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HUMAN LIFE CYCLE MODELLING

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The relevance of the topic, goal, and objectives of the research is substantiated, the purpose of the article is formulated, and an overview of previous publications is made.

The main part presents the results of the human life cycle main events modeling: prenatal development, calculation of age periods, and aging, and also presents the first and final iterations of the life cycle model as a whole.

Life cycle processes are considered within the framework of the theory of self-organization of complex open systems. Abstractions and axioms of the wave model of S-space, which describe its objects, states, operations, interactions, and measurements, as well as means of description and verification, are used as research apparatus. Soliton-wave models of the OM1 type were directly used for modeling.

Based on the available data of anatomy, physiology, and psychology, modeling of three key stages of the prenatal period was carried out: the transition from cellular to embryonic stages, the transition from embryo to fetus, and the transition from the fetal stage to birth. Based on the simulation results, a conclusion was made about the soliton-wave nature of the processes, an assumption was made about the need for resonance, as well as external modulations.

Based on the scenario of self-organization of I-space type (1S, 1O), the duration of age periods was calculated; comparison with empirical data in the field of pedagogy and psychology demonstrates their correspondence. The psychological orientations of the individual for each of these periods have been determined. The last circumstance is important for practical tasks of architecture and design (typology, stylistics, features of ergonomics, and possible directions of development of smart technologies).

Based on the available data on the symptoms of aging, as well as their theoretical interpretations within the framework of gerontological research, a model of human aging is proposed. Within the framework of the soliton-wave model (SWM), aging is considered as a decrease in the potential and a collapse of the system.

The first and final iterations of the life cycle model as a whole are presented. The presence of this model, which corresponds to the known data,

allows us to evaluate existing strategies for prolonging life and propose a new strategy.

The conclusions evaluate the theoretical and practical significance of the obtained results.

Keywords: life cycle, complex open system, soliton-wave model, theory of self-organization.

Statement of problem. The human life cycle includes such events as the emergence, development, aging, and death of a person; to answer a question about their origin, it will be necessary to start the research from the moment of life on Ancient Earth's emergence, tracing the path of evolutionary development. In this article, the life cycle is understood in a narrower sense - from the birth to the death of a person.

The life cycle, if we take into account only scientific works, is studied from the standpoint of anatomy, physiology, psychology and pedagogy, medicine, and gerontology at the levels of the organism, its systems, organs, and cells, and at the molecular genetic level.

The conceptual and methodological apparatus, as well as the rather narrow subject areas of most studies, lead to fragmentation and incompatibility of the results. For example, there are about 300 actual theories of aging.

The lack of unified concepts and models is not only a theoretical but also a practical shortcoming. Based on existing ideas, it is difficult to determine the parameters of a comfortable environment, the meaning, and content of education at different stages of life, determine a strategy for extending life, etc.

The development of interrelated life cycle models in general and individual processes is an important theoretical and practical problem.

Recent research and publication analysis. The human life cycle is not universal for living organisms: there are 4 types of cycles depending on the methods of reproduction [2].

It is necessary to distinguish the life cycle as a characteristic of the species from ontogenesis - the development of an individual from its appearance to death or division.

The beginning of the life cycle is the emergence of a new living organism. However, this moment itself is defined ambiguously; there also is a legislator's point of view - this is the period when abortion is still allowed.

Events throughout the life cycle include coordinated anatomical, physiological, and psychological changes [1, 3, 5-9, 11, 13, 14].

An overview of the proposed modeling apparatus and the practice of its use is given in [10, 112].

The article's purpose is to present models of the human life cycle and its key processes, as well as the consequences that follow from this.

Main part. Let us consider the consequences of modeling.

Modeling of the prenatal period. The emergence of a human living organism as a result of sexual selection was shown. The conditions for

successful sexual reproduction are the presence of the reproductive age of both parents, the periodically arising readiness of the mother's reproductive apparatus (menstrual cycle), the father's spermatogenesis that has passed all phases, and a non-periodic event – sexual intercourse. The process of conception in a person is often accompanied by higher feelings – love and others, and the influence of the mother's psycho-emotional state on the development of the fetus is recognized by modern researchers [13]. This can be seen as the presence of external modulation and the occurrence of resonance.

We will interpret the chromosome component after the union of male and female chromosomes as a soliton pair (since the chromosomes are unchanged here, with the exception of minor mutations). Let us also represent the body composition as a soliton, and the field component as a wave having the modality ⁄ after the fusion of the gametes of the parents as a result of resonance modulated by external influences.

This entire SWM system as a whole has the modality of the actual existence ***A*** as a cell and the potential existence ***P*** as a multicellular embryo that has yet to form (Fig. 1).

