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CHANGING OF MENTAL MODELS FOR EFFECTIVE DECISION-MAKING

Abstract. This article explains the role of mental models and the need of their change to make effective decisions. It is substantiated that the mental model rests on changes to save the system and minimize the risk. An example of this resistance is the complicated and slow process of political reform in Ukraine, which forms a new national mentality model. Political initiatives are aimed at creating a new legitimate mental model, which should be more effective than the previous, in a new environment. But from 2014 to 2017 of the nearly five thousand proposed legislative proposals, the Verkhovna Rada of Ukraine has only adopted a few dozen. It is noted that the review of mental models is a complex process that requires additional energy expenditure, such as stress, loss of comfort, security, money, etc. The ability to change the mental model may require personal cour-

age, creativity, independence, and imagination. To view mental models, the leader must apply the appropriate leadership power and styles, establish an appropriate organizational culture and climate, show positive and optimistic behavior to encourage team members and motivate them to change.

It is noted that in the new environment, the decision maker can fluctuate closely to the so-called “line of comfort” for making a decision. This is a line of psychological comfort according to the existing mental model. For better and faster decision-making, you may need to create a new “line of comfort” by looking at the mental model. Thus, in a new environment, the decision maker can again make decisions on the basis of a new mental model.

It is proved that mental models are relatively stable, but changing the environment makes them look. The growing conflict between the system and the environment inevitably forms a new mental model, which should again balance the system.

Keywords: mental models, system, environment, equilibrium, critical, creative, systems thinking, effectiveness.

ЗМІНА МЕНТАЛЬНИХ МОДЕЛЕЙ ДЛЯ ЕФЕКТИВНОГО ПРИЙНЯТТЯ РІШЕНЬ

Анотація. Пояснюється роль ментальних моделей та необхідність їх змін для прийняття ефективних рішень. Обґрунтовано, що ментальна модель опирається змінам, щоб зберегти систему та мінімізувати ризик. Прикладом цього опору є складний і повільний процес політичних реформ в Україні, який формує нову національну ментальну модель. Політичні ініціативи спрямовані на створення нової легітимної ментальної моделі, яка повинна бути більш ефективною, ніж попередня, в новому середовищі. Але з 2014 по 2017 роки із майже п'яти тисяч запропонованих законодавчих проєктів Верховна Рада України прийняла лише кілька десятків. Відзначено, що перегляд ментальних моделей — це складний процес, який вимагає витрат додаткової енергії, такої як стрес, втрата комфорту, безпеки, грошей тощо. Здатність змінити ментальну модель може вимагати особистої мужності, творчості, незалежності та уяви. Для перегляду ментальних моделей лідер має застосовувати належні лідерські влади та стилі, встановити відповідну організаційну культуру та клімат, показувати позитивну та оптимістичну поведінку, щоб заохотити членів команди та мотивувати їх для змін.

Відмічено, що у новому середовищі особа, яка приймає рішення, може коливатися впритул до так званої лінії комфорту для прийняття рішення. Це лінія психологічного комфорту відповідно до існуючої ментальної моделі. Для кращого та швидшого прийняття рішень може знадобитися створення нової “лінії комфорту” шляхом перегляду ментальної моделі. Таким чином, в новому середовищі особа, яка приймає рішення, може знову зазвичай приймати рішення на основі нової ментальної моделі.

Доведено, що ментальні моделі відносно стабільні, але зміна середовища змушує їх переглядати. Зростаючий конфлікт між системою та середовищем

неминуче формує нову ментальну модель, яка повинна знову зрівноважити систему.

Ключові слова: ментальні моделі, система, середовище, рівновага, критичне, творче, системне мислення, ефективність.

ИЗМЕНЕНИЕ МЕНТАЛЬНЫХ МОДЕЛЕЙ ДЛЯ ЭФФЕКТИВНОГО ПРИНЯТИЯ РЕШЕНИЙ

Аннотация. Объясняется роль ментальных моделей и необходимость их изменения для принятия эффективных решений. Обосновано, что ментальная модель опирается на изменения, чтобы сохранить систему и минимизировать риск. Пример этого сопротивления представляет собой сложный и медленный процесс политических реформ в Украине, который формирует новую национальную ментальную модель. Политические инициативы направлены на создание новой легитимной ментальной модели, которая должна быть более эффективной, чем предыдущая, в новой среде. Но с 2014 по 2017 годы из почти пяти тысяч предложенных законодательных проектов Верховная Рада Украины приняла лишь несколько десятков. Отмечено, что просмотр ментальных моделей — это сложный процесс, который требует затрат дополнительной энергии, такой как стресс, потеря комфорта, безопасности, денег и тому подобное. Способность изменить ментальную модель может требовать личного мужества, творчества, независимости и воображения. Для просмотра ментальных моделей лидер должен применять надлежащие лидерские власти и стили, установить соответствующую организационную культуру и климат, показывать положительное и оптимистическое поведение, чтобы поощрить членов команды и мотивировать их для изменений.

