1893	3
24	Life expectancy increase (by 12% since 1800 - the world average)	Life span growth	1900	4, 41, 56
25	Electronic logic gate (W. Bothe, Germany)	Digital technology	1924	42
26	AI Conference (Defining AI name, mission, first Success and key players for AI, Dartmouth, USA)	Artificial Intelligence (AI)	1956	27, 35, 46

This table presents resources at the stage of analysis when the expansion of resource groups has not yet been considered.

The proposed name of the primary resource is shown in bold in the column "Primary Resource". Detail on how and where a primary resource was implemented are shown in the same column in parentheses. The name of the resource group to which this resource is allocated in our model is given in the column "Resource Group". The first known date of use of the primary resource in a specific resource group is recorded in the column "Time of occurrence". This data is extracted from the research which is named in the link mentioned in the "References".

This table represents the mankind system consisting only of primary resources. It was noted above that the date of occurrence of resource groups is determined by us by the date of occurrence of the primary resource in these groups. Thus, the dynamics of the system with primary resources is identical to the dynamics of the system with resource groups.

Note that the system under consideration developed from 1 - 2 initial components.

8. SUMMARY AND CONCLUSION

In this work, we propose the model of mankind system. The elements of this model are abstract discrete components, i.e. resources or resource groups. Four criteria are defined for the search of such resource groups. Those criteria are importance, durability, mass character of the use, and the possibility of expansion into new areas of application. 26 resource groups matching the search criteria have been proposed. These resource groups cover an extremely wide range of human activity areas. These resource groups are objective parameters characterizing the possibility of mankind actions. They are not related to social structures, politics, economics, morality, and the impact of humanity on the environment.

The dynamics of mankind's system development are presented as an increase in the quantity of resource groups or primary resources. This value may be considered together with tables 1 and 2. Such a model allows at each moment in the mankind history to know the quantity and specificity of the resource groups created up to this point. The dynamics of the emergence of those resource groups is presented graphically. It is shown that the rate of increase in the number of resource groups accelerated in the second half of the second millennium AD.

The main achievements are as follows:

1. A model of the mankind system is proposed. It includes resources and groups of resources. A social, political, economic, geographical features and the impact of humanity on the environment are excluded from the model. Criteria are proposed for the search for components and groups of components being resources and groups of resources. A large amount of scientific data was processed, which allowed 26 groups of resources to be identified based on the criteria.

2. The identified material presents the dynamics of mankind development throughout its history. These dynamics underlie the story that we all know: the history of human actions and events.

3. The model with resource groups shows that the development of mankind system was nonlinear.

4. It has been established that humanity is moving towards an increased arsenal of resource groups, i.e. increased the ability of humanity to act. It is shown that the total number of resource groups accelerated its growth over time.

We intend to continue working with the quantitative model.

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