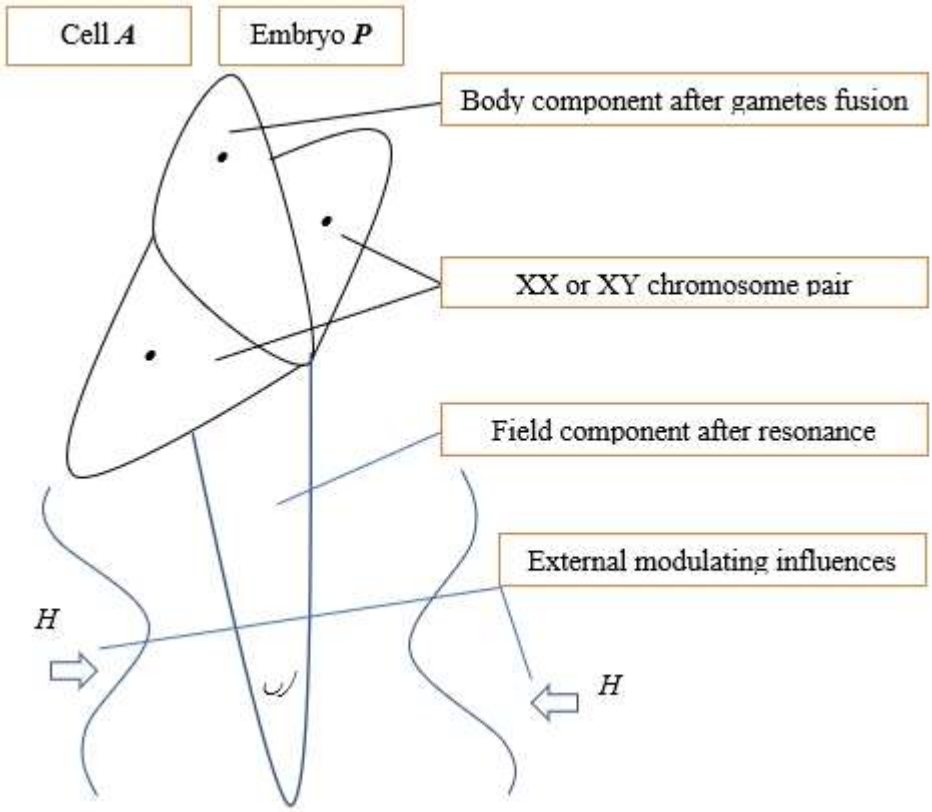

Fig. 1. SWM of the zygote with designations of modalities and external modulating influences. Waves are shown in gray; solitons are shown in black

We note the asymmetry and imbalance of the system, the high potential (due to resonance) of its wave component, and its increased sensitivity to external influences.

Embryonic period. The following model changes take place: due to the potential of the field component, all soliton components are activated and

acquire ⁄ modality. In this case, the chromosomes do not change, and hereditary information is used for the development of the body of the embryo.

An increase in body size and morphological changes show how the potential increases and the transition of this component into a wave state. In general, the system acquires modality ***A*** as an embryo and ***P*** as a fetus (Fig. 2).

