The Fundamentals of Talented Thinking

Guidelines

Author
Julijs Murashkovskis
SIA „PAC Agenda" (Latvia)
www.pacagenda.lv

2013

Training materials created during the Latvian, Estonian and Finnish adult educators' cooperation project "Let's Find and Use Your Creativity".

A project supported by the Nordplus Adult Programme.

Content

The Fundamentals of Talented Thinking

Part 1

1. Introduction

The whole development of human culture happens through a series of consecutive changes. These changes do not occur by themselves or by the sudden intent of certain individuals. They are caused by a real and objective necessity.

Example 1: Human ancestors were ‘scavengers’, that is, they ate the remains of animals killed by large predators. Our ancestors – *homo habilis* – were small, weak, apelike creatures with serious competition among scavengers – jackals, hyenas, and vultures. Therefore, our ancestors developed a strategy to grab the biggest chunk of food and get away with it as quickly as possible - but how could you tear a big piece of meat using weak, little fingers?
This exact situation led to an invention – the use of a stone to remove large pieces of meat.
Such technology dramatically improved nutrition. *H. habilis* rapidly increased in population, which led to an increase in food consumption, but the nutrition problem soon re-emerged.
The use of a random stone has serious limitations. The stone must be small so that it can be easily picked up and swung. However, you cannot chop off a large piece of meat with a small stone.
Along comes another invention – chipping a piece from a stone using another stone to create sharp cutting edges. It is much easier to cut off a big piece of meat with the sharp edge of a stone.

Each new invention led to more problems. Even these first two advances led to the problem of finding an appropriate stone that was solid enough to chip another stone. This invention has led to serious changes in the human psyche. Now we were forced to move from the simple chain of thoughts **‘reason – action’** to far more complex ones: **‘reason – tool use – action’**, and then **‘reason – tool creation – tools use – action’**.

During the primitive stages of human development, problems would take thousands of years to be solved. It was ‘groups of contemporaries’ and not individuals who found solutions to problems. In ancient times there were so many problems and some needed solving in a couple of years, not centuries. Therefore, the collective experience of the whole tribe became an unacceptable method. Subsequently there appeared certain individuals who were solving problems much more quickly than the tribe. In modern times these individuals are referred to as talented or ingenious.

A talented, ingenious solution is not an accident as many think. The most popular example for supporters of 'accidental discovery' is Newton’s apple. Sir (well, not sir yet) Isaac Newton saw a falling apple and immediately discovered gravity, and if he had not – the world would remain without it.

This is a quaint fairytale. When a hundred years before Newton, Johannes Kepler discovered the planetary motion around the Sun, he started to ponder 'why do they move but not fly away?' He then suggested that the planets are drawn in by the Sun. Then why do they not fall into it? Kepler suggested that the planets have some property that keeps them moving after their driving force has ceased to operate. He called this phenomenon – inertia.

The idea of gravity became very popular among scientists. A contemporary of Newton, Robert Hooke even derived a formula – the pull of gravity is equal to the sum of the masses of two bodies, divided by the square of the distance between them.[1]

Although a lot of gaps remained in the theory, the young mathematician Newton was trying to fill them in. He pondered this for twenty years and developed a generalised theory of gravity, which is relevant not only to planets but also to all bodies in the Universe in fixed motion, as well as steady and direct motion.[2]

The story of the falling apple only appeared after Newton's death.

So, we have discovered a very important phenomenon. Talent and genius are manifested when addressing some very specific problems - and not just any problems, but those that develop human civilization.

Another phenomenon occurred when certain individuals appeared who were solving specific problems. It became clear that problems aren't solved by recklessly banging rocks together. To solve a problem you first need to imagine it. That is, all problems are solved in our heads. The solution to a problem is a change in perception.

M.S. Rubin proposed the following generalised scheme of the creative process:

or

the object (O) → mental model of the object (M) → conversion procedure → changed mental model of the object (M') → changed object (O')

This means that all changes in human culture – technology, science, art, economics, etc., start with a change in perception.

Talent and ingenuity - the ability to perceive in new ways which are quite different from previous ones, and to open up new possibilities for humanity.

However, there is one serious ambiguity in the definition. What does **quite** different from previous ones mean?

---

[1] For various reasons, this formula was later attributed to Newton.
[2] The theory of relativity began with Einstein pondering why Newton so disliked the irregularly of moving bodies.

2. Levels of Change

(Measuring the results of talented thinking)

2.1. Various differences

If we compare every discovery or invention with its prototype, we soon discover that changes or deviations from the prototype can be very different.

As an example, let us compare three facts.

Example 2: Alchemists knew of three reaction types: combustion, calcination, and distillation. They viewed every reaction and every substance separately, without trying to find something in common.

Example 3: In 1703, Johann Becher and Georg Stahl put forward the combustion theory, which stated that combustion is a release of a special fluid – phlogiston. This allowed them describe various reactions using a single mechanism, explaining the difference between metals and non-metals, and classifying many substances. This was the first scientific theory in chemistry.

Example 4: In the 18th century the phlogiston theory faced an inexplicable problem. Phlogiston, as all the other fluids, was weightless. However, during combustion, the weight of many substances increased. Karl Scheele explained it away with the hypothesis that during excretion, phlogiston leaves pores which are immediately penetrate by air, thus increasing the weight of the substance.

Let us compare not the situations but the difference between the new situation and the previous one. The theory of phlogiston, in comparison with the views of the alchemists, radically changed the view of nature. It brought order into the chaos of substances and their interconversions. The world in the eyes of natural scientists had changed.

However, Scheele changed neither the view of the world nor the concept of combustion, as phlogiston in his model continued to be released. He changed the view with one additional little process that accompanied the release of phlogiston.

The difference between the two changes is obvious. In the first case it is huge, in the second – small, although significant to the details of the processes under study.

Here is another example, this time from the realm of music.

Example 5: In the 19th century reined the supreme idea of 'nationality'. Nobody could explain what it was, but everyone understood that it was a necessity, so artists tried to integrate nationality in their works.

Particularly in music, it was expressed with inserted bits of folk songs or dances. These were arranged and merged with the author's music and thus expressed 'nationality'.

In 1858, composer M. Balakirev wrote 'Overture on themes of three Russian folk songs'. He put a whole melody of the song 'In the field stood a birch tree', which was properly arranged.

In 1866, P. Tchaikovsky also put this song in the final of his Fourth Symphony, and a full version as well. Moreover, the arrangement was not too different from Balakirev's.

In 1869-1887 A. Borodin was working on the opera 'Prince Igor' and, of course, he did not spare 'nationality'. However, for that purpose he took a different folk melody – 'The song about mountains'. Borodin divided it into parts and used each part at different places in the opera with different arrangements.

If we take Balakirev's overture as the prototype (both Tchaikovsky and Borodin had heard it), then which composer's changes are bigger?

It is clear that Tchaikovsky had not changed a lot of things in comparison with Balakirev - the same song in the same form with a similar arrangement. In his composition, Borodin took a different approach. First, he chose a different song. Second, he did not use the full version; he instead used the song in parts. Third, he made a couple of different arrangements and placed them in different parts of his opera. It is obvious that Balakirev's work is a lot different to Tchaikovsky's.

2.2. Measurement of the differences

All prototype changes can be conditionally divided into five levels, or degrees, of difference. Let us consider them, starting with the largest, the fifth.[3]

> **5th level - Synthesis:** This is a new way of thinking, a new view of nature and society, a new type or genre of art, a new kind of technology. There is no specific prototype; the whole system of previous views is the prototype.

Example 6: Transportation had always been on land or water; however in 1647 Tito Livio Burattini made the first fixed wing flying model. In 1848 John Stringfellow launched a steam engine monoplane on a 9 meter sloping wire. It gradually climbed up the wire until caught by a canvas screen. Stringfellow's next creations flew without a wire, eventually travelling unaided for about ten meters. These devices changed the concept of transport and introduced civilization to a new method of movement – flight. This was the beginning of aviation.

Example 7: The ancient Babylonians, watching the night sky, noticed that the stars were moving together and in one direction, as if revolving around the Earth. This reminded them of a wheel revolving around an axis. The wheel became a symbol for the Universe in Babylon. Gradually, the idea of a celestial sphere that revolved around the Earth, to which the stars were attached, took shape. That model changed the concept of the world. Instead of being chaotic, it became ordered and comprehensible. The science of astronomy was created.

Example 8: Humanists of the Renaissance believed that people's lives could be improved by returning to the achievements of antiquity. They started to study ancient science and art. This was very difficult, as middle-aged Christianity had destroyed almost all evidence of 'pagan' antiquity. Books were washed off ancient parchments, temples and sculptures were destroyed, and scientists were sadistically executed. Not many remnants of ancient science and art got into hands of the humanists. Of course, their ideas of antiquity were surreal. In particular, amateur musician Jacopo Peri, when trying to resurrect ancient theatre, misunderstood the surviving records, concluding that in the ancient theatre, artists played music and sang. Together with his

[3] The principle of dividing changes into five levels was proposed by G.S. Altschuller.

friend, the poet Ottavio Rinuccini, they ‘revived’ antique plays. In 1594, they wrote a musical show based on an ancient Greek legend, where the characters did not talk, but sang, accompanied by a harpsichord. In the second performance by the same authors, 1600 singers were accompanied by an instrumental quartet. A new kind of music was created - opera. It changed the concept of theatre.

> **4th level - Deployment:** In essence, the new concept is not changed, but its main parts are replaced in concordance with observations and experiments. New theories, technological trends, and types of artistic expression start to appear. The result of changes on the fifth level is the prototype.

Example 9: The ancient Greeks, having adopted the celestial sphere from the Babylonians, drew attention to the fact that not all the stars moved equally. Some of them deviated from the general movement, as if wandering through the sky. They were called ‘vagabond’ planets. To reconcile these observations with the theory of the celestial sphere, the Greeks assumed that outside the sphere of stars there were additional spheres for each planet, the Sun and the Moon. The concept of the Universe revolving around the Earth stayed the same but the basic principles of revolution had changed.

Example 10: Stringfellow’s airplane wings were flat and horizontal. Some designers, including the Wright brothers, changed the wing geometry, making tipped wings and also made the leading edges thicker. This took advantage of aerodynamic effects and dramatically increased the wings’ lift. The Wright Brothers’ airplane flew for hundreds of meters, and finally kilometres.

Example 11: The presentation of Peri’s second opera was attended by a young composer Claudio Monteverdi. He immediately realised that Peri was not even using a tenth of the musical potential of that time. Monteverdi wrote his own opera but there was a whole orchestra with melodic arias and duets. Both polyphonic and monadic styles were used.

> **3rd level - Adaptation, large adjustments:** Certain details are changed and adapted to the new system of ideas and observations. There are many of them and, as a result, the whole picture becomes diversified, coherent and logical. Particular theories, new units, and parts of technical devices start to appear, as well as specific new artistic means of expression. Certain ideas, details and expressive means are the prototypes.

Example 12: Some features of planetary motion are not even consistent with individual spheres. Sometimes planets moved in the opposite direction and then again continued moving forward. This is the reason why the ancient Greek astronomers suggested that additional small spheres - epicycles that rotate independently, were attached to the spheres of the planets (cycles). Planets were attached not to cycles but epicycles. Due to the different rotation speeds of cycles and epicycles, it seemed that sometimes planets were moving backwards. The idea of the rotation of the Universe and individual spheres did not change; however, the concept of epicycles reconciled these ideas with the observations.

Example 13: The Wright Brothers’ airplane wings were solid and immobile. The pilot manoeuvred the airplane by changing his position, altering the centre of gravity. A. Bell patented the so-called ailerons - movable parts of the wing that could control the height and direction of an airplane. The principle of flight and the lifting force did not change but machines became more controllable.

Example 14: New expressive means, melodies and orchestration techniques started to appear in the works of Gluck, Mozart, Verdi, Puccini, and in many other composers’ operas.

2nd level - Idioadaptation, small adjustments: Minor changes in details, peculiarities of concepts, and external aspects of expressive means. Views are slightly refined, not changed.

Example 15: Epicycles still could not explain some minor peculiarities of planetary motion. They had to introduce epicycles of the second and third order (epicycles attached to the epicycles), eccentricity (when axes of epicycles do not coincide with cycles slightly), etc.

Example 16: During the assembly of metal airplanes they started to use rivets instead of bolts and screws. This increased streamlining and eased assembly procedures but did not affect the operational principles of the airplane or its parts.

Example 17: The technique of opera singing became more complicated and more beautiful, the number of orchestra instruments had increased, and the scenery became more complex… However, none of it reflected on the basic principles of opera.

1st level - Regression, microscopic changes: There is growing evidence and the refining of the smallest, insignificant details of known concepts. The use of technical devices is facilitated; their use, efficiency, and convenience increase. There is growing parergon in arts and appreciation of the smallest details of expressive means.

Example 18: The diameters and locations of epicycles, and the distance between the spheres are specified. The calculating technique of orbits using long-known formulas is improved.

Example 19: The Finishing of airplane surfaces is improved, some companies stop painting their airplanes, as their surface is smooth enough. This reduces costs; the airplane becomes slightly lighter, decreasing fuel costs by a fraction.

Example 20: Operas are now ‘churned out’, not written. Given the popularity of this kind of music, writing operas becomes mass production. Operas become very much the same.

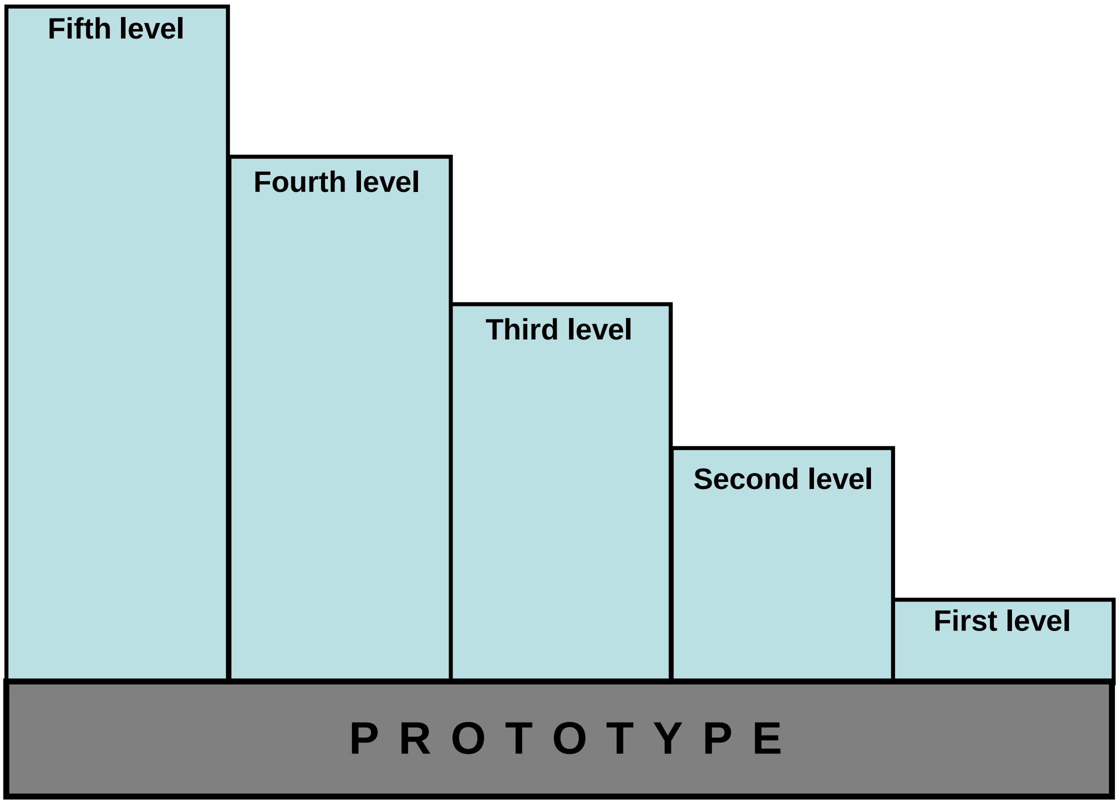
A variety of specific explanations not connected with any general system (*ad hoc*) and explanations resembling wordplay (*linguistic explanations*) start to appear in science.

Example 21: The so called ‘psychologist’s advice’ spawned in magazines are not connected with any psychological theory. Most of them are either banal, everyday observations or are simply made up.