Отмечено, что в новой среде лицо, принимающее решение, может колебаться вплотную к так называемой линии комфорта для принятия решения. Это линия психологического комфорта в соответствии с существующей ментальной модели. Для лучшего и более быстрого принятия решений может потребоваться создание новой “линии комфорта” путем просмотра ментальной модели. Таким образом, в новой среде лицо, принимающее решение, может снова обычно принимать решения на основе новой ментальной модели.

Доказано, что ментальные модели относительно стабильны, но изменение среды заставляет их пересматривать. Растущий конфликт между системой и средой неизбежно формирует новую ментальную модель, которая должна снова уравновесить систему.

Ключевые слова: ментальные модели, система, среда, равновесие, критическое, творческое, системное мышление, эффективность.

Target setting. Change of the organization (system) and the environment force revising of mental models to make right decisions. This process is complicated and requires clear explanation and research.

Analysis of the recent research and publications. Mental models play an important role in the decision-making process (DMP). Kenneth Craik introduced the notion of “a mental model” first in 1943. He supposed that human mind creates “small-scale models” of reality to apply it to foresee the future. “If the organism carries “a small-scale model” of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them react to future before they arise, utilize the knowledge of past events in dealing with the present and the future, and in every way to react in a much fuller, safer, and more competent manner to the emergences, which face it” [1, p. 61]. Craik showed mental models as mechanical devices: “my hypothesis then is that thought models, or parallels, reality — that its essential feature is not ‘the mind,’ ‘the self,’ ‘sense-data,’ nor propositions but symbolism, and that this symbolism is largely of the same kind as that which is familiar to us in mechanical devices which aid thought and calculation” [2, p. 57].

Philip Johnson-Laird and Ruth Byrne created the mental model theory of conditionals — “Conditionals: A Theory of Meaning, Pragmatics, and Inference” [3] that discusses mental models and reasoning. Jay Forrester described a mental model as “the image of the world around us, which we carry in our head, is just a model. Nobody in his head imagines all the world, government or country. He has only selected concepts, and relationships between them, and uses those to represent the real system” [4]. Peter Senge highlights the importance and difficulties to

change mental models to make the system effective. “The discipline of managing mental models — surfacing, testing, and improving our internal pictures of how the world works — promises to be a major breakthrough for building learning organizations” [5, p. 163].

The purpose of the article is to explain the need of change of mental models and propose an approach to revise them for effective decision-making.

The statement of basic materials. The DMP has a purpose to maintain dynamic equilibrium between the system and the environment in order to provide system effectiveness and achieve a desired end-state. The DMP based on mental models because they influence human thinking. Understanding of relativity of mental models and the need of their change is critical in order to establish the right end-state, conduct the DMP properly and make a wise decision. Effective decision-making requires clear understanding of mental models of the participants of the conflict and possible dynamic of their change. For example, Americans, after long-term operations in Iraq and Afghanistan, agreed that misunderstanding of mental models of local population has become one of the main reasons of failure to establish peace and democracy in these countries and decrease terrorism [6].

Change in the system implies a change in mental models or vice versa. Interior system change and exterior (environmental) change are two main reasons that disturb system balance. The system always fluctuates and looks for a point of a perfect balance in conditions of the changeable environment. Maintaining of this balance requires

change — interior change (system adaptation), exterior change (shaping of the environment) or mutual adaptation to each other. In many cases, system adaptation to the environment is more suitable than shaping of the complex environment, especially for small and middle size players. If human ambitions, wishes, and creativity change the system, it can try shaping the environment also in order to restore equilibrium.

To provide system balance a leader has to conduct the DMP — to accumulate data, analyze information, use knowledge, and develop appropriate courses of actions based on thinking. “Thinking is the systematic transformation of mental representations of knowledge to characterize actual or possible states of the world, often in service of goals” [7, p. 2]. Therefore, knowledge and its development become critical in thinking.

Peter Senge supposes mental models are “deeply ingrained assumptions, generalizations, or even pictures of images that influence how we understand the world and how we take action” [8, p. 8]. They originate based on influence of others (mass culture), personal experience, rewards and incentives (social approval) [9], analogical reasoning and inherited, developed in a certain geopolitical environment mindset that defines behavior of the system.