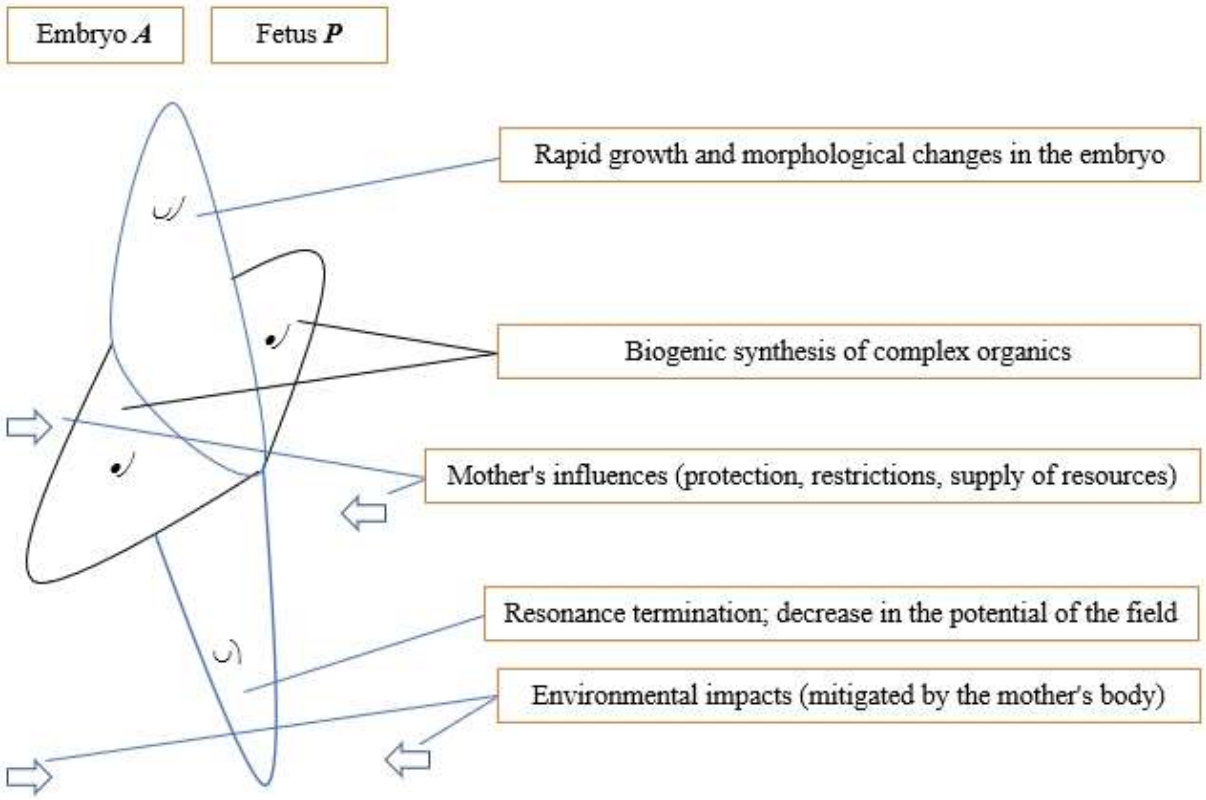

Fig. 2. Model of embryonic development with the designation of modalities

The dynamics of the processes are aimed at ensuring that, on the one hand, the embryo is formed as an independent organism (development of membranes, separation of blood circulation, and so on), and on the other hand, an integral system of the embryo with the mother's body is formed (attachment to the wall of the uterus, development of the placenta, and so on). If this process is "cleared" of the mechanisms of heredity, an analogy with the behavior of a parasite becomes visible, where the parasite – the embryo – uses the resources of the donor organism. External influences cease to correspond to the conditions of resonance, and the influences from the maternal organism can be characterized as protective and restrictive.

The fetal period entails such changes in the model (Fig. 3):

• return of the wave corresponding to the body component to the state of a soliton (conservative effect of the mother and a decrease in the potential of the field component);

• decrease in the potential of the field component (environment impacts do not create resonance conditions, the potential is partially used up);

• the synthesis of organics is actively continuing with the use of the

resources of the mother and the program of heredity, but there are no qualitative changes, so there is no longer any reason to designate modality ⁄;

• the system as a whole acquires the modality A as a fetus and P as a child;

• the limits of adaptation of the donor mother to the parasitic fetus are exhausted by the end of pregnancy according to the most critical of the restrictions (the size of the birth canal) and its rejection (delivery) begins.