Example 22: Here is an interesting example of an explanation on the level of wordplay, which is the popular doctor’s advice to use as little table salt as possible to help prevent deposits of salts in the body’s joints. This so called ‘deposit of salts’ (tophus) is not really a deposit but rather growths on the heads of bones. These growths, like bones themselves, mainly consist of salts such as phosphate and calcium carbonate. Table salt is sodium chloride, meaning it cannot be deposited in the joints, because it simply is not there. Even if it is, it is still perfectly soluble in water (and, therefore, in joint fluid) and cannot accumulate there. However, this play on words ‘salt-salts’ is very convincing. Doctors still believe in it even though they have studied chemistry.

Let me just warn you. The level of change is not the evaluation of the result. It is the size of change from the prototype. In the same way as we describe a mountain by specifying its height above sea level. It is not the mountain terrain, its rock composition or the beauty of the mountains against the backdrop of a sunset sky. This is simply the height from a reference point. It is just one of the indicators - but an important indicator.

This is how it might look as a scheme:



When evaluating the level of change, we must remember that we do not always know what the previous discoveries or inventions were. It is a question of our erudition and the presence or absence of information. Therefore, an absolutely unbiased evalution is impossible to achieve. During the working process we inevitably collect materials and enhance our knowledge, so the accuracy of evaluations increases.

2.3. Training tasks

The essence of all learning is the recognition of new concepts in different cases. We are now acquainted with the concept of levels of change. Now let us practice these levels in different situations. After all, the ability to see the size of change is one of the elements of talented thinking.

I will present some examples of changes in various fields of human activity. Try to determine the level of change described in these examples. Please do not forget that when coming up with these changes, the great minds of the past did not know many of the things that we know now. Therefore, evaluate their results from their point of view, and based on their level of knowledge. I will try to describe them in the following exercises.

Some quotations from various sources will be used, and we must remember that the author was relying on very different principles and was writing for other purposes. Minor changes could cause excessive delight and big ones could simply be unappreciated. Therefore, do not pay attention to the author's emotions. We are the ones who are solving the task, not the author of the quotations.

We will now analyse a couple of examples.

Task 1: The first known device to be driven by steam was described by Heron of Alexandria in the first century. Steam that was tangentially coming from nozzles attached to a ball, made the latter turn. There was no use for this invention, it was simply a toy.
A 16th century Arabian philosopher, astronomer and engineer Taqi al-Din proposed a method for spit rotation using steam flow directed at blades, affixed to the rim of a wheel.
A similar machine was proposed in 1629 by Italian engineer Giovanni Branca for the rotation of a cylindrical anchorage, which turned to lift and release a pair of pestles in mortars.
What is the level of change here?

The solution: Objectively, Heron's device was the first machine that used steam energy for rotary motion. For this reason it can be considered an invention of the fifth level.
Taqi al-Din invented a new type of technology – the steam turbine. It is also the objective fifth level – A new direction in technology.
Branca's invention objectively did not change the essence of al-Din's invention. However, his machine transformed steam energy, not into rotary but reciprocating motion. Objectively, it is a new principle within the limits of a previously created direction - the fourth level. On the other hand, it is doubtful that Branca knew about al-Din's invention, meaning, subjectively it is the fifth level.

Task 2: A Young Moldovan circus team 'Frumos'… debuted in the arena of the Kishinev State Circus. <...> The search for a unique image led to inimitable circus acts never seen before. For the first time a whip, staff and 'kushma' (a special sheep hat) became juggling props. Peculiar acts were created by comic musical actors, who played not only old Moldovan instruments – fluers, kavals but also sopilkas, which are made from a certain type of dried pumpkin. (В. Летов. На арене "Фрумос". "Советская культура". 1.11.88.)
What is the level of change here?

The solution: Despite the assurances of the author of the quotation, nothing has changed in the art of circus. The genres also have remained the same – juggling, comical musical acting. The technique of juggling and playing did not change either. The only thing that has changed is the props. It is a typical second level of change.

Task 3: "The band 'Jethro Tull' was linked to that music genre (*progressive rock – J.M.*). Yet their compositions differed with a strong foundation in jazz". (А. Гаврилов. Комментарий на обложке альбома «Джезро Талл». «Мелодия», 1987 г.).
To the best of my knowledge, elements of Jazz were previously used in rock music but in the form of random, unrelated elements.
What is the level of change here?

Task 4: In Newcomen's steam machine, steam was used to push a piston that cooled in the same cylinder, causing the piston to return to its starting position. In other words, engine performance was periodical. In 1763 James Watt improved Newcomen's steam engine by separating the boiler from the condenser by using a steam distributor. This allowed the steam engine to operate continuously.
What is the level of change here?

Task 5: In 1891 physicist J. Stone suggested calling electrically charged particles 'electrons'. What is the level of change here?

Task 6: Before Giotto di Bondone, paintings were flat. Giotto focused his attention on discovering methods that would contribute to the impression of looking at three-dimensional shapes. How do you achieve this? First of all, by using light and shadows. Secondly, by using the reduced term. (Joanna Guze. Na tropach sztuki. "Nasza Księgarnia". Warszawa. 1982. s. 144-145)
What is the level of change here?

Task 7: In 1936 K. Zuse built his first computer, using the electrical relay and in 1946 D. Mouchli demonstrated his computing machine working on vacuum tubes - the ENIAC.
What is the level of change here?

Task 8: In the 19th century, the wave theory of light was based on the idea that light is transverse waves in an elastic fluid, called ether. However, Poisson had mathematically proven that transverse waves in an elastic fluid were impossible, as they can only exist in solids. Fresnel introduced the idea that ether has the properties of a both liquid and solid at the same time, 'saving' ether theory.
What is the level of change here?

Task 9: (*About I .Grekova's story 'the Fracture' - J.M.*) Among the many I would like to highlight Dr. Chagin, he is outwardly surly, 'sharp', but with a delicate psyche and surprisingly noble. To oppose the appearance of the hero with his content, of course, is not the 'cutting edge' method. Nevertheless, the vivid description of the man is innovative (I cannot help myself but quote: "Chagin's two-story house, pretty, frowning, with a roof over the front door that looks very similar to its owner"). (А. Андрианов. Удары счастья. "Литературная газета" 7.10.87.)
What is the level of change here?

Task 10: To prevent fingers from sliding, the surface of the computer 'mouse' pad was made textured.
What is the level of change here?

Task 11: Before Faraday, magnetic properties were considered only relevant to solids. Faraday was the first to study the magnetic properties of liquids and gases, and discovered the magnetism of Earth's atmosphere.
What is the level of change here?

2.4. Development and consumption

Now the question is: which changes demand talent and ingenuity, and which changes require only relevant skills in that field?

The experience of working with students, and at seminars shows the majority of people quickly determine that talent is needed on the 5th, 4th and 3rd levels. The 1st and 2nd levels are 'craftwork' levels. This is not just a formal division. High-level changes have a different nature and a different mechanism than low-level changes.

Here is another reason why psychologists failed to find the nature of talent! They mostly studied low-level changes. They gave the subjects simple arithmetic or even everyday tasks, and reached profound conclusions. Such tasks like ‘guessing which lamp will light first’ or ‘multiply two two-digit numbers in your head’ do not have any relevance to creativity or talent.

We will only scrutinise high-level changes. This is where talented thinking lies.
However, before we proceed to the technology of talented thinking, let us try to answer the last of the preliminary questions. Almost every participant of our studies had this question.

Why, in the history of opera art Jacopo Peri is not mentioned anywhere and Claudio Monteverdi is considered as the father of opera? Why does the greatest popularity and title of talent, or even genius composer, generally go to those who have not made any serious contribution to the development of this kind of music? Why is Stringfellow never mentioned among the hundreds of talented aircraft designers? Why in the history of mechanics, and the list of brilliant physicists from the 18th century, is the name Emilie du Chatelet, who concluded the formula for kinetic energy of a falling body, mysteriously omitted? At the same time we know a number of physicists from those times who made no outstanding discoveries.

The reason is that the first and most important new views are generally incomprehensible to contemporaries. Besides, they are objectively bad. Peri’s operas were simply a series of couplets on motives, rather reminiscent of church hymns. The best Stringfellow airplane only flew for about ten metres.

It is no surprise. The authors of high-level changes do not yet know how to do it well. Nevertheless, they are showing the way. Their followers improve their discoveries and bring them to the level of consumer technology, science or art. The consumer gets used to these discoveries and they become a part of their life and outlook. Those discoveries and inventions become recognisable and whatever is familiar and recognisable is rather pleasant. It is natural that we label as ingenious those people who gave us these pleasant and recognisable things. The first daily life opera ‘Carmen’, by G. Bezet, was a failure. However, Gobatti, who lived around the same time, set a record worthy of entry to the Guinness Book of Records - he was called back for an encore 69 times. Now, his name is almost impossible to find even on the Internet.

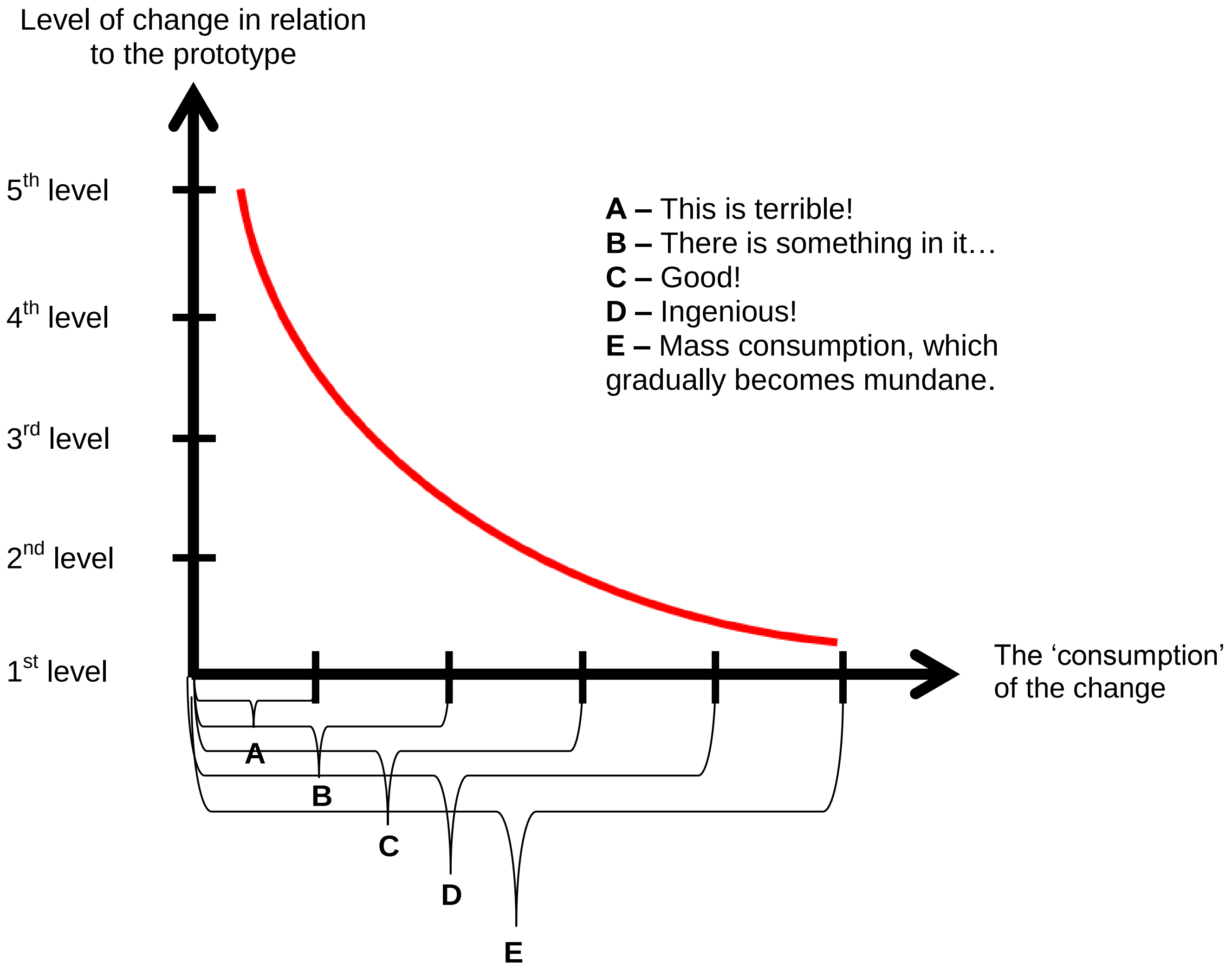
Who can name the writer who invented the technique of contrasting the appearance of the hero to his inner world? The name of this genius sunk into oblivion. Why then, do critics admire the cheap and worn out technique of I. Grekova, mentioned earlier? It is precisely because it is worn out and recognisable. It causes pleasant memories in the critic’s mind.

Peri’s operas had no analogues in contemporary popular culture while Monteverdi’s operas found such recognition and response. Peri’s name is not even mentioned in the majority of scientific papers on the history of opera.

Emilie du Chatelet’s story is even worse. In the 18^{th} century a woman by any means could not make a great discovery in science! It would be unthinkable or simply disgusting for the whole of European culture. This is the reason why male scientists in the 18^{th} century used her formula but were ashamed to name the author. In the 18^{th} century Emilie du Chatelet was simply forgotten.

It is this same reason why T. Edison is called the greatest inventor even though he hardly made a single qualitative new invention. The majority of his results are refinements of previously known technical systems. Moreover, he battled by all means some of the truly pioneering inventions of others.

If we built a diagram binding the level of change with its 'consumption', recognition and popularity, we see an interesting pattern. We describe the level of consumption as a reaction of the majority of consumers.



In music there is the 'pop' genre. Pop songs are primitive, singular, easily recognisable and, therefore, massively popular. One should not think that this phenomenon is only relative to songs. Such a genre also exists in other forms of arts. There is also popular technology, and popular science. Here are a couple of examples.

Example 23: Power line insulators were fixed with bronze couplings. However, bronze is a precious metal. Therefore, it was suggested that bronze couplings be replaced with ones made of cheap steel. This invention was patented by a team of authors, although it could have been done by a kindergarten graduate. It did not change anything in technology, in power transmission technology, or the construction of insulators or couplings. It is the first level of change – typical popular technology.

Example 24: Today, asteroids are monitored in large numbers. Dozens of small space "rocks" are discovered every year. The list of asteroids for 2008 totals 237,000. There are a number of observatories, laboratories and the Minor Planet Centre, which specialises in this field. Nevertheless, this does not affect astronomy in any way. It is typical popular science.

Example 25: In Russian literature of the 20th century there was a movement called the 'village prose'. These are almost identical novels and stories about the 'village'. Villagers were declared as bearers of the highest spirituality while townspeople were completely devoid of morals. This is popular literature.
Concepts evolve from the fifth to the first level. There are relatively few changes of the fifth level in the history of human culture. They demand powerful, talented, ingenious thinking, and a tremendous amount of courage. Changes of the fourth level also demand such ways of thinking but to a lesser degree. These changes occur within concepts formed at the fifth level. They require a fair amount of courage to put forward new ideas. The third level demands a minimum amount of talented thinking, and is also rather complicated, requiring some courage to adjust the concept of 'authorities'. For all that, changes of the second and the first levels do not require anything like that. Only several working skills and the execution of established rules, traditions, and norms are necessary. These are calm levels and they are more lucrative. This is why they are so popular in any environment.

We need to bear in mind that the lowest levels and the 'pop' phenomenon do not affect the development of culture. They only replicate what was created earlier. There is no need to fight against it. They will disappear, leaving no trace. However, their development was not possible without the higher levels.

Changes of the fifth level have another feature. They change not only their own area, but also human psyche and our perception of the world. For example, take the invention of the spear. Before the spear, the world of human action was limited to arm's length. Everything beyond was unreachable at any given moment. The spear made objects that were at its distance flight reachable. People who learned how to use a spear had to change their thought structure, their perceptions of distance, and ways of affecting their surroundings.

The invention of the airplane fundamentally changed the perception of distance, speed, and flight experience. It took weeks to sail to America from Europe while a flight is now only a matter of hours. The entire body is opposed to the flight experience but the airplane made flying possible and habitual.