Mental models are fundamental for subfields of thinking such as human reasoning with deduction and induction, judgment, decision-making, and problem solving. David Marr said: “When humans perceive the world, vision yields a mental model of what things are where in the scene in front of them”

[10]. Reasoning is about philosophy and logic to make conclusions based on premises. Philip Johnson-Laird highlights “reasoning is more a simulation of the world fleshed out with all our relevant knowledge than a formal manipulation of the logical skeletons of sentences. We build mental models, which represent distinct possibilities, or that unfold in time in a kinematic sequence, and we base our conclusions on them” [11]. Keith Holyoak and Robert Morrison suppose, “Judgment and decision-making involve assessment of the value of an option or the probability that will yield a certain payoff (judgment) coupled with choice among alternatives (decision-making). Problem solving involves the construction of action that can achieve the goal” [12, p. 2].

Mental models regulate, synchronize, and coordinate human activities in a certain environment in order to establish optimal relationships among people to balance the system. They establish “rules of the game” that influence the DMP. Change of the environment creates a new set of rules, which may be very different from previous one. It may require revising beliefs, values, and social norms. This process is complicated and psychologically painful. Therefore, leading the process of change of mental models is critical to make reality-based decisions.

Mental models are relatively stable, but environmental change forces them for revising. Growing conflict between the system and the environment inevitably forms a new mental model that has to balance the system again. For example, new mental models of independent countries, the former republics of the Soviet Union, have replaced the

Soviet mental model that lost effectiveness in the new geopolitical environment.

The mental model resists changing in order to save the system and minimize risk. An example of this resistance is a complex and slow process of political reforms in Ukraine that forms a new national mental model. Political initiatives are directed to create a new legitimate mental model that should be more effective than previous one in the new environment. However, from 2014 to 2017 years out of the nearly five thousand of proposed legislative projects, the Verkhovna Rada of Ukraine has approved only a few dozen [13]. Therefore, revising of mental models is difficult process that requires spending additional energy such as stress, loss of comfort, security, money, and other. An ability to change the mental model can require personal courage, creativity, independence, and imagination. To revise mental models a leader should apply suitable leadership power and styles, establish appropriate organizational culture and climate, show positive and optimistic behavior to energize team members and motivate them for change.

The author supposes that in the new environment the decision-maker may fluctuate close to a so-called “comfortable line” to make a decision. It is a line of psychological comfort according to the existed mental model. To make decisions better and quicker may require creating a new “comfortable line” through revising of the mental model. Thus, in the new environment a decision-maker can make decisions habitually again based on the new mental model.

Revising of mental models requires understanding that “the interactions of a living system with its environment are cognitive interactions, and the process of living itself is a process of cognition” [14, p. 37]. Fritjof Capra introduces the notion of “reflective consciousness” based on “the critical role of reflection in the higher-order conscious experience.” He supposes, “Reflective consciousness involves a level of cognitive abstraction that includes the ability to hold mental images, which allows us to formulate values, beliefs, goals and strategies [15, p. 39]. An approach to influence on “reflective consciousness” may help to revise mental models.

To change mental models is possible by influence on their elements such as beliefs, values, moral, ethic, religion, human preference indicators, risk, expectations and wishes, experience, rationality, and other. Beliefs, values, thinking and emotions are more fixed and invisible [16] human features in comparison with observable and changeable human behavior and results. People forms morals, ethics based on beliefs and values. It forces making decisions and showing emotions and behavior according to the mental model. Thus, beliefs and values affect human thinking, emotions, and behavior.

Beliefs and values are the start points to understand human needs and wishes. They initiate the DMP, generate mental models, form unwritten rules of behavior, create morals and ethics, and present a basis to develop state documents such as the National Security Strategy. Values present our abstract conceptions of relative desirability [17]. Beliefs (unconscious feelings) are our notions of what is true. Beliefs, in many cases,

present conscious and unconscious behavior based on experience, geopolitical location, and economical, historical and religious connections. Beliefs may remain different while values are similar. For instance, it is possible to assume that beliefs of population of Western and Eastern parts of Ukraine may differ because of geopolitical location. At the same time, values such as a high level of life, national and cultural identity, and psychological comfort for both sides of Ukraine are the same. Thus, in spite of shared values, difference in beliefs can force making different decisions and their correctness is a philosophical question.