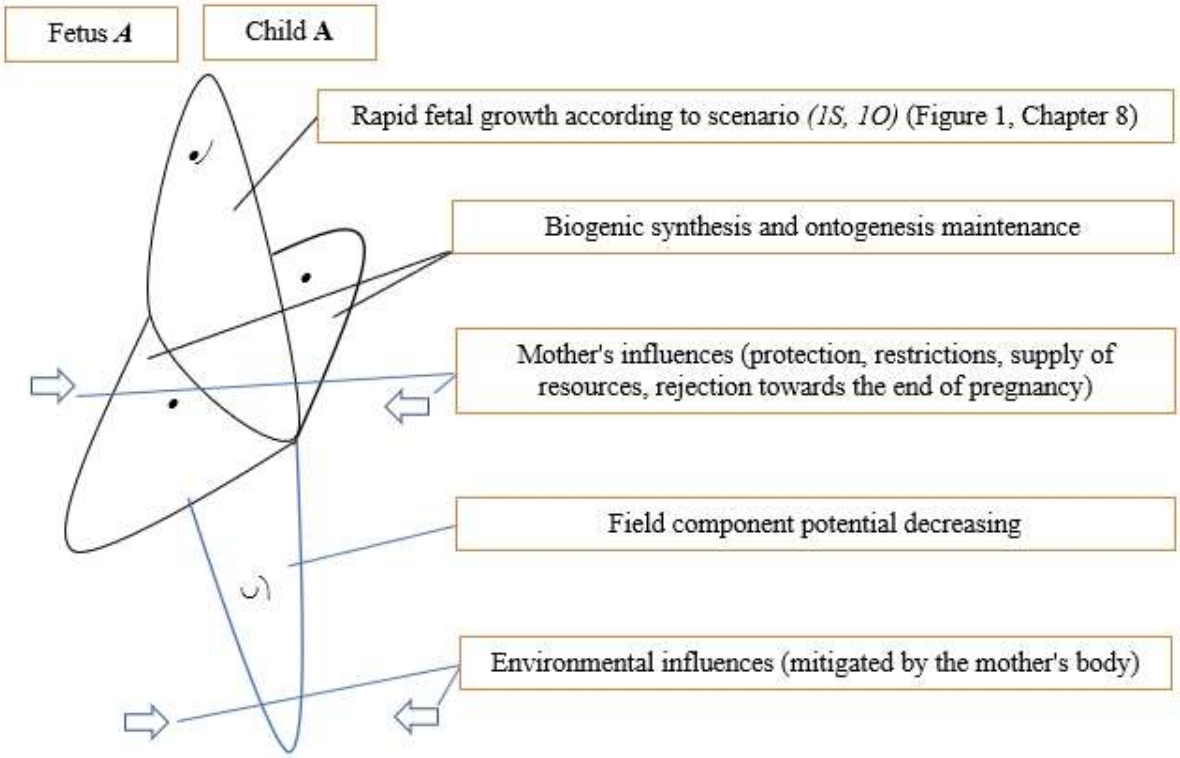

Fig. 3. Model of fruit development. Color coding as in previous figures

The system is gradually stabilizing.

Childbirth does not mean a break in all ties – mental ties (love, at the level of the intuitive channel) and partially physiological (the mechanism for feeding a child) remain and even intensify; in the latter case, the leading role is played by the complex mechanisms of heredity (with the connection of the humoral system, and so on). However, rejection by the mother marks the most important milestone: the transition of the child to a new, rather hostile environment (albeit under the protection of parents) and checks its viability as an independent organism: it needs great potential to adapt.

Age periods terms and characteristics. Assume that scenario *(1S, 10)* takes place. Then the composition and duration of age periods are determined by the Fibonacci number series: 1-1-2-3-5-8-13-21-34-55-89, and in the first five stages the structure of levels and channels of human interaction with the environment is already fully formed environment (Table 1).

Firstly, we note that Table 1 correlates well with the facts presented in [4].

Secondly, a definition of age periods, justified by the laws of self-organization and the sequence of development of channels of perception, is proposed.

Thirdly, there are numerous correlations between the degree of development of certain channels of human interaction with the environment and his psychological type, employment, belonging to a social stratum, needs, and so on. All this, as well as comparisons with other similar systems, are discussed in detail in [12]. The discussion has an important practical goal: the creation of a comfortable living environment for representatives of different psychotypes and different ages.

Table 1

Life cycle according to scenario *(1S, 1O)*

Cycle stages (age in years)	**Level of interaction with the environment / basic needs**
1. Infancy (< 1)	Intuition/need for love and protection
2. Early childhood (1-2)	Ego/awareness of one's difference from the environment
3. Preschool childhood (3-5)	Will, reason/interaction with the environment
4. Junior school childhood (5-8)	Nous/rationalization of relations with the environment
5. Teenage (8-13)	Passions/emotional attitude to the environment
6. Youthful (13-21)	Need for a feeling of adulthood
7. Adulthood (21-34)	Striving for success
8. Maturity (34-55)	Maintaining success
9. Old age (55-89)	Renunciation of life's blessings and life itself

Fourthly, transitions at the age of 13, 21, and 55 are perceived subjectively as major crises, others are easier to endure.

Fifth:

• by the age of 13, the structure of the system of interactions is fully formed; in the future, only redistribution of potentials between channels and their slight increase as a result of properly organized interactions with the environment is possible.

• By the age of 21, the body grows, social connections and needs are formed, for which a certain potential is also spent;

• When growth stops, these costs also stop. The adaptive potential is used for external expansion - an active struggle begins for the embodiment of one's ideals and building a career, and family affairs, which is the main content of the adult stage;

• and one of the most important properties of open systems begins to appear - their finiteness, due, in this case, to the soliton-wave nature of the system. The potential is not restored, and gradually, instead of expansion, there is a desire to maintain the achieved positions, which is especially felt at the end

of the maturity stage.

• the period after 55 years - old age - there is a time when the potential decreases. As a result, metabolic disorders and weight gain, problems with the musculoskeletal system, etc. The rejection of excessive needs helps to prolong life and, in the end, to renounce it. The period of old age will be discussed in more detail below;

• accordingly, at stage 6 it is necessary to ensure the implementation of new views on life inherent in the younger generation, at stage 7 - to create conditions for self-realization, at stage 8 - to maintain achievements, and at stage 9 - for their painless renunciation.