On the other hand, changes of the lower levels take us back to the primitive concepts. Changes took place that made airplanes more comfortable and silent, flights smoother, provided services on-board, and passengers are no longer there to just experience the sensation of flight. Beverages are available at the touch of a button, and during the flight there may be no perceivable sensation of flying. Soft, reclining chairs promote sleep instead of the study of landmarks through the window. Travel has been reduced to the distance from the terminal to the airplane at the departure point and from the airplane to the terminal at the point of destination.

3. The Qualities of Talented Thinking

(The system of a talent's thinking process)

3.1. Identification system

The qualities of talented thinking referred to in this book are not kindled from a 'Divine Spark' or reach us from mysterious 'information fields'. Their identification was held and continues as follows:

A card index of talented solutions in various fields of culture – science, technology, art, social communication, etc. is being gathered, however, only solutions of the highest levels (3-5) are being collected.

Those solutions are then compared with previous solutions and with the previous conditions of the same system.

Then the most important thing: The identification of the thought process that was carried out to acquire the new solution from the previous one. Procedures that lead to solutions of the highest levels and are continuously used tens and hundreds of times in any field of culture, are the qualities of talented thinking.

Example 26: In the ancient world the causal connection between events was short. That is why it can be reflected on the stage during one 'scene' day. It is this reason why Aristotle formulated the rule of the 'unity of time' - the action in the play must take place in a single day. This rule formed the corresponding dramaturgic thinking. Nonetheless, in the Middle Ages the length of events had increased. Playwright Lope de Vega (1562-1635) was the first who broke the 'unity of time'. In his plays, the action could last for several days.

Example 27: Christianity began with one of the heresies of Judaism, which argued that already this generation will face the end of the world. The so-called relevant eschatology appeared. Time passed, one generation replaced another, but there was no end of the world. How to explain such a deviation from the prophecies?
Theologians have found a solution: there will be the end of the world but in the future. Meaning, they have passed from the current eschatology to the postponed eschatology.

Example 28: Mitochondria are a part of the cells of living organisms. They are the 'power stations' of the cell. The structure of mitochondria is very similar to bacteria – it has its own membrane, its own internal structure and even its own mitochondrial DNA. One hypothesis was that mitochondria are independent bacteria captured by the cell of a living organism, which lives in symbiosis with it. However, mitochondria isolated from a cell, dies. It is not an independent organism. How to explain this contradiction?
It has been hypothesised that many millions of years ago mitochondria were independent bacteria, yet they evolved over time and became unsustainable in independently of the cell.

Example 29: Various devices often need to be attached to concrete columns that support the roof of the guild. For this purpose a tilted hole is drilled in the column. Then a metal rod is inserted into the drilled hole. Following this, the required object is then hung on or welded to the rod. However, drilling concrete takes a lot of power and time. How to facilitate and accelerate the process of attaching objects to the columns?

It was proposed in advance that during the column manufacturing process, sloped plastic tubes should be inserted in the form and then the form filled with concrete. When the concrete hardens, the resulting columns have premade holes.

Let's look at the four examples in the following sequence: ‘used to be - changed - a problem aroused – became’. And try to determine how did it ‘become’.

1. In the ancient world, events were not perceived in the same way as they are now. The thought process was not accustomed to multi-step combinations. That is why events were perceived as a consequence of the closest previous events. If a goat was bred, there would be milk and meat. That is understandable. However, the fact that huge herds of goats in Greece were destroying the soil with their sharp hooves, resulting in crop yields declining, was too complex a conclusion and the Greeks were ‘not yet ripe’ for it. It is for this reason it was easier for them to explain the crop yield fall as anger of the gods. Such single-cut event perception had its impact on dramaturgy. All the events of the play took place in one stroke, during one scene-day.

In modern times thinking has changed dramatically. The study of nature and political and economic intrigues led to certain habits of comprehending multi-step combinations. The consequence could already be the result of the chain of causes. This chain was stretched out for several days. Nevertheless, dramaturgy could not reflect that on stage, being bound by the rules of ‘unity of time’. A serious dramaturgic problem had arisen.

The solution to the above mentioned problem was in ‘stretching out’ the plot time. It started to last for several days.

2. At the end of the 1st century BC the Roman Empire was experiencing a serious economic, political, and cultural crisis. It was especially noticeable in the outskirts of the empire, in places such as Judea. Note also that the Roman Empire meant the world to its citizens. Therefore, the end of the empire (such a feeling these days also accompanies a major crisis) was seen as the end of the world. The Judah sect appeared, predicting the end of the world in the near future, during the life of the present generation. (These days, among people with a fragile psyche, crises are accompanied by episodes of ‘end of the world’ syndrome.)

The ideas of those sects became popular. Gradually a new religion appeared. However, after one generation passed, then a couple of generations, the crisis was long over but the end of the world did not come. A serious theological problem had arisen.

The solution to the problem was in the ‘stretching out’ of religious time. There will come the end of the world but not during this generation. Later. We do not know when but it will happen.

3. In the middle of the 20th century there was a boom in the study of living cells. Among other discoveries, there were successes in understanding the structure and functioning of mitochondria. It appeared that mitochondria were surprisingly reminiscent of bacterial cells. They even have their own DNA, different from the DNA of the cell where the mitochondria is situated. It has been suggested that mitochondria is a bacterium that lives in symbiosis with the cell.

However, during the studies, it became clear that mitochondria have major differences from bacteria and that they are unsustainable in isolation from the cell. A serious scientific problem had arisen.

The solution was in ‘stretching out’ biologists time representation. Once, at the dawn of life on Earth, mitochondria were independent bacteria. Then it symbiotically merged with another cell type. Later, it changed and adapted to a new way of life, and lost its independence.

4. In any production department there is always a need to fix something to a wall or a column. There is a long developed standard behaviour in such cases – to quickly drill a hole and insert something in it, and then attach the necessary object to that ‘something’.

However, as the load on columns continued growing it prompted the need for new and especially rugged construction materials and concrete. Such materials cannot be drilled in five minutes. Moreover, there is no time for drilling all day long. A serious technical problem had arisen.

It was solved by the ‘stretching out’ of technical time. Not only for today’s column but also its past – the process of manufacturing – the pouring of liquid concrete into a form, was included in its scrutiny. This ‘liquid state’ of the column was then used to prepare the holes.

I presume it is obvious that all four solutions were achieved by using the same procedure – by introducing the time category, by ‘stretching’ it out, by using longer periods of time – from several days to billions of years.

Dozens, even hundreds of examples later – we start to realise that this is one of the representation conversion procedures. It consistently brings powerful and talented results. It has its own features and internal mechanisms. Those mechanisms can be mastered. We shall return to this later.

There are 18 such procedures – the ‘qualities of talented thinking’, known today. The most important thing is that these qualities are not singular or independent. They form a system of thinking that can only be called talented or ingenious.

I would like to draw your attention to yet another corollary of our examples. Talented ideas did not come from a divine spark or from outer space. They have always been a solution to a problem. The problem is created not by conspirators, bureaucrats or other types of people who make our life harder, but by a subjective development of the situation.

Let us take a look at these 18 qualities of talented thinking that we must learn. They can be divided into two groups: basic and additional qualities. Basic qualities are combinations of cognitive procedures, the use of which leads to talented results – discoveries, inventions in science and technology, new social concepts, etc. Additional qualities are the ones that help to use and develop basic qualities.

3.2. The matrix of talent

Here is the list of the talented thinking qualities identified to date.

Basic qualities:

1. **The ability to see the systemic character of objects and phenomenon (systemic thinking).**
2. **The ability to resolve contradictions.**
3. **The ability to build a generalised model.**
4. **The ability to outline the single model of a scrutinised object or phenomenon. The ability to see the hierarchical and temporal boundaries of object properties.**
5. **The ability to not relate a fact to a certain model.**
6. **The ability to overcome and change the hypermodel.**
7. **The ability to get into supersystems of concepts.**
8. **The ability to identify the absolute model of the phenomenon, and then abandon it.**
9. **The ability to move from the consideration of one object to the consideration of groups and sets of objects.**
10. **The ability to operate multiple parameters simultaneously. The ability to switch from one-parameter to multi-parameter system.**
11. **The ability to increase or decrease any of the parameters of objects and phenomena without limit.**
12. **The ability to deploy the time view. The ability to see the processes, not just events and conditions.**
13. **The ability to move from consideration of ontogeny to phylogeny.**

Additional qualities:

14. **The ability to control the associative imagination.[4] The ability to build and develop analogies.**
15. **The ability to come up with new terminology.**
16. **The ability to process large amounts of information.**
17. **The ability to see the flaws of the built model.**
18. **Courageous thinking.**

The qualities of talented thinking appear (in those cases when they do appear!) not simultaneously, but in sequence. This sequence is similar to the historical sequence of the appearance of these qualities in humanity. These qualities can be taught only at a certain age. A 3-4 year old child can be taught the basics of generalisation. However, operating in time cannot be taught at that age, no matter how ingenious the child's ancestors were. Small children do not have any perception of time. It is not yet accumulated in their personal experience. They can hardly become familiar with their personal time, not to mention historical time or universal time.

We will take a closer look at two of the qualities of talented thinking - systemic thinking and the ability to operate the associative imagination.

[4] The term 'associative imagination' was offered by N.V. Rubina.

4. Systemic thinking

(The structure and basic principles of talented thinking)

4.1. The history of systemacity

The qualities of talented thinking can be compared with areas on a map. In one area there is a plain and the map shows you the best crossing point and resting place. The other location has mountains and the map shows us the passes. The third area has a river and the map shows us the best place to cross it.

Nevertheless, in order to understand all this, it is necessary to know the general mapping principles.

Therefore, we start with the general principles that all these qualities comply with. These principles form so-called 'systemic thinking'.

Systemic thinking of humanity gradually formed throughout the history of human culture. It continues to take shape now. The first, separate fragments of systemic thinking were formulated in ancient times by Plato, Theophrastus, Democritus and other philosophers. They drew attention to generalisation and laid some of the foundations for hierarchical representations.

Example 30: Plato put forward the idea that there is some general concept of object types. He contrasted it to each object individually. For example, there are certain apples – all of them are different. However, there is a collective apple. Plato considered certain objects as the 'shadows' of the generalised object. According to Plato, the difference between a wise man and a fool is in the ability to see generalised objects.

Example 31: Theophrastus established the first plant classification. He divided them into two groups: trees-bushes and shrubs-grasses. Trees-bushes were also divided into deciduous and coniferous.

In medieval times the hierarchical representation continued to develop.

Example 32: Cesalpino created a classification in which plants were divided into two sections, each of which was divided into fifteen classes.

In modern and contemporary history the category of time entered talented thinking.

Example 33: Georges Cuvier proposed the theory of catastrophes, which states that there used to be other plants and animals. There was a global disaster, everything was lost and then replaced by other plants and animals. Cuvier's followers increased the number of catastrophes to a few dozen.

The basis of systemic thinking is the concept of the system. There are many definitions of the word 'system'. They are written in heavyweight 'scientific' language. Here is one of the 'scientific' definitions: *The system is a set of elements whose properties are irreducible to the sum of the properties of the elements.*

Modern systemic thinking includes three principles:

1. The principle of hierarchy.
2. The principle of evolution.
3. The principle of emergence.

Let us take a closer look at them.

4.2. The principle of hierarchy

Take a simple wooden chair. It is composed of easily distinguished parts – seat, back, and legs. The more complicated question is – why do we need a chair, and what is its function? Usually, students and seminar participants immediately answer – to sit! On the other hand, sitting is the action of a man, not the chair, so what does the chair do?

The next typical answer is – the chair is standing. Such a response always makes the audience laugh. Everybody understands that there is something wrong, but what exactly? It makes me ask the following question: “I am also standing. Am I a chair?”

Gradually, the function of a chair is figured out – to keep a man sitting in a comfortable position.

Example 34: What is the function of a guitar? No, not to play, the guitarist is playing. The function of a guitar is to make certain sounds when strumming the stings. The musician himself organises those sounds.

Example 35: What is the function of the $E = mc^2$ formula? To clearly demonstrate the interdependence of the total energy of the body and its mass.

Example 36: What is the function of D'Artagnan? If we look at him as a literary character, his function is to be an example of a positive romantic protagonist.

Now let us take a closer look. Does the chair seat on its own entirely fulfil the function of a chair? You can sit on it, of course. Doubtfully comfortable though. What about the back of a chair? Even worse. Or the legs? The audience always laughs at this point, and there is no need to continue.

Thus, no parts of a chair, taken individually, perform the desired function, but the whole chair does. This explains better than any definition, that a chair is **a system**.

In the system a new quality, a new feature is given by the structure of the system, not by the parts. We can change the construction of chair legs, back and the seat; however, it will not change its function. Nevertheless, if we build a chair from the same parts but put them in different places (for example, attaching the back under the seat, and legs pointing in different directions), there will be no chair on which you can sit comfortably.

What is a house made of? Walls, a roof and a foundation? Now we understand that it is not exactly like that. The position of these parts is important. If we build a house, a car or a computer in the wrong order, there will be just a pile of useless rubbish.

Parts of the **system** are called **subsystems**. So, now we know one important feature of systems. They consist of subsystems, structured in a specific way. This exact structure allows the system to perform its function.

Example 37: A book consists of the following **subsystems**:

- cover
- spine
- pages (more precisely, the book block)

- sometimes a dust cover

Example 38: A river consists of the following **subsystems**:
- water
- bed
- banks

These can also be considered:
- source
- upstream
- midstream
- downstream
- estuary

Example 39: A plate consists of the following **subsystems**:
- base
- rim
- surface

In fact, each subsystem also consists of something. If we consider the back of a chair as an independent system, it turns out that it consists of, for example, layers of plywood. Those layers had been put in a certain order, so the fibres of one layer are placed across the fibres of the other. These layers will be **subsystems** of the back of a chair, and in relation to the whole chair, they will be **sub-subsystems**.

Example 40: A book page consists of a paper sheet and the characters printed on it.

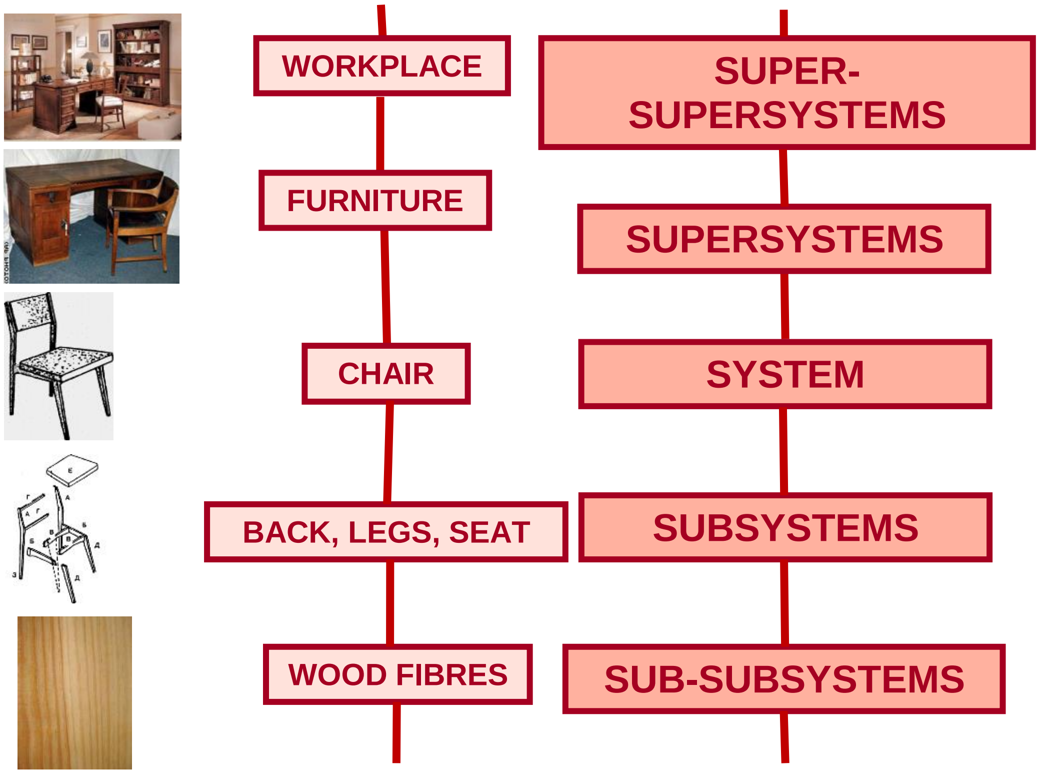
Example 41: River water consists of water (H_2O), dissolved substances (natural minerals, substances of industrial and domestic origin) and substances suspended in it (mud, sand, and other fine insoluble substances).