Change of beliefs and values can make a society vulnerable. Different exterior and interior players can use it to promote their interests by dividing the country into parts based on weak or different beliefs and values. In the transformational period it is possible to observe fluctuation or change of mental models that may shift people from “ethical behavior” to “behavior to survive” when moral and ethics become weaker or even disappear because there are no rules. In this situation, “instinct-based decision-making takes place at the atomic/cellular level, because the actions that arise are based on learned DNA responses, principally associated with issues of survival” [18, p. 3]. Maintaining of “ethical behavior” may require soft revising of mental models by applying of flexible leadership, constant feedback, active participation of “public governance”, and an appropriate level of decentralization.

Social dissatisfaction, as a lack of equilibrium between the system and the environment, can cause conflict when a

new system will replace the old one. It is a moment when people may destroy their icons such as statues, names of the streets, perceptions of the past. For instance, people removed royal statues and monuments after the February revolution of 1917 in the Russian Empire, Stalin statues in 1953 after his leadership in the USSR, communist and Soviet statues and symbols, as decomunization, in 2014 in Ukraine, historical statues of the Confederates in 2017 in the USA [19]. All these events can correspond to a bifurcation point (revolution) or achievement of the critical level of equilibrium between the system and the environment. Restoring of this equilibrium requires decision-making based on the revised mental model. In this moment the system is about to lose effectiveness without possibility to be restored and the coefficient of dynamic equilibrium between the system and the environment — K_{eq} [$0 < K_{eq} < 1$] [20, p. 9] achieves a certain critical level — $K_{eq\,crt}$ [21, p. 146] (fig. 1). $K_{eq\,crt}$ may be determined by the frequency of fluctuation of the leader’s ability to lead the social system effectively and the capability of the system to endure the pressure of the environment.

If the existed mental model does not satisfy human needs, the society looks for a new mental model as a qualitatively new approach to think in order to make decisions to restore equilibrium between the system and the new environment. Applying of experience to new conditions may be not effective. Mental models should reflect and support the future. The author suggests that change of mental models should start in a certain moment that corresponds to $K_{eq\,min}$ [22, p. 201] (fig. 1) — before achieve-

ment of the $K_{eq\ crt}$ in order to avoid system destruction.

The mental model should correspond to the environment and provide maximum possible system effectiveness with a certain optimal coefficient of dynamic equilibrium $K_{eq\ opt}$ (fig. 1). In condition of mutual change to achieve ideal equilibrium between the system and the environment ($K_{eq} = 1$) is impossible because adaptation is a reaction with delay. The DMP and decision implementation take time. Thus, there is an optimal $K_{eq\ opt}$ that provides maximum achievable system effectiveness in conditions of changeable environment.

To prove this idea it is possible to observe system functionality and its adaptation. There is a certain point when system adaptation may change the system functionality because of probable loss of its previous shape. Hence, adaptation of the system should be sensitive especially in aspect of revising of mental models because next environmental change may require another system change that can be completely opposing to the previous direction (change the strategy). For instance, it is possible to refuse using old standards, but in a certain moment, the system may return to them on the new wave of

system development. Thus, maintaining of $K_{eq\ opt}$ may provide enough system flexibility and maximum effectiveness in conditions of continuous change. The possibility and speed of change of mental models can define $K_{eq\ opt}$ of the system.

Accordingly, there are three key points – $K_{eq\ crt}$, $K_{eq\ min}$, and $K_{eq\ opt}$ to control and lead the system effectiveness. In the interval $[K_{eq\ min} - K_{eq\ opt}]$ (fig. 1) the system is functional and effective enough. In the interval $[K_{eq\ crt} - K_{eq\ min}]$ (fig. 1) the system losses functionality and without quick change may be destroyed. It is possible to suppose that under condition $K_{eq} > K_{eq\ opt}$ the system can be vulnerable and not balanced because of high openness and fast transformation. Also, this condition may force the system to change functionality.

$K_{eq\ opt}$ may correspond to a certain balance that provides maximum system effectiveness (fig. 1) under the condition of saving system functionality. If $K_{eq} \rightarrow 1$ in the interval $[K_{eq\ opt} - 1]$ the system can change its structure and functionality because of its high openness and vulnerability. The ratio between segments $[0 - K_{eq\ opt}]$ and $[K_{eq\ opt} - 1]$ defines the position of the $K_{eq\ opt}$ that may be relatively constant

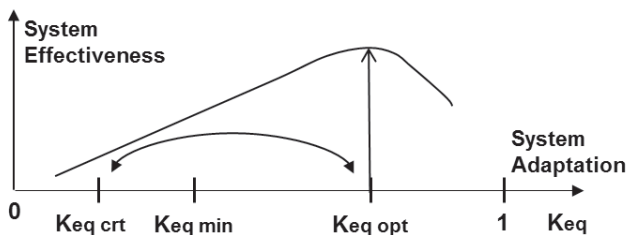


Fig. 1. System effectiveness and the coefficient of dynamic equilibrium

Source: Created by the author.

for the system. Change of the system structure may influence the $K_{eq\ opt}$.