Just as for the prenatal period, we have an increase in the duration of subsequent stages of the life cycle compared to the previous ones, while the duration of large evolutionary periods was reduced. This confirms the crucial importance of the event of resonance modulated by external factors during the fusion of the gametes of the parents on the events of the entire human life cycle.

Modeling of aging. The scenario of self-organization in old age is the convolution of *Sp*. However, although very serious violations of the functions of organs are observed, their physical disappearance does not occur (with the exception of the traumatic impact of external irresistible forces). This fact can be explained by the operation of the inheritance mechanism that maintains the established structures. Therefore, it will be correct to speak of a partial convolution. The time when this process will cover more than one organ or organ system, but will become complex and irreversible, should be considered the beginning of old age. This usually occurs (Table 1) over 55 years of age.

Let's try to set its parameters. Theoretically, three options are possible: degradation of the subject space (wave component), which can be expressed in senile dementia; degradation of body functions (soliton component), which can be expressed in the form of extreme weakness and systemic age-related diseases; degradation of the components of the soliton-wave system while maintaining their balance. All these cases are described in [11].

However, what is the most likely scenario? The soliton (substance) component most often degrades faster, and this creates the basis for the destruction of the unity of the system. Interpreting the degradation process as a partial convolution, we obtain a model of this process shown in Fig. 4

Life cycle modeling in general based on the relationship of wave and soliton. Let us show a graph of the change in the value of the *Sp* ***A*** and *Sp* ***P*** potential, which determines the course of the sweep scenario *(1S, 1O)* and its inverse convolution, including the theoretical life span. Recall that the potential is a dimensionless quantity, calibrated depending on the conditions.

The total potential of *Sp* ***A*** manifests itself in the formation of the human body and psyche, ensuring the functioning and resistance of the organism throughout life. It is interpreted as an area bounded by the graph of changes in the values of the wave and soliton amplitudes and the axis showing the lifetime. The current total value of the amplitudes is the potential that can be used at one

or another moment of life. Since the variety of factors, as well as the modeled characteristics is very large, we will use the iteration method, moving from simpler models to more complex ones.

Iteration 1 (Fig. 5). We will show the theoretical life expectancy and designate the age periods in accordance with Table 1.