Example 42: the bottom of a plate consists of the disc and the collar-stand at the bottom of the disc.

It can be looked at from another point of view. Let us formulate the situation this way - ‘the chair back is one of its parts’, not vice versa - ‘a chair consists of parts, including its back’. That is, we will consider the chair from a position of the back, instead of considering the back from the position of a chair. Then the chair will be the **supersystem** of its back, and the back of the chair will be **supersystem** for the layers of plywood.

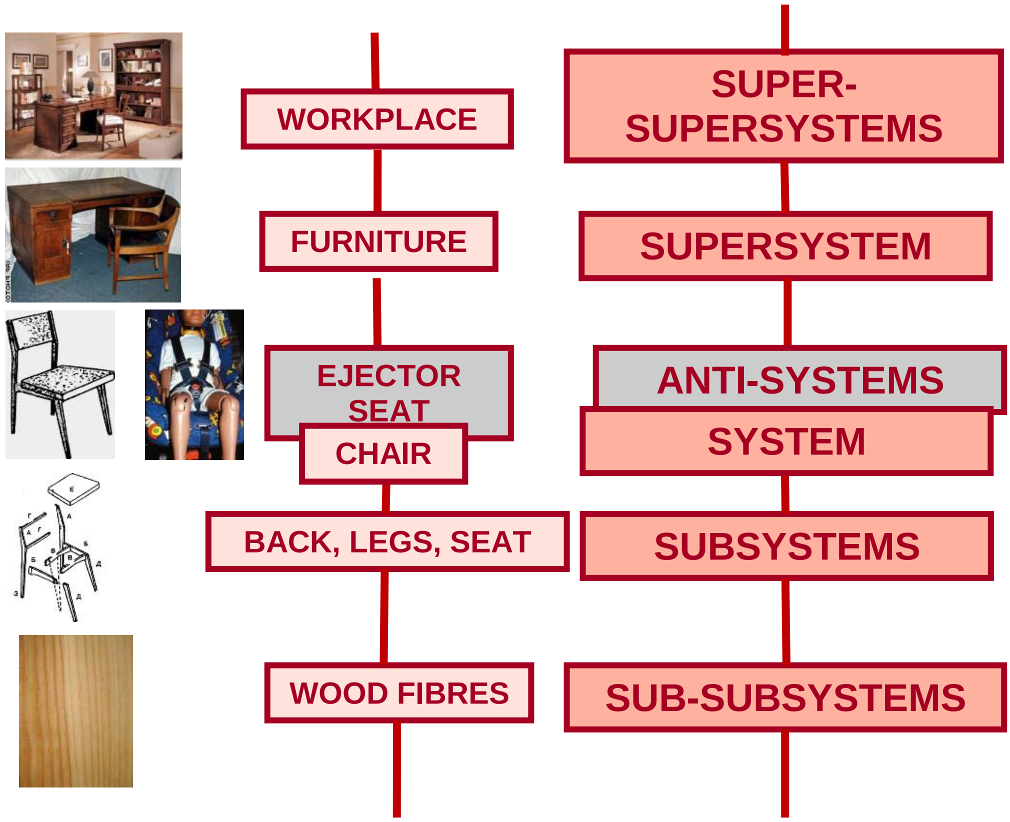
This is the **hierarchy of systems**. It is infinite in both directions. The layers of plywood consist of wood fibres, and wood fibres consist of cells. The chair is a part of a more complex system – a working place, a set of dining room furniture or any row of chairs in auditorium.

All these floors of system hierarchy are called the system ranks. On each rank, systems have their own functions. If the whole chair is supporting the whole person who is sitting on it, the back of the chair is only supporting the back of that person. The legs are not supporting the person at all, and the seat does only at a certain height.



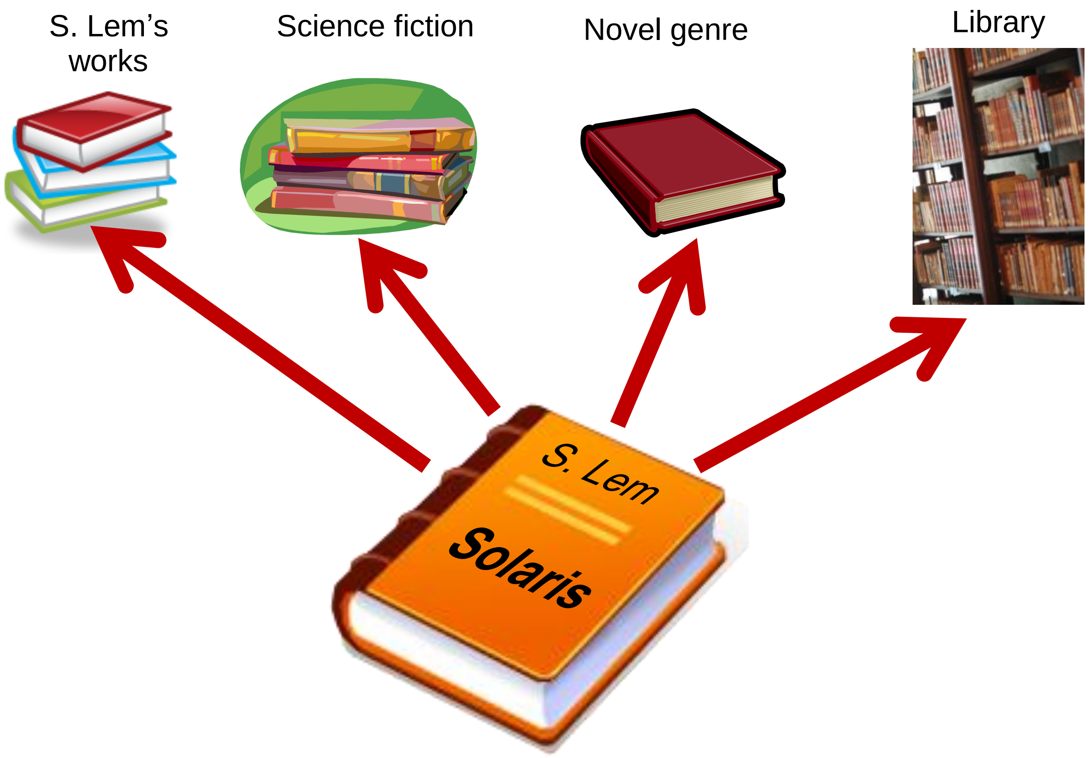
That is the facade of a system hierarchy. Apart from the facade, there is another side. In addition to function you can imagine anti-function as well. For example, for a chair it will be not the support, but vice versa – throwing the seated person. There is such system as well. It is called the Ejector seat and ejects a pilot from a plane in an emergency.

Such systems that perform the opposite function are called anti-systems. They also form their own hierarchy.

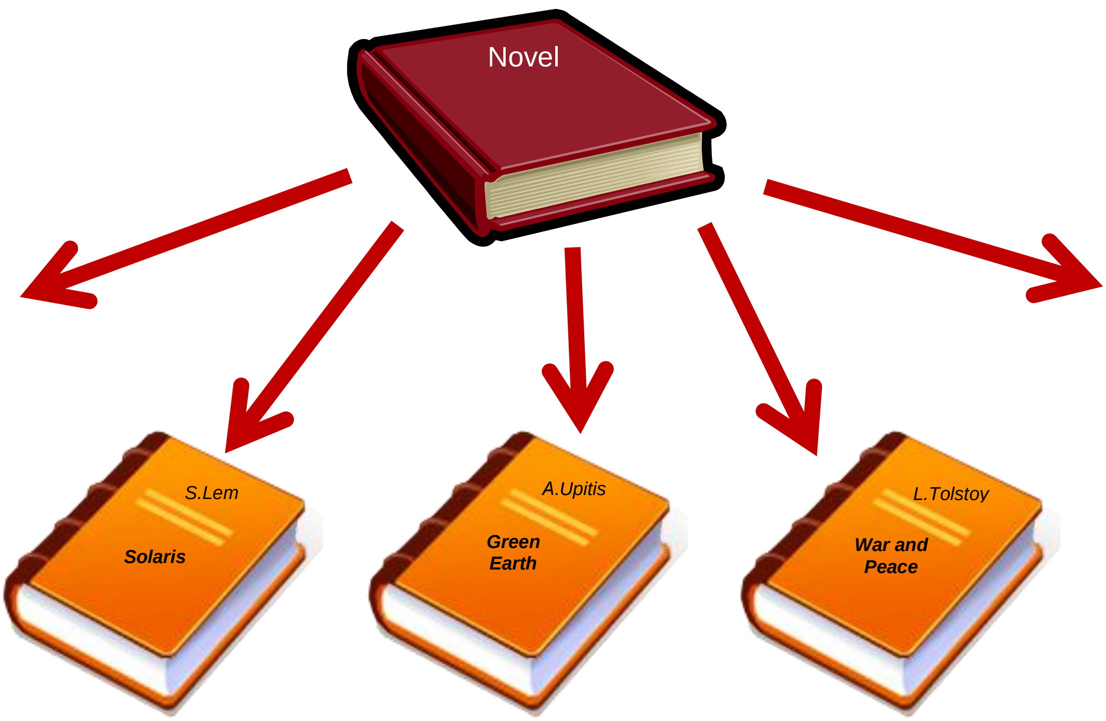


4.2.1. Branched systems

System hierarchies have one important feature. They are constantly branching in all directions. Take, for example, the book 'Solaris' from the great science fiction writer Stanislaw Lem. This is not the only book in the Universe. It can be a part of dozens or hundreds of different supersystems. It is a part of 'all S. Lem's works', 'science fiction genre', 'novel as a type of literature' and simply part of a library. These supersystems already exist. However, we can add our own new supersystems, where the present book will be a part of their subsystems. It can be in a group of sand-coloured books (I have precisely this publication). It could be part of a collection of works that start with the letter 'S' or even a saucer, if we use this book as a tea stand, so that the hot cup does not ruin the polished table.



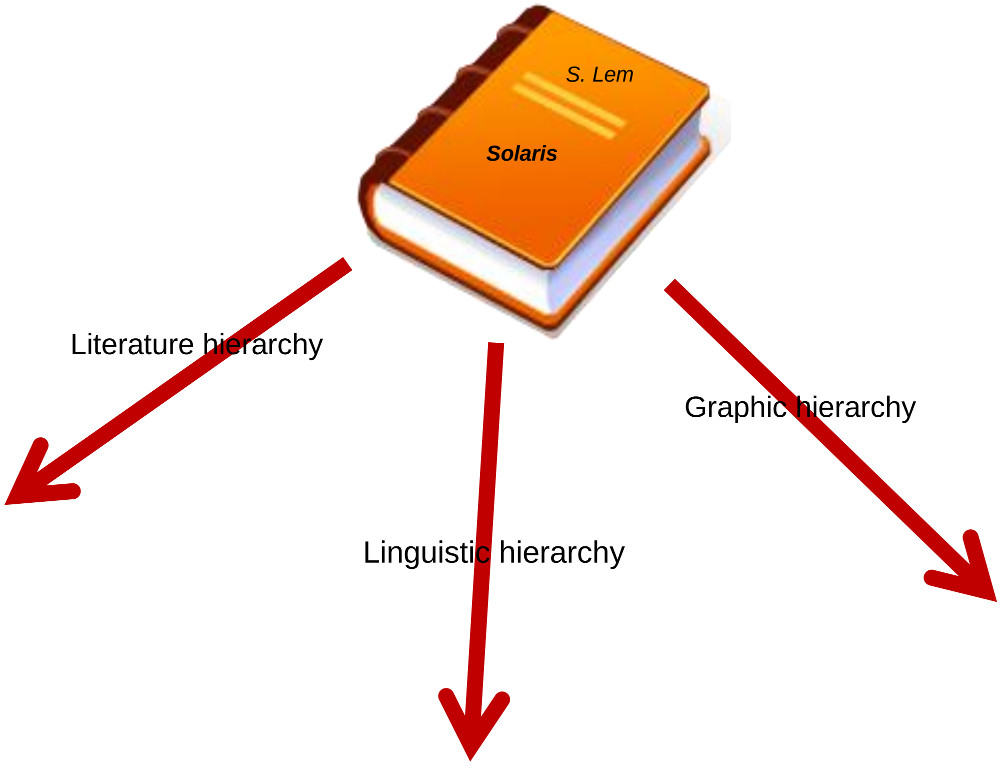
Nevertheless, each of these named and unnamed supersystems do not consist of only this book. For example 'novel' – it consists of millions of novels, written during the whole history of humanity. Here we have 'War and Peace' by L. Tolstoy, 'Green Earth' by A. Upitis and 'Solaris'. They are branches of one supersystem.



The chosen book can also be 'branched' to its subsystems. Once again they will have completely different directions. If we consider this book as a literary work, it consists of a number of storylines – Kris Kelvin's, Sartorius's, Snow's and even Gibarian's. His small storyline is formal, as he committed suicide a few hours before the start of the plot in the novel. Of course, we can't not mention the storyline of the most intelligent ocean Solaris and its creations – Kelvin's wife Rheya, who died long before the described events. Moreover, each storyline consists of episodes. Etc.

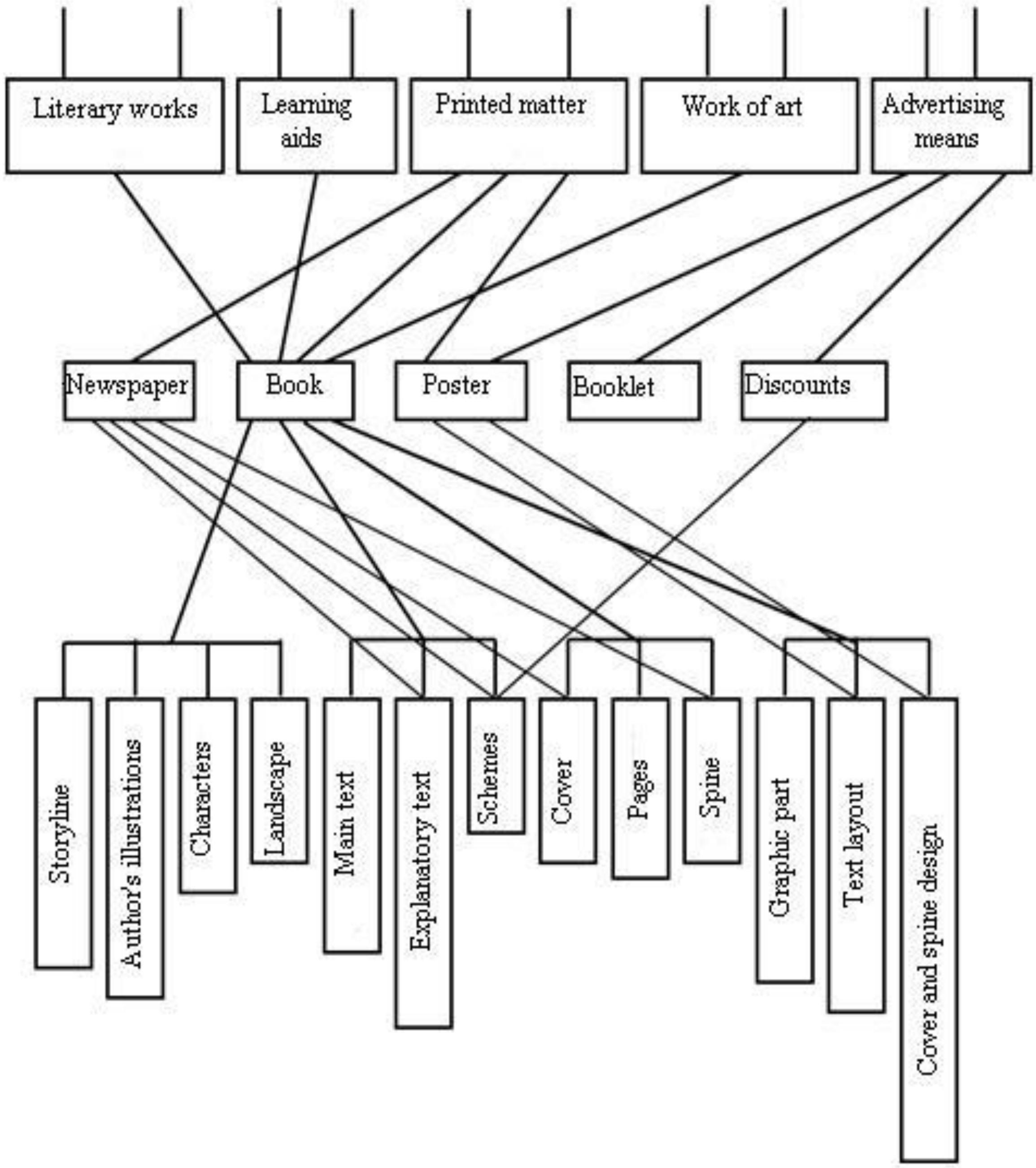
If we consider this book as a linguistic system, we need to divide it into semantic fragments, which are divided into phrases, clauses, words, syllables and letters (if we consider the written version rather than oral). Etc.