Maintaining of system effectiveness and functionality in the dynamic environment can require acceleration. Late system reaction to environmental change can be not effective or, moreover, useless. In the interval $[K_{eq\ crt} - K_{eq\ min}]$ (fig. 1) the system is in danger and acceleration of the system is a vital to save its functionality. Thus, the position of K_{eq} in the interval $[K_{eq\ crt} - K_{eq\ opt}]$ defines the required speed of change of the mental model.

The speed of system change — Va [23, p. 146] describes dynamic of system adaptation to the environmental changes. Acceleration of the system (As) is the first derivation of the function of Va ($As = f'(Va)$) that describes system agility. If K_{eq} is in the interval $[K_{eq\ crt} - K_{eq\ min}]$ the system adaptation should be accelerated in order to react to the environmental change as soon as possible.

Acceleration can complicate changing direction for big strategic systems because of their mass and inertia. Thus, short-term acceleration is effective, but long-term acceleration may be negative for big inertial systems. Nevertheless, decentralization with flexible leadership and “public governance” can increase system acceleration, agility, and eliminate the problem of inertia of the big system.

Decentralization can accelerate system agents as a process of mutual adaptation between the system and the environment. It is possible to suppose that the level of decentralization is connected with the notion of K_{eq} . Decentralization, technological development and communication can increase

$K_{eq\ opt}$ by making the system agile and competitive. John Cotter proposes to accelerate the system through decentralization and network development [24]. He describes a dual operating system that supports innovation on the strategic level while the system works on the lower levels according to usual operational cycle [25]. Accordingly, decentralization with “public governance” may accelerate adaptability of the system by applying of double-loop learning process [26]. To implement change may require decentralization in order to apply mental models of different groups (communities) to achieve the strategic goal.

The state, as a system with diverse territorial communities, should establish a certain level of decentralization that will allow maintaining required system effectiveness to achieve the strategic goal (to maintain national interests). The national mental model should be constructed according to this requirement in order to form mental models of territorial communities. Leading of the social system may require flexibility in decentralization that should be balanced (measured) in a certain proportion in order to save system functionality.

The system should be balanced and perform a required job. Applying of criteria of system effectiveness such as a measure of effectiveness (MOE) and a measure of performance (MOP) [27, p. 15–2] may help to define K_{eq} . They show how the system is successful on the way to achieve the goal. MOE answers the question — “are we doing right things?” MOP answers the question — “are we doing right things well?” Knowledge of K_{eq} can allow defining a

favorable period for system change and, therefore, to plan changes.

Mental models should be secured and revised at the same time. This paradox raises a question how to lead mental models in order to maintain equilibrium between the system and the environment and save the system. Stability of mental models is a matter of system survivability. The system should be secured in a certain degree from absolute openness, because it makes the system vulnerable, by a certain mental filters. Quick change of beliefs, values, and other human norms may decrease their credibility, initiate chaos, and even destroy the social system. To change believe and values while remaining honest and devoted to the national norms is complicated. For instance, soldiers have to swear to be devoted to the country only once in their life. Is it possible to take the oath many times and not lie to yourself? It creates a problem of maintaining the human balance in the changeable environment without a clear justification of the need of revising beliefs and values. Therefore, speed and the level of change of human norms become critical in order to adapt the system to new environment.

To avoid social conflict, initiated because of delay in system reaction, may require gradual system adaptation by applying of a learning organization [28, p. 3–4] — an open and adaptive system with constant feedback. The leadership model of “public governance” with decentralization may be similar to the “learning organization.” It provides “soft” system adaptation and decrease conflict because people present the state authority. They can revise mental models through open collective dis-

cussion based on cognition, constant feedback, and quick implementation of changes.

Possible differences in beliefs and values create diverse mental models that separate social groups. Technological development, increased communication, and globalization erase boundaries between the national mental models. At the same time, common challenges create unions, partners and corporate organizations based on common beliefs, values, interests and motivations. Possible differences in beliefs and values of social groups (see figure 2) may explain the logic of behavior of territorial communities.