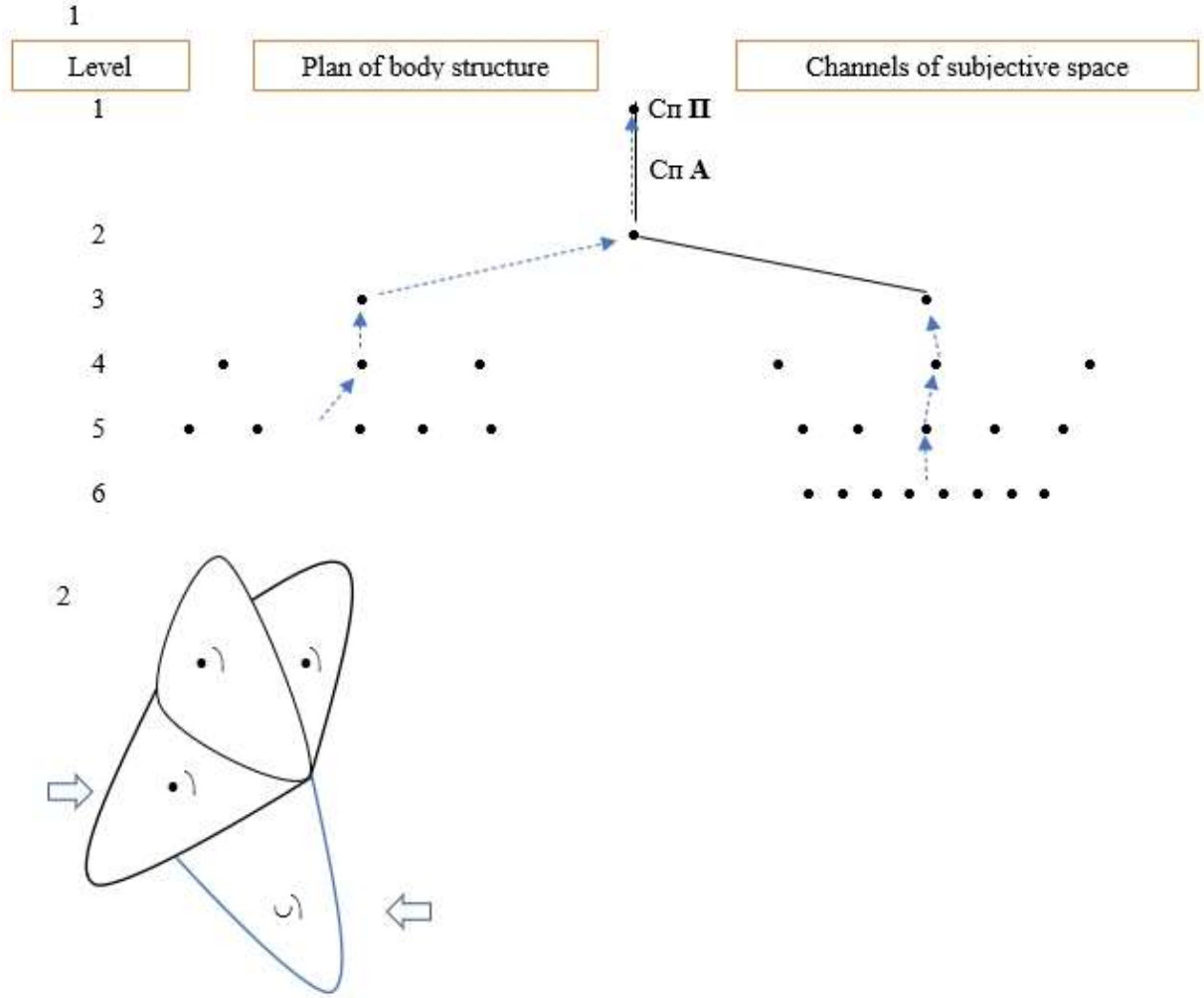

Fig. 4. Interpretation of old age as a convolution (1) and the distribution of potentials of the soliton and wave components in the later stages of life (2).

Iteration 1 shows a rapid increase of the potential ***Sp A*** during pregnancy and early childhood – it is enough for the formation of the new structure; a decrease in its growth rate to zero in maturity – here it is enough to maintain existing structures and ensure reproduction; a progressive decrease in old age when it is not enough to maintain vital parameters and compensate the pathologies.

Let's take into account the data on the aging of systems and organs, and show the actual life expectancy (Iteration 2). In accordance with the progressive decrease in *Sp* ***A*** potential, signs of aging are observed: muscle atrophy, reduced growth, and so on. Death occurs due to a disruption in the functioning of the components that destroy the integrity of the SWM, which cannot be compensated. The soliton component continues to exist after the destruction of the integral system.

The next portion of refinements is interactions with the environment (Iteration 3). They can be beneficial or destructive. The former increases the potential, and the latter reduces it, demanding compensation. In addition, external influences are necessary for the construction of psychophysiological structures. We also take into account the following:

• during pregnancy and childhood, the most favorable external conditions are provided, and the potential increases rapidly;

• a person can form useful or bad habits, he will fall into favorable or unfavorable conditions, and this also affects changes in potential.