Furthermore, the book is also a graphic system. As we have already seen, it consists of the spine, cover and pages (more precisely, the 'book block', which in turn consists of pages). Etc.



That is, the division of the system into subsystems directly depends on where in the supersystem we consider this system.

In this case, the same subsystem can be shared by multiple lines of consideration. These lines cross and branch, forming a continuous field of systems. Here is a fragment of a branched scheme for a book, which was composed by V. Gerkena. It is only a fragment, as the whole scheme would require a separate book.



Our world, our entire Universe (and perhaps not only ours) is a densely filled field of systems. If we can see this field, this solid interlocking system in a broader, denser and more detailed way, our thinking becomes more talented.

Example 43: In 1866, a chemist named Crookes hypothesised that the inaccurate atomic mass of a number of elements can be explained by the fact that the item is actually made of modifications of the same substance. The atomic mass of those modifications differs. For example, the atomic mass of chlorine is 35.5 atomic mass units (amu). In fact, chlorine has two types of atoms - with a mass of 35 and 37 amu (they are called chlorine-35 and chlorine-37). If we take many chlorine atoms, chlorine-35 will be 75.5% of those atoms, and chlorine-37 – 24.5%. That is why the average atom mass of chlorine is 35.5 amu.
A number of observations testified that Crookes' hypothesis may be true. However, the greatest chemists could not distinguish these modifications for a long time.
How to prove Crookes' hypothesis by distinguishing these modifications?
The solution was found on a **supersystems** level. It is natural that **chemists** were looking for **chemical** methods to distinguish those modifications. Besides **chemical**, there are other

methods, including **physical** ones. They were applied after half a century, and as a result J.J. Thomson discovered isotopes in full compliance with the Crookes hypothesis.

Example 44: According to the Watson-Crick Model, the double helix of the DNA molecule is twisted to the left. A. Rich, in his turn, when studying DNA under x-rays, discovered that the helix is twisted to the right. Both conclusions are justified by observations.
What does DNA look like?
The solution was found on a **subsystems** rank.
Rich has put forward the hypothesis that the fragments of DNA are twisted both right and left. Subsequent studies have confirmed this hypothesis.

Example 45: Why do people see?
Pythagoras, Plato, Euclid, Hipparchus, Ptolemy and others thought human eyes emanate eye rays, which enable a person to see.
Then one must be able to see in the dark but that does not happen.
How then, do we see?
The solution was found in the **anti-system**.
In the 11th century, an Arabic optician named Alhazen hypothesised that light rays reflect from objects and then enter the human eye.

The practice of teaching systemic thinking to students and seminar participants shows that anyone can learn the principle of hierarchy. To do that you need to overcome erroneous previous concepts that are rooted in our culture.

4.2.2. Exercises

Let us take the following objects:

- a clock
- a mountain
- a train
- a film
- an apartment
- a sunset
- a country
- a traffic light
- an apple
- a play character

Exercise 1: Design a hierarchy of subsystems of these objects - two or three ranks.

For example, the original system is a simple ballpoint pen.

The first rank of its subsystems: the body, the ink cartridge, and the mechanism for pushing out the cartridge.
The second rank. The body can be divided into upper and lower parts, a cap and a clip, which can be attached to the pocket. The cartridge consists of a cylinder, a ballpoint mechanism, and ink. The mechanism for pushing out the cartridge consists of a button, ratchet, and spring.
The third rank. Lower body part consists of the main and threaded parts. The ballpoint mechanism consists of a wide part, which is inserted into the cartridge, as well as of the narrow part, where the ball is placed, and the ball itself. The cylinder consists of a main tube and lugs that hold the spring. The ratchet consists of a part with teeth and a rotary part.

Exercise 2: For the above mentioned objects please design and name as many supersystems as possible, in which the specified object is included as an integral part.

For example, the ballpoint pen is a part of:
- pens in general (as a type of a pen)
- a set of office supplies lying on the table (or in the bag)
- elongated objects
- the contents of the pocket
- plastic products, etc.

Exercise 3: For the above mentioned objects please name as many qualities or functions for that object as possible, and then suggest the anti-system for each quality or function.

For example, the qualities of a ballpoint pen:
- long (anti-system – something short, e.g. a coin)
- fragile (solid, e.g. a stone)
- light (heavy, e.g. an elephant)
- ink (transparent, e.g. water), etc.

The functions of a ballpoint pen:
- to leave marks on paper (to erase marks, e.g. an eraser)
- to pierce soft objects (to strengthen soft objects, e.g. glue)
- to scratch head (to cause itching, e.g. a flea), etc.

Exercise 4: For the above mentioned objects please name several different subsystem hierarchies, depending on the supersystem, in which you consider that object.

For example,
- in the 'pens in general' supersystem, our scrutinised pen consists of the body, the cartridge and a mechanism for pushing out the cartridge.
- in the 'contents of pocket' supersystem, this pen consists of the body and the clip.
- in the 'plastic products' supersystem, this pen consists of several parts of plastic
- and so on

Exercise 5: Please design this hierarchy, branched to both directions for a randomly selected object.

4.2.3. The designers of supersystems

It may seem that the hierarchy of systems is an original given structure. The Earth is a part of the Solar system supersystem, and nothing can be done about it.

That is not true. Supersystems do not simply 'exist', they either appear or are created. In the 'unconscious' nature they arise.

Example 46: About 1.2 billion years ago, life on Earth was represented by very complex, yet single-celled creatures. Then they began to coalesce. It is still hard to say what made them take such a step but the existence of multicellular organisms (including us) is sufficient proof that they did. The first known multicellular organisms are called 'Ediacaran biota'. They looked like a drop-shaped substance, similar to a bag filled with cell mush. There are also known intermediate stages of this transition. These are the cell colonies (the cells are still independent

but already held together) and Volvox (more congested union of cells, in which they already slightly depend on each other and interact).
When a human comes into play, the transition to a supersystem becomes conscious and constructive. In artificial systems, supersystems are being created.

The chair did not exist and could not exist before Homo sapiens combined the legs, the seat and the back. A supersystem of details has been created, which is known as a chair.

Example 47: In actual fact, a film is a combination of photographs showing different phases of movement. The combination is artificial. There are also known intermediate stages of this combination. There are some drawings on ancient Greek amphora, depicting the phases of a dance. If you rotate this amphora, the painted figures begin to 'dance'. Praxinoscopes (zoetropes with mirrors) were popular in the 19th century. They are similar to the big spinning tops, on which phases of movement are drawn - a galloping horse, a girl with a rope, etc. You can see praxinoscopes in the following videos:
http://www.youtube.com/watch?v=Ez_UJAafRMs
http://www.youtube.com/watch?v=WsI6PNR_Eg0&feature=related

Example 48: The ordinary pencil, to which we are all accustomed to, began as silver or lead sticks, which left a weak gray mark on paper. Such sticks have been known since the 13th century. After the first graphite deposits were discovered in England in the 16th century, sticks for writing and drawing started to be made from it. On the other hand, graphite heavily soiled hands. That is why artists started wrapping graphite rods with paper or string. Later, this wrapping was replaced with a wooden body. The first evidence of such pencil is in 1683. That is, a pencil is a combination of a drawing stick and a wooden body.

At first, it may seem very easy to combine two or several known elements into a new supersystem. Note that drawing sticks were known since the 13th century and wooden handles since times immemorial, however, these objects only got combined in the late 17th century. Four hundred years is the price of that simplicity.

Such artificial combination of systems into previously non-existent supersystems is also an element of talented thinking.

4.2.4. Tasks and exercises

Exercise 6: What artificial combinations of a pencil with other objects and systems can you name? What new features compared with the pencil are given by that combination?

Exercise 7: Invent new, not yet existing supersystems of a pencil. What can you combine it with? What will be the benefits of the new supersystem?

Exercise 8: You will be given randomly matched pairs of objects from nature or culture. Think of the way they can be combined. What application variants of the combined object can you offer?

Task 12: In early human settlements houses were built haphazardly. Gradually, people started to realise that it is more convenient to build houses according to a general plan; houses were combined into towns and cities. What new features were offered by this combination?

Task 13: The origin of a new plant is given by the combination of parental plant genes through pollination. The origin of a new organism (including human organisms) is given by the combination of the parents' genes. What new positive features and benefits are given by this combination?

Task 14: Combining music and poetry gave some new genres and types of art - songs, cantatas, operas ... Combining painting and theatre gave scenery and set design arts. What types of arts have not been combined yet? Suggest such combinations. What new expressive possibilities can be offered by these combinations?

4.3. Principles of evolution

The wooden chair, which has helped in the analysis of system hierarchy, was not always a chair. Before that it was a board, and before being a board it was a log. A log was a tree.

However, sooner or later our chair will become refuse. After that, depending on the situation, it may turn into splinters, and then into paper, or maybe it will be fuel for a fireplace or a stove. It is also possible that it will serve as food for bacteria somewhere in a landfill. Either way, a chair will not always be a chair.

Systems live in time. They have a past (recent, distant, God knows when), a future (near, distant, God knows when) and a present (which we love to declare eternal).

Example 49: A book begins with the author's idea. It then becomes a draft, and finally a completed manuscript. After this it moves to the printing supersystem and becomes a layout and then finally it turns into a book. Later, the book finds (or does not find) its reader, who reads (or does not read) it. After some time the book turns into waste paper and goes through recycling, or becomes food for bacteria.

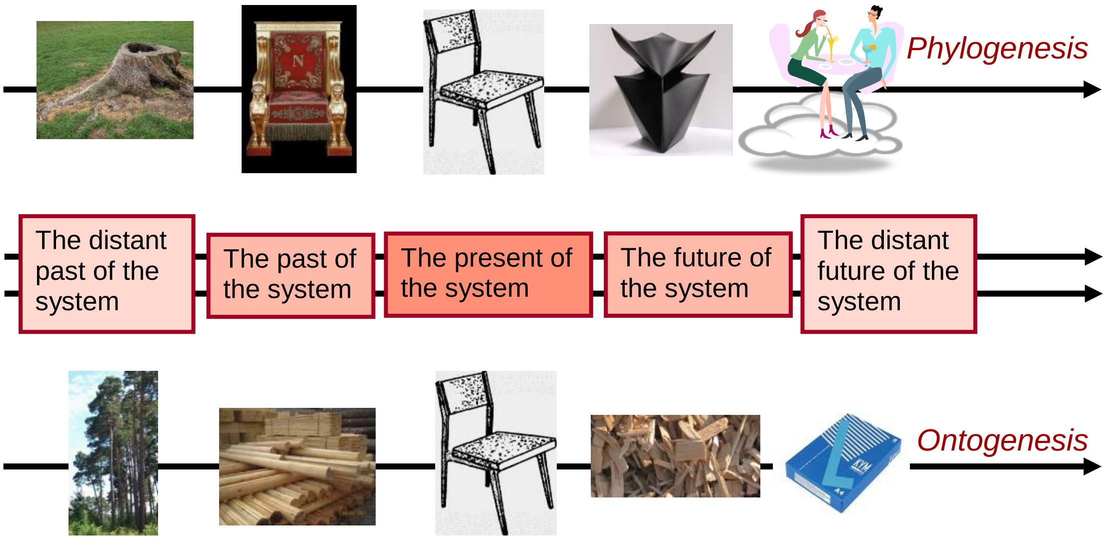
Example 50: A river starts in the sky. As precipitation, water seeps into the ground. However, even without precipitation, groundwater is sufficiently enough. In some places groundwater comes to the surface to form a stream and then, by consuming confluents and underground springs, it becomes a river, expanding, flowing around obstacles. It gouges out a river bed, freezes in winter, floods from melting ice, dries up in summer (floods in some places due to rains, does not freeze or dry up) and then finally flows into another river, lake, sea or ocean.

Example 51: A plate begins with clay. An appropriate type of clay is extracted from deposits and is then mixed with other substances, formed, fired, painted, coated with a protective or decorative layer and sold to consumers. A plate serves for storing food, as a stand for a flower pot, as an argument in marital conflicts, etc. Sooner or later it gets broken and finds its way to a landfill, where it slowly decomposes.

At first glance everything is simple, but only at first glance. Even to the simplest question - what is the chair's history? - often receives two completely different answers. The first answer we know already – a tree. However, some people say: fancy chairs of the 18th century, and before them - medieval benches, stones, stumps and even tree branches.

This answer also seems logical. Which answer is the right one?

Both are, as usual. The case is that every system lives as if in two times. There is the time of a single system and the time of all types of the present systems. The development of one system is called **ontogenesis**, and the development of a type – **phylogenesis**. Meaning, every system lives in both ontogeny and phylogeny times. 'Tree → chair → wreckage' is ontogenesis. 'Stump → bench → chair' is phylogenesis.



Example 52: Take the phylogenesis of a book. Stories of various aoidos, storytellers, akyns, etc, - is something like an ancient oral book. After, information began to be carved in stones. Later there was a switch to lighter media - papyrus, parchment, wax, or clay tablets. Bound books appeared together with the invention of paper. Now books are increasingly moving towards electronic media.

Example 53: According to one of the most common hypotheses, in the history of Earth there was quite a long period when there were no rivers at all. There was just a stone sphere – the planet. Water appeared as a result of volcanic activity. It gradually covered the whole planet with a small primordial ocean. Geological processes then led to the formation of land when water courses appeared on the surface. Rivers started to evolve due to the changes of the Earth's surface and the climate. Then intelligent life entered the stage and led to artificial changes in river system – dams, pipelines, artificial water reservoirs, etc. This is river phylogenesis.

Example 54: It seems that the first dish was cupped hands. Then came the use of dried fruit and animal skulls. There are also preserved samples of dishes carved out of wood. Functionally, these were mostly bowls, not plates. Much later came ceramics – baked clay ware. At this point, the plate was separated from the bowl and got its modern shape. These days, plates are made not just from baked clay, but also from glass, plastic and cardboard. Plates become narrow-functioned – soup ('deep') plates, small plates and saucers of different sizes and shapes. This is plate phylogenesis.

Once again we are confronted with a need to consider the system from the standpoint of various supersystems. We have just described the phylogenesis of a book; however, it was a 'graphic' book. The phylogenesis of a 'literary' book is another story. In the history of literature the nature and functions of characters, plot structures were changing. Second, third, tenth storylines appeared and temporal rearrangements were introduced. More details and events were not described by the author and left to the reader's imagination. Homer devoted a whole chapter to a description of the appearance and history of Achilles' bow. Now he would simply write: 'Achilles shot an arrow from a bow'. The modern reader could imagine the rest themselves.

It seems that a dense system field is applied to time as well. However, over time this field is constantly changing. Some systems disappear, some of them appear. Remote systems start to interact and the nearest suddenly lose contact with each other. Systems flow into each other,

exchanging parts. Moreover, this is all happening within two times at once. Although in some cases we have to consider more timelines.
Nevertheless, this seeming chaos of system transformations has its own order. If you noticed, I purposely did not say ‘the past of the system was’, ‘the future of the system will be’. I used the present tense ‘the past is’, ‘the future is’. This is not a mistake. The matter is that systems change according to certain laws. In this sense, the past and the future of systems is predetermined as **laws of structure change**. However, not in details, of course, as it is difficult to predict the details.

All failures of futurists and other forecasters, all the short-lived inventions, hypotheses and works of art arise from not knowing these laws. The one who accidentally guesses the next step in these laws is traditionally called talented and ingenious.