Each social group should satisfy human needs (individual, team, organizational, national, society) according to the Maslow’s Hierarchy of Needs [29]. It is possible to assume that for majority of people individual needs are stronger than group needs. However, a person is a social being who should be in the community. In order to satisfy individual needs a person may influence on others and look for an appropriate social group (change the working team, the organization or the environment — the country, the society).

Interpretation above may explain the problem of combining of different territorial communities in order to make the state strong. If national beliefs and values are weak, interior and exterior players can influence the country by using strong mental models of lower levels. Territorial communities may joint together based on mutual benefits. They can work together and support each other inside of not only one nation, but also communities of other countries based on similar prob-

№	Social groups	Beliefs and Values
1	Individual	They may be difference and individual for everyone even for members of one team or organization. It forms an individual mental model that defines personal decisions
2	Team	Similar goals, motivation, interests based on shared experience, working conditions form one way of thinking, emotions and behavior
3	Organization	Teams can be grouped into one organization with one big goal, politics, appearance, attitude, behavior (organizational mental model)
4	Territorial community	Language dialect, climatic conditions, objects, mutual interests, living standards, prosperity force communities to unite or divide (decentralization). It forms the general regional mental model
5	Nation	To compete and survive among other nations on the international arena and feel belongings to a certain group, based on traditions, language, culture, feelings, religion form national mental model. Even in different countries, a small national community is very strong and connected with the main part of the nation. Moreover, this small part may think more about national identity and its existence than the main national part (national mental model)
6	Society	Shared human, values based on mutual profitable cooperation (historical), religion form European, Asian, African or other societies that present a union of different nations that are ready to coexist together. It forms mental models of the international society

Fig. 2. Beliefs and values of different social groups

Source: Created by the author

lems, beliefs and values. In addition, individuals with sheared experience, even from different nations can find common languages and build corporate organizations.

Mental models are “barriers for innovations and they interrupt the transformation of learning. We have to learn to reduce our mental models and keep only those that can help us to increase our knowledge” [30]. Finding of approaches and tools to influence mental models as soon as possible is critical for effective decision-making. It is possible to assume that understanding of beliefs and values, national, corporate cultures of own and the opposing sides can help to find an approach to change the system with its mental model. It is possible to do through influence on “the center

of gravity of the system” [31] as “primary sources of moral or physical strength, power and resistance” [32, p. IX] of the system.

Applying of system, critical, creative thinking, and knowledge management may allow revising mental models to make right decisions. It is important to identify patterns of system movement to the future based on an ability to revise facts and conditions, to learn right information that should challenge existing beliefs and values. Thus, knowledge is powerful to influence beliefs, values and, therefore, decisions by applying of the process of learning.

There are three types of the process of learning. The first one is a simple cycle process of system development or feedback process with the identified

problem, the DMP, and feedback. Single and double-loop learning processes (figure 3) present the next two processes of learning that already apply the mental model for the DMP. Possible changes in the mental model distinguish the double-loop learning process from the single-loop learning process. Chris Argyris explained the difference by analogy: “a thermostat that automatically turns on the heat whenever the temperature in a room drops below 68 °F is a good example of single-loop learning. A thermostat that could ask, “Why am I set to 68 °F?” and then explore whether or not some other temperature might more economically achieve the goal of heating the room would be engaged in double-loop learning [33].

Changing of mental models requires applying of the double-loop learning. “Unlike single loops, this model includes a shift in understanding, from simple and static to broader and more dynamic, such as taking into account the changes in the surroundings and the

need for expression changes in mental models” [35]. The double-loop learning entails the modification of goals or decision-making rules. The first loop uses the goals or decision-making rules and the second loop revises them. The double-loop learning distinguishes that the way a problem is defined and solved can be a source of the problem [36].

The DMP presents a “data-information-knowledge-wisdom” cycle [37] based on mental models. Wisdom answers the question “why” that corresponds to the second loop of the double-loop learning process and may influence the mental model.

Also, there are different practical recommendations to revise mental models. For example, Diana Durek proposes:

- 1) Be willing to change: what would happen if you did not change your mental model? (to encourage people); how important to change your mental model to the success of the organization?
- 2) Open your mind: tune in; look for opportunities; challenge yourself.