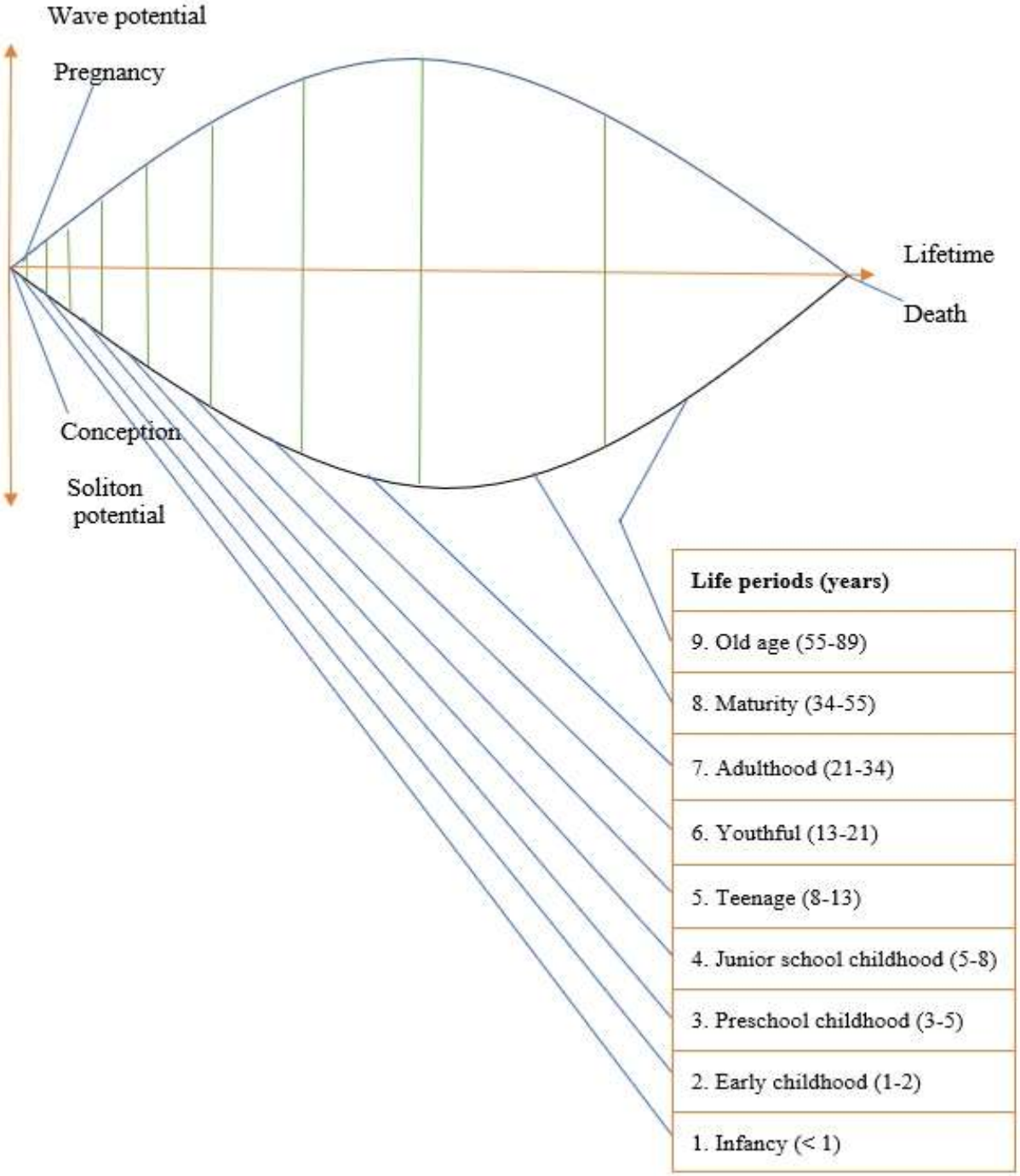

Fig. 5. Life cycle SWM, iteration 1

The value of the potential Sp A is shown conditionally

Iteration 4 (Fig. 6). Finally, let's take into account the resonance associated with conception. This is the undistributed potential *Sp* ***P***, which has not yet expressed itself in the formation of any structures of the body or psyche but creates the potential possibility of their appearance. It can also be used to compensate for destructive external influences and pathologies.

The soliton and the wave already at the moment of gamete fusion have a non-zero potential, and they are consistent with a certain error; after birth, this inconsistency can lead to the destruction of the integrity of the system, which may explain the phenomenon of infant death, which has no apparent cause.