By the way, this is another reason why brain and individual psychology learners will never find the mechanism of ingenuity. What mechanism can exist in chaotic guessing? Throughout the history of human culture, each next step in its development was guessed, not found. Despite the fact that this fortune-telling was called the ‘trial-and-error method’, its nature has not changed, fortune-telling remains fortune-telling.

The situation had changed after G.S. Altschuller’s works. Researching technical inventions, he discovered that their sequence is not accidental. Technology develops according to immanent laws, beyond the control of human will. Altschuller identified the system of these laws, originated principles and methods of their conscious use (not guessing!) for the development of forthcoming inventions of higher levels.

Later Altschuller’s followers and disciples discovered that any systems, both natural and artificial, i.e. generated by culture, are subject to the same laws. Science, art, economics, etc. – all of them develop according to the same laws, regardless of our wishes or manipulation from economists, engineers, artists, politicians, etc.

This is a real opportunity to train our thinking so that we are able to recognise and use these laws.

4.3.1. Training tasks

In the first group of tasks you will be given the ontogenic process. You will need to name the relevant phylogenic process. Let us analyse one example.

Task 16: The weather is always changing. Name the appropriate phylogeny process**.**

The solution: Weather is one object, but all weather of a sufficiently large region in a substantial period of time forms the climate. Historical climate change is a phylogenic process with respect to the weather.

Task 17: Educational school curricula vary from first class to last.

Task 18: A child’s conceptualisation changes from infancy to adolescence.

Task 19: The process of building a house.

Task 20: The process of decorating a house.

Task 21: The process of writing a book.

Task 22: The process of publishing a book.

Task 23: Biogeocoenosis is a region in which all biological and geological objects interact, forming an independent equilibrium system. One book states that: 'Biogeocoenosis does not have a phylogenesis'. What do you think? What is the phylogenesis of biogeocoenosis?

In the second group of tasks you will be given the phylogeny process. You will need to name the relevant ontogeny process. For example:

Task 24: It is well studied how the wild potato became a crop. What can be considered as ontogenesis in this case?

The solution: The history of the potato as a crop is the history of all potatoes. Meaning, the ontogenesis will be the 'history' of one potato bush – from planting to collecting tubers.

Task 25: The development of transport.

Task 26: The development of cars.

Task 27: The development of writing tools.

Task 28: The history of the pencil.

Task 29: The development of plants.

Task 30: The development of trees.

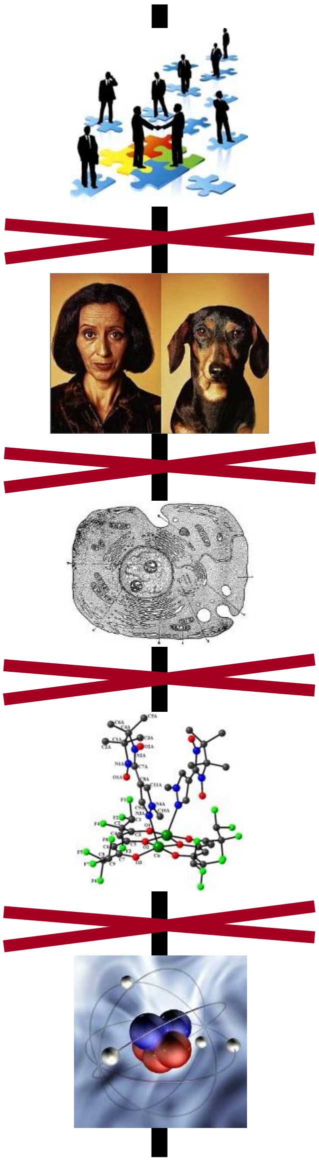
Task 31: The history of human diseases.

4.4. The principle of emergence

So, now we know that any object and any system has a certain system rank, and that it is developing. We even understand that the development is not chaotic, and happens according to certain laws.

The principle of emergence tells us that each rank has its own system activity laws. Let us take a car as an example. The laws of chemistry operate in the fuel rank, the laws of mechanics – in the car engine, and traffic rules - in the road transport rank.

The principle of emergence manifests in two ways. On one hand, the laws of any system cannot be reduced to the laws of its subsystems. On the other hand, the law of this system cannot determine the laws of its supersystems. Laws which operate a car cannot be reduced to the laws of fuel combustion. Even if we study a car's performance down to every last bolt, we can never derive the rules of the road from it.



This diagram clearly shows how the principle of emergence separates large, main ranks of matter. In fact, the laws according to which elementary particles combine to form atoms do not affect the laws of chemistry, that is, the laws of molecule life. Molecules, in turn, do not ‘suggest’ to living cells how to function. The rules, according to which cells function, are not related to the principles of the physiology of multi-cellular organisms, including humans. A human’s physiology does not explain social laws.

Conversely, no social law can change the laws of physiology. It doesn’t matter what a molecule is connected to, the composition and the structure of an atom, it will not change.

Example 55: In 1827 Scottish botanist Robert Brown discovered and described a surprising phenomenon. In absolutely calm and still water, very fine particles (Brown studied pollen) are in constant chaotic motion.
This phenomenon was explained only in 1905 by A. Einstein. He showed that this Brownian motion could be caused by water molecules that are bombarding particles, pushing the molecules in one direction and then another.

As we can see, the body (in this case, water) can be motionless, and its subsystems (in this case, the molecule) - mobile.

Example 56: In the Middle Ages there were many theories that explained the persistence of a number of local winds. In general, they stated that winds were caused by river streams or ocean currents. However, these theories cannot explain the large number of winds, constantly blowing away from rivers and streams or changes in wind directions.
William of Conches developed a theory according to which winds and currents are combined into a global system. He believed that two oceanic streams are flowing from the equatorial ocean to the east and west. Each of these splits at the edges of our ecumene to form four streams that join at the North and South Poles in the ocean perpendicular to the equatorial ring (Amphitrite). The main winds are born in four places: two of them are situated at the joints of the ocean, where streams are branched, and other two – at the poles, where they converge. However sometimes, by accidental circumstances, it happens that one of the streams flows stronger than the other, and the point of convergence shifts from the pole. The shift of the convergence point explains the appearance of additional winds.
With all of this speculative theory William made a huge step forward in the understanding of nature. He moved on to a supersystem and took into account the principle of emergence - the properties of the global system of water and wind differ from those of every river and every wind alone.

Failure to understand the principle of emergence sometimes leads to peculiar incidents.

Example 57: Researcher J. Korchmaryuk is developing a new science – the settleretics. The main idea of it is the need for humanity to move from biological carriers to technical ones. The author believes that the human brain has too little speed and capacity, therefore, in order to reach a new level in development, humanity needs to gradually replace the biological brain with a mechanical brain using artificial intelligence.

The idea is not new. Nevertheless, the author sincerely believes humanity will immediately reach a new level by dramatically increasing the volume and speed of used and processed information.

If we collect several tons of bacteria, we still cannot make an elephant out of them. An elephant is a different level of organised cells. No matter how big the erudition of humanity would be according to Korchmaryuk, the new level will not be achieved. Knowledge has to be organised in a different way. It is not a question of information processing speed but the procedures of its processing. A new level of thinking should not be super-fast, but properly organised and talented.

There are no insuperable barriers between the ranks. There are two slots in these fences.

First, the laws of neighbouring ranks still slightly affect each other. I would like to highlight that they don't define, but slightly affect each other. Chemical bonds do not change the overall structure of atoms, but slightly change the shape of electron shells. Changes in the working processes of a group of cells can somewhat affect specific physiological processes. Rules of human behaviour in society cannot change human physiology but may regulate some physiological processes and introduce a certain framework. For example, society recommends releasing the remains of digestion from the body in certain places, not just anywhere and not depending on the 'will' of the body.

Secondly, there are system-wide laws, which are applicable to all ranks.

Let us draw some conclusions. At the present stage of development of human culture, systemic thinking consists of the ability to recognise the whole system field of our world in all its hierarchy and intertwinement, the ability to see patterns of continuous development of these systems of any ranks, and the ability to separate the laws of these ranks from each other. The broader and bigger our systemic thinking is, the closer we are to talented, ingenious thinking.

4.4.1. Training tasks

This time, let us try solving a new set of tasks. First, let us practice to recognise the system and its manifestations in talented solutions. Secondly, let us try to get some talented solutions in simple (to begin with) situations.

As usual, we will practise together first.

Task 32: In the first half of the 19th century, geology was dominated by the 'Neptunian' theory of the origin of rocks, developed by Werner. According to the theory, most rocks derived from the world's ocean sediments. However, such rocks like granite or basalt did not meet the definition of sedimentary rock.
Hutton, who developed the so-called 'Plutonic' theory, explained the problem in the following way: not all rocks have a sedimentary origin; many of them are the result of volcanic activity, the pressure and temperature of the inner layers of the Earth's crust, weathering, etc. These days all of these processes continue.
Which systemic transition did Hutton make with his theory?

Let us first analyse the prototype – Werner's theory. Sediments were formed, pressed ... and remain so to the present day. The source of the sediments is the ocean.

Hutton has made major changes in these views. Firstly, he introduced the concept of continuous time: the processes of rock formation did not occur and then stopped, it continues until this day. Secondly, he introduced a number of new sources of rock formations – volcanoes, 'lava', wind...and these factors also operate to this day. That is, **supersystem factors** were added.

These two transitions - the introduction of supersystem factors and the dramatic expansion of the time of their actions are Hutton's merits by reason of his talented thinking.

Task 33: In Sir Arthur Conan Doyle's story 'The Disappearance of Lady Frances Carfax', criminals kidnapped a lonely rich woman and needed to get rid of her. Sherlock Holmes knew that they had ordered a coffin. Obviously, they decided to bury her. However, when Holmes broke into their lair at night and opened the coffin, there was indeed a dead woman – the criminal's old maid. According to all other indications, Holmes correctly discovered the criminals plan. How were they planning to dispose of the rich girl?

First we need to solve this problem from the perspective of the criminals. They suspected that Holmes would go and check. Nevertheless, they could not change the plan for getting rid of the rich girl under the guise of the maid funeral. Only one thing was left - **the introduction of the time factor**. The dead maid is left in the coffin for the duration of the possible checking period. However, at the very last moment the maid could be replaced with the rich girl.

Here are several tasks for independent solving.

Task 34: The worst enemies of coal mines are methane, coal dust and water. Methane and coal dust are explosive, and ground water can flood the mine. Methane and dust are pumped out by ventilation, and water - by pumps. Although, it is expensive - two complicated and powerful pumping systems. This is also a long process – before they are pumped out, the gas can accumulate again.

How was it possible to make this process a lot cheaper and quicker?
Please, do not refer to not knowing mining equipment. It has nothing to do with it. A simple systemic approach is enough.
(Let us use one of the subsystems of harmful effects. Water can also be a source of energy. It was proposed to guide the pumped out water to a turbine, and then use it for generating additional electricity. This dramatically reduced the costs for ventilation).

Task 35: A classic detective story is based on a smart detective catching a wily criminal. The detective never teams up with the police and the criminal uses a maximum of one or two assistants.
Predict the further development of the criminal's image in a classic detective story.
Again, it is sufficient to only use the hierarchy of systems.
(In later detective novels a detective joins forces with the police, and sometimes, as in Georges Simenon novels, the detective is himself a policeman. The criminal also moves into a supersystem as, for example, in the Rex Stout and Earl Gardner novels, the detective has to fight with an entire criminal organisation).

Task 36: Artificial marble is made by mixing concrete with small fragments of natural marble. After the concrete has set, it is almost impossible to distinguish artificial marble from the real thing. Blocks of any size and shape can be moulded, which it is very convenient. The trouble is that this block is very hard to polish due to the hard concrete.
How to get a polished block of artificial concrete without spending time and effort on polishing?
Do not forget about all the features of the system approach.
(We need to seek help in the supersystem. Its closest element is the form, in which a block of artificial marble is made. If the bottom of the form is smooth, then the block itself will be polished. It was proposed to put a sheet of glass on the bottom of the form).

Task 37: In the medieval world map of Lambert St. Omersky a great Southern continent is shown, and a comment to which states that when we have summer they have winter. In the western hemisphere it shows a big island. This area is provided with a comment: 'Here live our antipodes but their days and nights are opposite ours'.
If we take into account, that before there were wide debates about antipodes existence in general (the official Church, for example, argued that believing in the antipodes is a sin), then what were the system transitions Lambert St. Omersky made?
(The two transitions to the anti-system. Firstly, Lambert swapped seasons; secondly, he swapped days and nights).

Task 38: As we already know, the first chemical theory that explained the process of formation of ore and the process of smelting metals from ores was the theory of phlogiston. According to that theory, ore is a metal, which was left by weightless phlogiston fluid. When the ore is smelted with charcoal, which contains a lot of phlogiston, the latter gets to the ore and metal is obtained.
However, this theory could not explain why the weight of the metal is less than the weight of the ore. After all, if weightless phlogiston got into an ore, the weight of the metal must be equal to the weight of the ore.
What systemic transition can explain this phenomenon?
(The transition to the anti-system. When smelting a metal, phlogiston is not attached to it, on the contrary, some substance is released from it).

Task 39: People, who live near lakes of cold latitudes know that during freezing these reservoirs emit a buzzing sound. Medieval scholar Gerald compared them with the howling of large herds

of animals. He also gave an explanation of this phenomenon, which so far is considered as correct.
Try to explain the buzzing noise. What systemic transition did you use?
(Gerald had found the cause in the supersystem. One of its elements is air around the lake. The movement of air under the freezing ice is the cause of the buzzing sound).

Task 40: Studying the flow of current through different substances, Faraday drew attention to the fact that current passes through the water, but does not travel through ice; but after all, ice and water is the same substance!
What systemic transition can help explaining this phenomenon?
(The cause lies in subsystems. Faraday suggested that during freezing, water particles bond to each other and can no longer can pass current).

Task 41: In 1774, after beginning to study the process of tin calcination, Lavoisier already assumed that the conversion of metal into ‘earth’ (now we call it metal oxide) is due to a reaction with air, rather than the release of phlogiston. However, a series of experiments showed that no matter how much tin we make, during calcination only a fifth of the air, contained in the vessel, will be joined with it. Remember that in the ancient Greek era the air was still considered as an ‘element’, that is, a single substance. It was inexplicable that only a fifth part was participating in the reaction.
Lavoisier suggested that air is not an element after all. It consists of two parts – ‘clean air’, which is conducive to combustion and respiration, and ‘mephitic air’ that is not participating in these processes. Later, he would call these oxygen and nitrogen.
What systemic transition did Lavoisier use when creating this theory?
(Lavoisier divided air into two subsystems - oxygen and nitrogen).

Task 42: Rhyme is one of the strongest types of rhythm in poetry. It is especially desirable in dramaturgic poetry. However, poetic speech of a character does not sound natural in every situation. In such cases rhyme interferes. It brings clarity into characters’ speeches; on the other hand a speech ‘in rhyme’ is totally unnatural.
Playwrights of the 18th century have solved this problem by writing some parts of character monologues in rhyme with other parts remaining unrhymed. Here is an example of Shakespeare’s sonnet:

For ’tis the sport to have the engineer
Hoist with his own petard. And ’t shall go hard,
But I will delve one yard below their mines,
And blow them at the moon. Oh, ’tis most sweet
When in one line two crafts directly meet.

(‘Hamlet’, III, 4.)
What systemic transition was used for solving this problem?
(The monologue was divided into two subsystems – rhymed and unrhymed).

Task 43: In the novel ‘War and Peace’, Tolstoy wanted to show the Battle of Borodino in the eyes of different people – from short-spoken Kutuzov to verbose Bezukhov, from professed Napoleon to reasoning Bolkonsky. Such description would take up enormous time and space in the novel but the battle is a short and dynamic event.
How to show the dynamism of the battle and the most versatile look at it? Which systemic transition would be useful?
(The introduction of time. A part of the description is given before the battle - in the form of military plans, deployment of troops, etc).

Task 44: One of the tasks of K. Vonnegut's novel 'Slaughterhouse number 5' is to show that the war was brought to bear upon excessively young boys. Heroic deeds and horrific brutalities alike were done by 17-18-year-olds. The subtitle of the novel is appropriate – 'The Children's Crusade'.
To show the absurdity of children's war, Vonnegut makes the protagonist of the novel watch a film about the war in the reverse order. It turns out as a romantic story about saving the world from war, and bomber pilots, who in such interpretation were dragging the bombs from the ground back into the bomb bays, leaving the aircraft, getting dressed to become ordinary children.
What systemic transition did Vonnegut use?
(The transition to anti-system – the process was given in the reverse order).