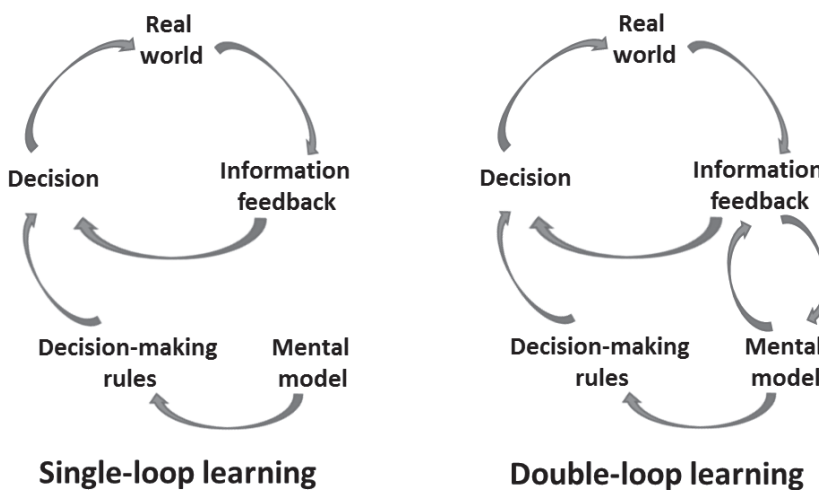


Fig. 3. The process of learning

Source: [34]

3) Use “Creative swiping:”do different things in the same way; do the same things in different ways;do different things in different ways.

4) Reverse your assumptions: state your assumption; reverse the assumption and write the opposite; consider the actions/behaviors/consequences of opposite assumption; what information does that provide about of accuracy of your assumption [38]?

To avoid mistakes in the DMP and revise the mental model a decision-maker should apply system, critical, and creative thinking. System thinking helps to adapt the mental model to the changeable environment. Peter Senge suggests that “system thinking” is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing “patterns of change” rather than static “snapshots.” He proposes teamwork to make a right decision because “we start to appreciate the real nature of human perception as a living system. None sees the reality correctly. We are not recording devices, we are living systems” [39].

Russell Ackoff highlights that “the system is a whole, which cannot be divided in independent parts. Conceptually, an essential property of the system is how these parts interact, not how they act separately. Therefore, defining properties of the system are properties of the whole, which system parts do not have separately” [40]. Thus, system thinking is a cognitive process to accept the system as the whole, understand possible mutual dependencies among different systems, their elements and visualize emerged system behavior. It is an ability of the decision-maker to see the system as a complete dynamic

process. System thinking is a characteristic of the learning organization that transforms and adapts itself through constant feedback loop.

The dynamic, changeable environment forces making irrational decisions that typically result from a reliance on intuitive biases that overlook the full range of possible consequences. The irrational approach looks unusual because a decision-maker has to take risk and apply a new mental model for the DMP instead of the existing mental model. This new mental model becomes the adopted, usual model and also can get outdated later in case of a next change of the environment. Irrational thinking is similar to double-loop learning process that forces changing of the mental model. Applying both – rational and irrational thinking would be significant to make a right decision because rational thinking is more suitable for a regular and clear situation when irrational thinking is effective for a new and unpredictable situation. Critical and creative thinking can help to evaluate situation irrationally.

Critical (convergent) thinking is a cognitive process of purposeful, unbiased, and self-aware questioning of the facts and conclusions to improve logic, analysis, and decision-making. Human experience, biases, prejudices, and expectations influence decisions. Decision-makers rely on simplifying strategies or “general rules of thumb” called heuristics, as a mechanism for coping with decision making in the volatile, uncertain, complex, and ambiguous environment [41, p. 129]. A decision-maker should avoid assumptions traps by “noticing what support your mental model and ignoring what does not; re-

mained attached to what made you successful; not trying what you believe is bad or impossible; focusing on current situation not anticipating” [42].

Development of critical thinking skills is important for a successful decision-making. “Critical thinking is the use of those cognitive skills or strategies that increase the probability of a desirable outcome. It is used to describe thinking that is purposeful, reasoned, and goal directed” [43, p. 6]. Stephen J. Gerras proposes “A Critical Thinking Model” [44, p. 7] as a practical tool to apply critical thinking in the DMP.

Creative (divergent) thinking is a cognitive process that offers novelty in order to open the system for adaptation. The system should be creative because “creativity — the generation of new forms — is a key property of all living systems” [45, p. 13]. Charles Allen supposes, “Creativity is the ability to develop new ideas and concepts that are effective in resolving situations at hand” [46, p. 3]. Roger Oech mentions “mental locks” [47, p. 14–15] or several attitudes that serve as barriers to creativity. They may be based on rational thinking or existed mental models. “Our challenge is to push outward from our comfort zone and enter the area of discovery” [48, p. 4]. Creative thinking can change mental models and establish other comfort zones for effective decision-making in a new environment.