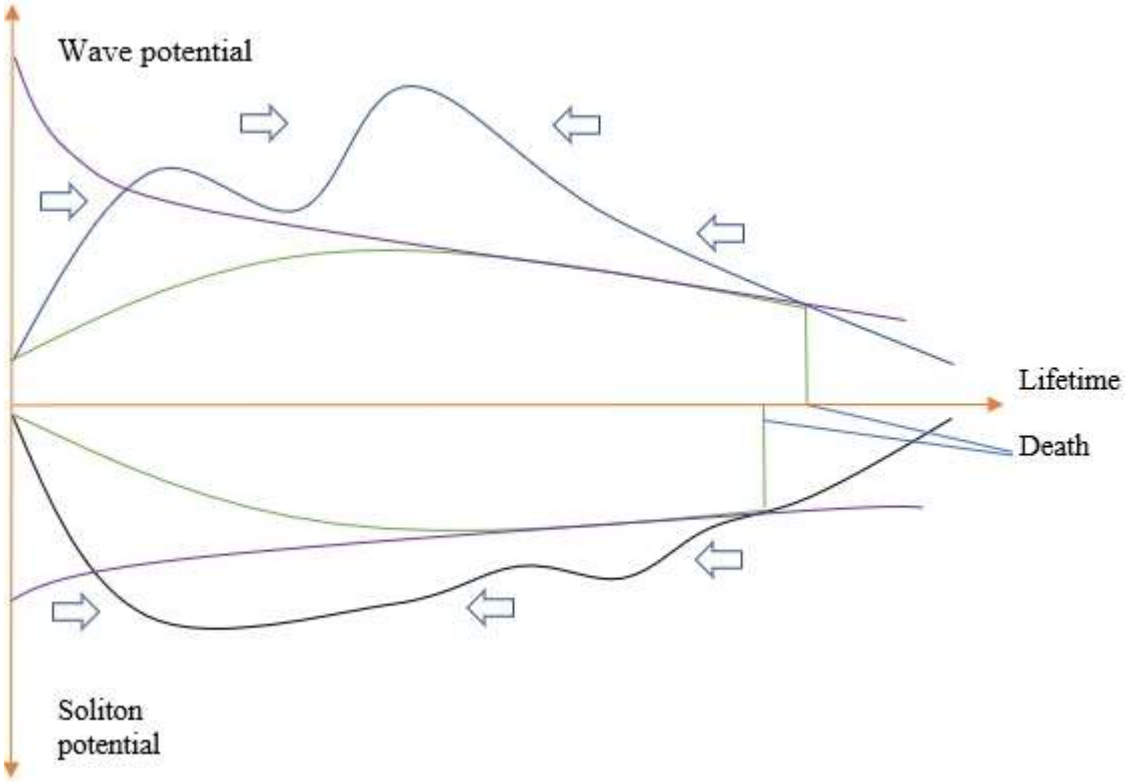

Fig. 6. Life cycle SWM, iteration 4

SWM iterations 1-4 correspond to the available data on the human life cycle. Their further refinement and development using the OM2 and OM3 models are possible.

Conclusion. The soliton-wave model is applicable for modeling the main life cycle processes from conception to senility; applicability is due to the nature of the human body as a complex open system and the correspondence of the S-space axiomatics to the properties of such systems.

corresponds to the tasks of the work. If necessary, the accuracy of modeling can be increased by using models of the OM2 and OM3 types, which provide better dynamics and the possibility of simulation.

The modeling of the aging process, makes it possible, due to the consistency and non-additivity and the possibility of calibration, to track changes of different quality at different levels within the same model. This

corresponds to modern ideas about the systematic nature of aging, and changes in the consumption of energy and other resources.

The theoretical significance of SWM lies in a better understanding of the aging process as a partial convolution, which is not the same for the soliton (substance) and wave (field, mental) components, which explains a number of phenomenological manifestations (uneven aging, pathologies, disorientation in time, etc.). The aging causes are also better understood, in particular, the influence of the "age" of a species on the course of ontogenesis, the role of systemic factors, evolution as self-organization, environmental influences, and especially modulation during conception.

The practical use of SWM is a clarification of age periods and their psychological and physiological characteristics, which is important for the design of comfort environment; the ability to calculate the correspondence between various parameters of the organism, including the determination of the necessary and sufficient set of biomarkers; classification and refinement of life extension strategies and selection of appropriate means; better understanding of the evolutionary process of taxa at different levels.

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МОДЕЛЮВАННЯ ЖИТТЄВОГО ЦИКЛУ ЛЮДИНИ

Ковальов Юрій, Калашникова Вікторія

В роботі обґрунтовано актуальність теми, мети і задач дослідження, сформульовано мету, зроблено огляд попередніх публікацій.

В основній частині наведено результати моделювання основних подій життєвого циклу людини: пренатального періоду, періодів після народження, старіння, життєвого циклу у цілому.

Процеси життєвого циклу розглядаються у рамках теорії самоорганізації складних відкритих систем. У якості апарату дослідження використані абстракції та аксіоми хвильової моделі С-простору, які описують його об'єкти, стани, операції, взаємодії і вимірювання, а також засоби опису та верифікації. Безпосередньо для моделювання застосовано солітонно-хвильові моделі (СХМ) типу ОМ1.

Виходячи із наявних даних анатомії, фізіології та психології, проведено моделювання трьох ключових етапів пренатального періоду: перехід від клітинної до ембріональної стадій, перехід від ембріону до плоду, перехід від плідної стадії до народження. За результатами моделювання зроблено висновок про солітонно-хвильову природу процесів, зроблене припущення про необхідність резонансу, а також зовнішніх модуляцій.

Виходячи із сценарію самоорганізації (1С, 1О), розраховано тривалість вікових періодів; порівняння з емпіричними даними демонструє їх відповідність. Визначено психологічні спрямованості особистості для кожного з цих періодів. Остання обставина важлива для практичних задач архітектури і дизайну (типологія, стилістика, особливості ергономіки та можливі напрями розвитку смарт-технологій).

Виходячи із наявних даних про симптоматику старіння, а також їх теоретичних інтерпретацій у рамках геронтологічних досліджень, запропоновано модель старіння людини. У рамках СХМ старіння розглядається як зменшення потенціалу і згортка системи.

Представлено перша і фінальна ітерації моделі життєвого циклу у цілому. Наявність цієї моделі, яка відповідає відомим даним, дозволяє оцінити існуючи стратегії продовження життя.

У висновках оцінено теоретична та практична значимість отриманих результатів.

Ключові слова: складна відкрита система, хвильова модель С-простору, теорія самоорганізації, моделювання та багатокритеріальна оптимізація.

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