As you can see, systemic thinking is a skill. It does not occur naturally, it needs to be learned and developed.

5. Bordering on truth

(The development of the associative imagination)

5.1. The foundation of new ideas

We have already seen that a person does not operate reality but its perceptions and mental models. They intervene in reality only in accordance with those models. Therefore, it makes sense to understand how these models are built and how they develop.

Let us start with ancient and medieval theories. These are simple and do not require specialised knowledge. We will then compare them with contemporary models.

Example 58: Greek philosopher Leucippus, followed by Democritus, believed that the world is made up of tiny indivisible particles – atoms, between which there is a void. Atoms can either attract or bounce off each other. There are an infinite number of atom forms and it is this multiplicity that determines the diversity of the world.

Example 59: Nun Hildegard of Bingen, a 12th century scholar developed an interesting model for the sky's motion. She considered four winds being the cause of its motion. They not only support and rotate the vault of heaven but also maintain order in the Universe and prevent elements from becoming mixed.

Example 60: Another medieval scholar, Adelard of Bath, explained the salinity of sea water in the following way: "I believe that the salinity of the sea is caused by the heat of the sun and the planets. For since the true ocean passes through the centre of the dry zone and the orbit of the planets lies over this very area, although not directly, but obliquely, the ocean is bound to heat up by a huge amount from the heat of celestial bodies, thus causing salt to appear". As proof, he cited the fact that "When dried in the sun, the sea water on coastal rocks can turn into salt without any help".

Do not rush to blame the authors of these erroneous hypotheses. You cannot evaluate the previous models from today's perspective. These days we simply have more knowledge. The models we now consider to be correct may seem absurd in fifty to one hundred years when more knowledge is accumulated.

Let us simply analyse why the authors had put forward these exact models.

Many things observed by the ancient Greeks consisted of parts. Sometimes they consisted of very small pieces such as sand. So, why then could the rest of the world not consist of small particles? That is, the hypothesis that was put forward by Leucippus was with the analogy of that which was already known.

The system of the world, consisting of four parts was known long before Hildegard of Bingen. Four cardinal points, four rivers of paradise, the whole world consisted of four elements. The fact that the wind can move objects, sometimes even very large ones, was also well known. Hildegard built her model of the Universe by analogy with these well-known concepts.

It was well known and was considered an indisputable fact that the elements[5] can be converted into each other and into other substances. That is why in the Middle ages the transformation of

[5] Let me remind you that this refers to the ancient Greek elements: earth, water, air and fire. Salt as a solid substance was considered part of earth.

water into salt by the effect of heat was not seen as anything supernatural. The fact that the sun is heating up the water is considered as correct to the present day. At that time the sun, along with planets, was considered a celestial body, so why then can the planets not also heat up the water like the sun does? This being, the theory of Adelard of Bath is just an analogy with the knowledge at that time.

Now let us move to more recent times, to the late 19^{th} - early 20^{th} century. Electrons, tiny particles of electricity, were already known. The idea that atoms have some internal structure had begun to take shape. It was not excluded that current passed through bodies because electrons are emitted from atoms.

J. J. Thomson proposed a model of the atom, known as the 'plum pudding' where electrons are embedded in the nucleus, like raisins in a pudding. Another analogy.

There were some uncertainties in this model; in particular, it was not clear how electrons are departing the nucleus. Then H. Nagaoka proposed a model, in which electrons are moving around the nucleus, like the rings around Saturn. Again, an analogy.

Maybe in other fields of science the situation is different? Well, let us have a look at the other branches.

Example 61: The idea of humans coming from ape-like ancestors was not put forward by Darwin, as it is commonly believed. Previously, Linnaeus had already placed humans and monkeys in one category in his enormous classification of animals. The original idea of evolution was put forward by its early proponent J.B. Lamarck[6]. Why were all these scientists so persistent about the idea that humans came from monkeys? We resemble monkeys! Here it is again - an obvious analogy!

Example 62: In the middle of the 19^{th} century, Louis Pasteur proved that fermentation is caused by microorganisms. Surgeon J. Lister saw the analogy between fermentation and suppuration of wounds and developed a wound treatment system, which kills microorganisms. The post-operation death rate dropped dramatically.

Example 63: The middle of the 20^{th} century faced an aging research boom. In the seventies one of the most popular theories of aging was that the DNA accumulates errors, or 'failures'. Is this not reminiscent of the process of 'aging' that occurs in all the things around us? Here is another analogy!

Maybe this is relevant only to science?

Example 64: The prototype of Leonardo da Vinci's work 'The Lady with an Ermine' was probably known in those days as aristocrat Cecilia Gallerani. She was a beautiful and educated woman, but bad-natured. To show this, without compromising the beauty of the portrait, Leonardo put an ermine in her hands, placing it in exactly the same pose as the heroine of the portrait. Among the aristocracy of that time, it was fashionable to keep ermines as pets, so everyone knew the predatory and insidious nature of these animals.

---

[6] If to be even more precise, the idea that humans came from hairy ape-like ancestors was proposed long time ago by Democritus.

One of the greatest art researchers G.E. Lessing considered imitation as the foundation of art. That is, analogy.

What about technology?

Example 65: In Europe, from antiquity, when dreams of learning to fly dominated the analogy with birds, numerous projects and practical attempts to create a workable ornihopter did not succeed (and still have not). However, in the 15th century the idea of a kite reached Europe all the way from China. It became popular in the 17th century. At the end of the 17th century C. Huygens proposed the first draft of an aircraft with fixed wings and propellers. In the middle of the 19th century, J. Stringfellow built an airplane that could fly for a few meters. All of this is an analogy with kites.

5.2. Where do analogies come from?

You can only compare to what is known. Why were all the primitive concepts of nature reduced to a comparison with a human? Why were all spirits and gods humanlike? What was so well known to primitive people other than themselves? This is the reason they compared everything to themselves.

Example 66: Here is a surprisingly poetic tale of the Maori people of New Zealand who lived before the coming of the colonialists in the Stone Age. It deals with the origin of a number of natural phenomena.

In those days, when the gods had not yet departed to heaven, many mountains lived happily on the shores of Taupo Lake in the middle of Maui Fish. They ate together, worked, played and loved each other, but as time passed, they began to argue. Then the young mountains decided to move. Some of them went to the North, others – to the South. The mountains travelled at night and stopped when the sun rose.

Only Tongariro, Ruapehu and Ngauru-Hoe stayed at Taupo. Tongariro married Pifangu, a small elegant mountain that lived next door. They had children: Snow, Hail, Rain and Frost. Pifanga loved gray-haired Tongariro, and when broad-shouldered Taranaki began to flirt with her, Tongariro furiously chased Taranaki away to the west. Taranaki ran to the sea and left behind a deep gorge through which now flows the Wanganui River (Wanganuir River flows into the Taranaki South Bay of the Tasman Sea). At the sea shore Taranaki could feel safe from Tongariro's retaliation; however the wind has brought a small cloud of smoke from the top of the angry mountain.

Taranaki shrugged his shoulders, and started slowly walking along the coast. He made a short stop in Ngaere, which left a large cavity that later turned into Ngaere swamp.

At dawn Taranaki reached the cape, which goes deep into the sea (cape Egmont that separates North and South Taranaki Bays in the Tasman Sea), and stayed there forever. Sometimes he sheds tears, remembering Pifangu, and covers himself with a mist. Tongariro sometimes recalls the audacity of his distant rival, then the flames of anger bubble in his chest and a thick cloud of black smoke hangs over his head.

This type of comparison was also preserved during the Middle Ages.

Example 67: 'The image of the world' - a popular book from the Middle Ages refers to the fact that inside the ground, the Earth is riddled with channels, similar to blood vessels in the human body. Wherever and whenever a person would start digging into the ground they would certainly find water. Through these channels and the air that constantly circulates between the oceans, water on the surface of the Earth is maintained.

In later times anthropocentric comparison (comparison with a human) has been the basis for new ideas.

Example 68: This is how Copernicus justified the appropriateness of heliocentrism: “In such way the Sun, as if sitting on the royal throne, controls the near rotating family of luminaries. Earth uses the services of the Moon and in the words of Aristotle in his treatise ‘De Animalibus’, Earth has the greatest affinity with the Moon. At the same time the Earth is fertilised by the Sun and carries the foetus for a whole year”.

In modern science such comparisons are also present, albeit implicitly.

Example 69: “The theory goes that every system is trying to take a position, in which its energy is minimal. <...> There are complicated mathematical formulas, which indicate that the total energy of two magnets touching one another is less than the energy of the magnets, separated by some distance. As the system should take the ‘lowest’ energy position, the magnets attract. The same can be said about a magnet and a piece of iron”.

‘The system is trying...’ is a typical comparison with human motivation.

The history of technology also shows that the first inventions in any branch of technology copied the human body and its actions. Mills were repeating human actions by rubbing grains between two stones. The first steam looms were copying the actions of a weaver at the handloom. Modern robotics still copies a human hand.

Comparisons with a human remain one of the foundations of art to this day. Today we no longer perceive this as real events but as a beautiful metaphor, but these metaphors are clear to us precisely because things and events are likened to ourselves.

Example 70: In V. Vysotsky’s song ‘We spin the Earth’ the cause of the Earth’s rotation from east to west is the advance of the Soviet troops, who were liberating the country from the fascist army. “*We are not measuring the Earth with steps, unnecessarily trampling flowers. We are spinning it with our boots – by pushing away, pushing away!”*

Now we have a lot more objects to compare.

We keep an incredible amount of knowledge in the storage place in our heads. The ones who say that they do not know a lot are just being modest. We know the names and properties of hundreds of thousands of objects that surround us; we remember a lot of the events that happened to us and our friends, or heard or read of in schools and institutions. We have simply learned a lot of natural and social laws from personal experience.

The only problem is that this information in our head is dumped in a chaotic heap.

5.3. The art of associations

How to get out exactly what you need out of this heap? The mechanism of association comes to the rescue. It is at the very heart of analogy-making.

Here is how Svetlana Burlak in her book ‘The Origin of Language: Facts, researches, hypotheses’ describes the neurophysiologic mechanism of association:

“When there are too many signs, various associations arise between them. As neural pathways are not isolated from each other by impenetrable walls, it appears that when activating the complex of neurons, which correspond to a single sign, also activates neurons, corresponding to some other signs that are their ‘neighbours’ - as W. Kelvin wrote: ‘Just as thick fingers might strike two piano keys at once or land on a neighbouring key’. The more signs are used, the more associations appear. Besides, activation of a neuron complex associated with the name, for example, of an object, activates neurons that are associated with the perception of its colour, smell and actions with that object.., – and these complexes can also be linked to their names”.

As it is impossible to pull out a speck of dust out of its pile without moving the other specks, it is impossible to activate a single neuron without activating the neighbouring and similar ones. Roughly speaking, if we activate the neuron, which stores the image of a apple, the neuron with the image of pears will always be ‘activated’, even in the slightest way.

What kind of neurons is activated in response to the activation of the first one depends on what kind of connection formed between them before. Many consider associative thinking as ‘given’. Like, everyone has it, it is ‘given’ and you cannot change it, forgetting that it was formed before.

Here another trap awaits us. We already know that the thinking was formed within the culture. We can say more precisely that thinking is a product of culture. We are used to calling cultural products artificial.

Yes, thinking is an artificial process. It is not given at birth, it needs to be learned. I am not saying anything about talented thinking!

After one of my lectures I was approached by a listener, and he asked: “You always talk about ‘talented thinking’. Can thinking be ‘untalented’?”

Of course, it can be! Such thinking is called ‘common’. Common thinking is formed in everyday life, where talent is simply not needed. In everyday life we need well-secured skills, conventional notions, and categories. The skills and common categories of such thinking are opposite to talented thinking.

If a child’s everyday life is stable, monotonous, and is a subject to simple and strict rules, the probability of the formation of their talented thinking is minimal. Conversely, if their life is diverse, if they constantly face unexpected, unusual events and make unusual decisions, the elements of talented thinking are far more likely to be formed.

Of course, it primarily depends on their parents. If they are not trapped inside routine thinking, the child takes that for granted and ‘tries it on’ for himself. This is where the myth of hereditary talent comes from. In fact, even ‘untalented’ parents can organise a ‘talented’ environment for the child. That is, of course, if they want to.

Let us get back to associative thinking. The mechanism, described by S. Burlak, seems ‘natural’; it was formed very early and at the level of everyday life. This mechanism also is not given. Watch how very young children learn this. A baby reaches for a bright red cup on the table, gets the cup, knocks it down and breaks it. Its parents try to explain that they cannot touch the cup. It seems that everything is clear and the child understood everything. However, in five minutes time the baby breaks another cup. We tend to explain this with a meaningless mantra ‘they disobey’. Nonsense! A very young baby does not know what it is to ‘disobey’. The baby clearly understood that they are not allowed to take the red cup. But the second cup was blue!

They do not have any associations with ‘cup’ at all. Everything is a lot more specific. They will gradually learn. However, the breadth and depth of their association will still be limited to the framework of everyday life, because another life still does not exist. A neuron which contains the concept of an apple will be connected to a neuron which contains the concept of a pear because the baby simply did not experience some papaya yet. A neuron with the concept of ‘flying’ will be connected to the ‘bird’ neuron. Step to the right, step to the left - and the child will encounter the worst word in the human culture. The ‘wrong’ word!

To form talented thinking, we need to move to a completely ‘artificial’ mechanism of associative imagination. It is necessary to ensure that the neurons are not randomly connected as it happened in daily life, but controllably connected to all of other neurons. So that when studying geometric shapes, when we hear the word ‘apple’, neurons would be activating the ‘ball’, ‘planet’ and ‘bearing’ neurons, not just the ‘pear’. It is an obligated condition of talented thinking. We need to learn how to cause the desired association ‘on demand’. Thus, when developing flying ideas, we would think of *more useful* analogies, such as a Chinese kite instead of an apple, which is a *closer* analogy.

Nevertheless, understanding the physiology of associations will never give us understanding of the analogies themselves. Just as understanding the chemical processes occurring in potatoes on a hot pan will never help us to understand why well-fried potatoes taste good and over-fried do not.

Can associative thinking be developed? Can an artificial system of talented associative imagination be build?

5.4. Storage guide

To help us build such a system, talented thinking storage must be organised as follows. On the first shelf of storage racks should be placed known objects and phenomena. This is a story of pure erudition. Erudition is a necessary condition of talented thinking, but it is insufficient. In the words of the Greek philosopher Heraclitus, “much learning does not teach understanding”.

Example 71: There is a story (I do not claim that it is true) about Einstein visiting T. Edison’s laboratory. Edison gave him a questionnaire, which the applicant must complete to be able to work in the laboratory. Einstein carefully read the questionnaire and sadly admitted that he cannot answer most of the questions.
The questionnaire was purely about erudition. The distance between the cities, the material, from which some objects are made, etc. Edison himself and those whom he recruited, knew the answers to all these questions. However, Edison’s laboratory did not have any new inventions (he was only improving the already known ones). In his turn, A. Einstein had developed two completely new general theories and a number of particular ones, but on a new basis for those times.

Knowledge is not a value in itself, but a tool. An eastern proverb teaches: ‘An army of sheep led by a lion would defeat an army of lions led by a sheep’. The one who can operate little knowledge is wiser than the one who does not know how to manage a large amount of knowledge.

The ways of transforming known objects and phenomena are placed in a vertical direction. If, say, there is an apple on the first floor, then a shelf, labelled ‘change form’ should contain cubeshaped, pyramid-shaped apples, apples stretched into a thin thread, twisted into a spiral, and so on – in all conceivable forms.

Example 72: If someone thinks that cubic apples are not serious, let me remind you that there is elaborate and costly research going on in the world on how to grow cubic watermelons. Imagine how much space there is between watermelons during worldwide transportation. If watermelons are cubic, then economic efficiency of their transportation would increase at least two-fold!

The shelf labelled 'change material' contains metal apples, apples, twisted from cloth, rolled out of palm leaves, liquid and gas apples, etc. The 'resize' shelf will contain elementary particles (microscopic apples), planets (e.g. Saturn), the Solar system, globular clusters, whose weight can reach 10^6 solar weights (these are unimaginably big apples).