To summarize, making right decisions in the dynamic environment requires revising mental models thought applying of the double-loop learning process, system, critical, and creative thinking. System thinking allows seeing the system and the environment as a whole. Critical thinking secures system

functionality by avoiding possible human traps and biases. Creative thinking opens the system through innovations and irrational approaches that facilitate revising obsolete mental models.

The author proposes the algorithm of maintaining system effectiveness by revising of the mental model (figure 4) as a practical tool to make effective decisions in the dynamic environment. It is a gradual and flexible process of leading of the system, which involves continuous monitoring of the relevance of the existing mental model in a today and probable future environment by determining the level of equilibrium between the system and the environment. This process can include three phases:

1) Under condition $[K_{eq} > K_{eq\ min}]$ — the system is effective enough:

- Play with leadership power;
- Apply suitable leadership styles;
- Keep the system structure and the mental model;
- Avoid achievement of $K_{eq\ min}$.

2) Under condition $[K_{eq} \rightarrow K_{eq\ min}]$ — the system is losing effectiveness:

- Visualize the future system in the future environment;
- Balanced ends, ways, and means in the framework of possible permissible risk in order to establish equilibrium between the system and the environment.
- Apply system, critical, creative thinking in the DMP, use knowledge management to collect data, produce information, apply knowledge and wisdom.
- Learn how to reduce our mental models and keep only those that can help us increase our knowledge by applying of double-loop

learning process when wisdom becomes powerful to influence human perception and stereotypes.

3) Under condition [$K_{eq\ crt} \leq K_{eq} \leq K_{eq\ min}$] – the system is about to be destroyed:

- Avoid achievement of $K_{eq\ crt}$ if you want to keep system functionality;
- Accelerate system adaptation by different ways and means (“public governance,” decentralization, increased communication and feedback);
- Apply system, critical, creative thinking in the DMP with double-loop learning process based on knowledge in order to revise mental models as soon as possible.

Conclusions. Mental models play one of the key roles in the DMP and require revising in order to adapt the system to the environment by decentralization and establishment of “public

governance,” increased communication and feedback. The algorithm of maintaining of system effectiveness by revising of the mental model (see fig. 4) can help to change mental models and provide “soft” system adaptation. Mathematical interpretation of the process of maintaining system effectiveness, especially for the complex system, can help to adapt the system and revise its mental model in time. Established indicators of system effectiveness with MOE and MOP, knowledge of $K_{eq\ crt}$, $K_{eq\ min}$, $K_{eq\ opt}$, and As form a mathematical approach that allows maintaining of system effectiveness and creating a plan of required reforms.

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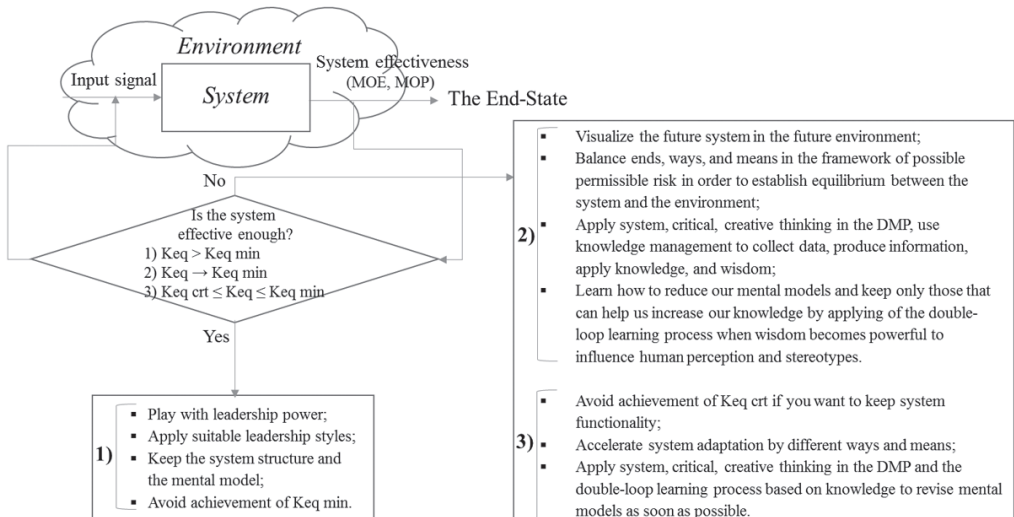


Fig. 4. The algorithm of maintaining system effectiveness by revising of the mental model

Source: Created by the author

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