Interestingly enough, all these options and the objects of the first floor, and changes on other floors fit into the already well-known evolutionarily hierarchical scheme. In fact, we have already put nucleus and Saturn on the same shelf. Here is Nagaoka's model. There was also the Solar system on the same shelf - this is Rutherford's model.

This gives us the opportunity to map our storage place. Besides, this is applicable not only to that, which is in this storage, but also to new things that can be placed there in the future, that we may discover, invent, and then put on the desired shelf. Something like Mendeleev's periodic table, this not only shows the already discovered elements, but also has space for those that are not yet discovered.

Such a table was composed by G.S. Altschuller. It was designed for Creative Imagination Development (CID) classes, which is why it is called a phantogram. It is repeatedly described in literature. However, at the moment we have enough with just the system operator.

5.4.1. Exercise room

The system of exercises for the development of the associative imagination is a sequence of exercises[7]. It is necessary to perform a group of exercises to consolidate a good skill, and after that we need to move to the next group. This is followed by a few exercises from each group. The rest of the exercises in a group must be the same type.

When you perform exercises from the first group, first of all, you need develop the ability to respond without thinking (first exercise), so that the answer is a natural and free association, without forceful thinking. Only after this skill is achieved, when you stop thinking about your answers, then you can move to the next set of exercises.

Another hurdle that must be overcome is the 'inner censor'. Apart from exercise questions, people inevitably bear in mind another question: 'What will people think about me if I say this?', and desperately try to think of a new word. Nevertheless, during training, this 'inner censor' gradually disappears.

[7] Some of these exercise are taken from practice from other tutors of TRIZ (Theory of inventive problem solving), some of them were invented by me, and some of them suggested by my students.

The first group (developing the freedom of associative imagination):

Exercise 9: (*direct associations*) Each participant is given a word that means an object. You must, without thinking and without listening to the 'inner censor', immediately name the first word that came to your head. Naturally, it also has to be an object, not a property or activity.

Exercise 10: (*general chain of associations*) The first participant is given a word that means an object. They need to immediately, without thinking name an object-association. This word will be the starting point for the next participant. This continues until all the participants name their associations.

Exercise 11: (*chain of associations*) Each participant is given a word that means an object. They need to name an association as quickly as possible. It will be the starting point for the next association. Etc.

Exercise 12: (*association bush*) Each participant is given a word that means an object. They need to name five associations as quickly as possible.

Exercise 13: (*double helix*) Each participant is given two words, which mean objects. They need to quickly create two chains of associations, and do it in turn - one word for each chain.

Each exercise should be repeated several times to reach maximum speed. After each exercise a little analysis identifying the types of situations, should be performed with the group.

Typical situations that are constantly repeated:
1. Objects are named that are too close to the source of one or similar groups, such as household, family, professional, etc.
2. This is especially noticeable during the performance of the second exercise, when there are frequent returns to the first words of the general chain group.
3. Such situations are also frequent in the individual chains of associations.
4. However, the association bush has an interesting phenomenon. After using two or three banal associations, a person is forced to look for more distant, more interesting and unexpected ones.
5. In the double helices there are cases when at first associations from different chains come apart, and then begin to converge, going back to one of the ordinary groups. However, it can also be the opposite way, when one notices the initial convergence and begins 'separating' the chains in different directions. This is the first serious attempt to control their associative imagination.

These and other possible typical situations should be discussed with the participants, at the same time improving the skill to analyse their own associative imagination.

The second group (transitions to anti-systems):

Exercise 14 (*transitional*)**:** You will be given the name of an object. Name as many its properties and functions as possible.
Example: object – **candy**. Properties – sweet, hard, harmful, soothing, sticky, nourishing, round, etc. Features – to bring fun, to serve as a projectile, to be a medium of exchange, to serve as a reward, etc.

Exercise 15 (*transitional*)**:** You will be named a property or a function. Name as many directly opposite properties and functions as possible.

Example: sweet – bitter; hard – soft; harmful – useful; soothing – exciting; sticky – repellent; nourishing – causing hunger; round – shapeless, etc. To bring fun – to make sad; to serve as a projectile – to defend from projectiles; be a medium of exchange – to be the object that reduces the value of other objects; reward – punishment, etc.

Two typical errors are made when performing this exercise. The first - instead of naming the opposite properties (functions), participants cancel the property (feature). Example: sweet – not sweet. Second error - instead of naming the opposite function, they simply name another function. Example: round – square. Square is just a different shape. It is necessary to pay special attention to these errors and try to eliminate them.

Exercise 16 (*gradual anti-association)**:*** You will be given the name of an object. Name its property or function, then appropriate anti-property and anti-function, after that quickly name another object that has that anti-property or anti-function.
Example: candy – hard – soft – a pillow; candy – reward – punishment – fine.
The exercise needs to be practiced until the chain is performed easily and without delay.

Exercise 17 (*mental anti-association*)**:** You need to perform the same actions as in the previous task; however, all the transitional steps need to be performed mentally. Compare with the speed of completion of the previous task. This exercise needs to be repeated till the mental chain becomes almost instantaneous.

The third group – transition to subsystems.

Exercise 18 (*transitional*)**:** You will be given the name of an object. Name its direct subsystems (of the closest rank).
Example: **House** – wall, roof, foundation.

Exercise 19 (*chain down*)**:** You will be given the name of an object. Name one example of several subsystems of decreasing rank.
Example: **House** – walls – bricks – voids – air in voids.

Exercise 20 (*down and up*)**:** You will be given the name of an object. Name one example of several subsystems of decreasing rank, and then generalise the last object.
Example: **House** – walls – bricks – voids – air in voids – **atmosphere**.

Exercise 21 (*subsystem associations*)**:** You need to perform the same actions as in the previous task; however, it needs to be performed mentally.

The fourth group – transition to supersystems.

Exercise 22 (*transitional*)**:** You will be given the name of an object. Name its direct supersystems (of the closest rank).
Example: **House** – street, buildings, dwellings, wind barriers...

Exercise 23 (*chain up*)**:** You will be given the name of an object. Name one example of several supersystems of increasing rank.
Example: **House** – street – quarter – district – city.

Exercise 24 (*up and down*)**:** You will be given the name of an object. Name one example of several supersystems of increasing rank, and then name a completely different supersystem of the last object.

Example: **House** – street – quarter – district – city – **transport**.

Exercise 25 (*supersystem associations*)**:** You need to perform same actions as in the previous task; however, it needs to be performed mentally.

The fifth group – time.

Exercise 26 (*transitional*)**:** You will be given the name of an object. Name ontogeny processes in which the object is active.
Example: **House** – creates an artificial environment for its residents, is a barrier for the wind, throws heat into the atmosphere, puts pressure on land…

Exercise 27 (*transitional*)**:** You will be given the name of an object. Name ontogeny processes in which the object was active in the past.
Example: **House** – before the construction of the house its bricks were piled into blocks and caused deterioration of transport and roads. Prior to that, in the process of production, they consumed a lot of heat and electricity, released moisture into the atmosphere. As a clay peace they were creating the geological structures of the crust. Clay extraction left voids that caused the redistribution of pressure in that region of the crust and changes in the distribution of groundwater. Due to that, there appeared new niche for living organisms.

Exercise 28 (*transitional*)**:** You will be given the name of an object. Name phylogeny processes in which the object is active.
Example: **Houses** – create more complex artificial environment for its residents, start to provide services for residents, become more active technogenic factors for the climate and geological processes.

Exercise 29 (*transitional*)**:** You will be given the name of an object. Name phylogeny processes in which the object was active in the past.
Example: **Houses** – cities occupied even bigger territories (today - about 2% of the total land area). Here we must add roads linking the cities. It is the building of cities and roads, as well as city heating that has changed flora of Europe, destroying most of the forests in the Middle Ages. Redistribution of ground water and the internal pressure in the soil gradually led to the subsidence of large areas. (Total area of subsidence of 50 major cities in China for more than 200 mm is 79 thousand square meters, which is nearly two Switzerlands). In even more ancient times, cities were centres of racketeering on the river trade routes that formed a certain type of economy in these regions.

Exercise 30 (*associations in ontogeny*)**:** You will be given the name of an object. Name ontogeny processes in which the object is active and was active in the past. After that, name the supersystems of those processes or elements of supersystems.
Example: **House** – creates an artificial environment for its residents – the subsystem of this environment is water pipes, sewage, heating, etc. in the apartment; the supersystem is all city communications - city water, city sewers, city heating system, etc.

Exercise 31 (*associations in phylogeny*)**:** You will be given the name of an object. Name phylogeny processes in which the object is active and was active in the past. After that, name the subsystems of those processes or elements of supersystems.
Example: **Houses** – cities occupied even bigger territories. Previously, these were small clearings on which homes and cities were built. Now it is a huge area, which basically is disposed from agricultures.

Exercise 32 (*temporal associations*)**:** You need to perform the same actions as in the two previous tasks; however, they need to be performed mentally.

In all exercises of the second to the fifth group it is necessary to gradually achieve a free orientation in the system hierarchy, as well as in ontogeny and phylogeny. When this is achieved, we can move on to the sixth group.

The sixth group – complex exercises.

The goal of the sixth group is to combine different lines of associative imagination, which so far we have been training separately. Exercises of the sixth group have to come up all the time. I will give you only one example.

Exercise 33: Transitions to anti-associations, as in exercises 16-17. Then scrutinise supersystems for these anti-associations, as in exercises 24-25.

According to this principle it is necessary to create exercises that combine any association directions.

Gradually, these mental operations become automatic and cover most of human knowledge.

5.5. Crossing parallels

It is very convenient to study the emergence of associations, and therefore analogies on very young children. They are not yet able to think 'mentally', therefore they think out loud. This is how we can study all the transitional stages. Here is a fragment of a dialogue, which I overheard on a bus. An approximately two year old thinker was sitting on his mum's lap, not far away from the driver.

- Grandpa... where is grandpa? Grandpa went to work.

Mother: "Yes, grandpa went to work".

- To work. Grandpa.

(Child fell to thinking, and then looked at the driver).

- Man. What is man doing?

Mother: "That man is working".

- Man is working.

(*A pause and a very busy look. And then happily:)*

- Man is working! Grandpa went to work!

It is a discovery! Mister and grandpa are two different people, they have nothing in common, and here he finds something in common! They are both 'working'. It does not matter what it means. Commonality is what is important.

This is analogy. The commonality of several objects in a certain parameter. These parallels never crossed before, and now they did.

The more parameters of objects we can recognise, the more communities we can notice - the more manageable our associative imagination, the more talented our thinking can become.

That is why so-called mental development tests reflect anything but mental development. In these tests, there are the ‘right’ and ‘wrong’ answers. A person is considered as mental, who can, like a mindless recorder, repeat the ‘correct’ answer.

In one of the most popular tests among psychologists there is given a number of objects, from which you need to indicate which one is different. For example, you are given: a **ball, a flower, a snake, a kitten and an elephant**. Let us see, how psychologists draw their conclusions.

The very first thing, which comes to our heads, is that all of these items, apart from the ball are alive. Due to banality of this answer, it was given the most. Therefore, psychologists recognise it as the right one, and the person who finds that answer is considered as intelligent. Consequently, all other variants will be wrong, and the people who name them, will be considered silly.

In fact, we can find dozens of laws, according to which any of these objects can be different. For example, only the elephant is big, everything else is small. Only the snake is poisonous, others are not. Only the flower smells nice. Only the kitten is fluffy.

Such findings of new connections between objects are the basis of all scientific (and unscientific) classifications. That is, judging by these tests, D. Mendeleev, who composed a new classification of the chemical elements, Linnaeus, who composed a new classification of living organisms, and F. Zwicky, who composed a new classification of stars - they were mentally challenged. After all, they were scrutinising new, previously unnoticed classification parameters.

In the history of culture, these ‘wrong’ variants turn out to be talented and ingenious solutions. Nevertheless, they are not immediately recognised as talented. People, who know the ‘only correct’ answer, shower the author of the ‘wrong answer’ with insults and derision.

Example 73: In 1866, at a meeting of the London Chemical Society, J. Newlands read a paper entitled: ‘The Law of Octaves, and the Causes of Numerical Relations among the Atomic Weights’. By analogy with the music, he discovered that if to arrange the chemical elements in increasing atomic weights, their chemical properties are repeated every seven elements.
The report did not generate any interest. Only Professor J. Foster sarcastically remarked – did the author try to arrange items in alphabetic order? Maybe some laws can be found there?
Disappointed, Newlands ceased his research activities. In 1882 the Royal Society of London awarded one of the most prestigious scientific awards of the time to D. Mendeleev for his discovery of the periodic law. In 1887, recollecting themselves, the Society awarded Newlands with the same prize, with almost the same wording.
By the way, the reaction of Mendeleev’s colleagues to his periodic report in 1869 was the same – a complete lack of interest.

Example 74: In 1951, V. A. Fabrikant and his colleagues applied for the invention of a new method of amplifying light. Now it is called a laser. As acknowledged by J. Maksarev, the former chairman of the State Committee for Inventions and Discoveries (Goskomizobretenie): “experts laughed at this ‘Hyperboloid of Engineer Garin’, but just in case they have sent it to the conclusion of experts. The experts did not just laugh - they ripped the idea to shreds”. The Author's Certificate (which replaced patents in the USSR) was issued only in 1959, after a number of failures.
At the heart of this invention lies the discovery by V. Fabrikant - environments with negative absorption of electromagnetic radiation. Scientific journals simply refused to publish articles on this topic. The scientist received the discovery diploma only in 1964.
In the same 1964 M. Prokhorov (V. Fabrikant’s student) won the Nobel Prize in physics for his works, which led to the creation of lasers.

Example 75: Today it seems that antiseptics, i.e. disinfection of wounds, is a self-explanatory thing. However, doctors were totally against Lister's discovery. It took about twenty years for this innovation to be accepted into medicine.

Example 76: In France 1874, there was an exhibition of artists who called themselves the Impressionists – Manet, Monet, Degas, Renoir, Sisley, Pissarro and others. The absence of the traditional contour of the depicted, vague shapes, the 'wrong' location of strokes caused a hail of mockery and harassment of artists. Thus, the writer M.de Montifaud called Cezanne *"a mentalist who took the brush in a fit of delirium tremors".*
By the late 1880s, Impressionist methods were used academically and in salon painting. Degas later remarked: *"Not only do they shoot us, but they search our pockets, as well".*

Example 77: Compare de Montifo's statement with F. Sinatra's 'definition' of rock and roll: *"It smells phony and false. It is sung, played and written for the most part by cretinous goons and by means of its almost imbecilic reiterations and sly, lewd—in plain fact, dirty—lyrics, and as I said before, it manages to be the martial music of every side-burned delinquent on the face of the earth …".*
Alas, for a hundred years in the evaluation did even a single expression was changed.

These are just some of the millions of results of love for the 'right answer'. His Majesty the right answer is still the foundation of the world of education and assessment of discoveries and inventions in all fields of human activity.

5.6. Shine and poverty of analogies

As long as the analogy works, it can develop in the direction of expansion, that is, to extend its range of application. A successful analogy is attempted to be used when explaining more and more new objects and phenomena.

Example 78: Democritus moved the idea that everything is made of atoms, to vision as well. He believed that every luminous object emits small particles that fall to the surface of the eye, and then, after a time it reaches the heart.

Example 79: The principle of an airplane wing moved to a completely different branch of engineering: aliform upper trunk of the car, the centrifugal angular velocity sensor, turbine speed controller and a number of other inventions, which contain parts made in the shape of the wing and can create lift.

Example 80: In order to display mother's feelings, the artists of the Middle Ages began to use the comparison with the Mother of God. This method is used to this day, sometimes in creative arts very distant from Christianity. For example, in S. Eisenstein's film 'Battleship Potemkin', in a scene shot at the Odessa staircase a woman with a dead child in her arms distinctly stylised as Madonna.

Analogy is being expanded and brought to different aspects of the phenomenon, to different subsystems and even on a part of the whole supersystem.

Example 81: Hertz applied all the same basic experiments that were carried out with light rays to the 'rays of electric force'[8]. He enhanced them with a metal mirror, curved in the form of a parabola, placing it in the focus of the radiation source. He observed the interference of the direct and reflected rays. Showed linearity of their distribution, and tried to observe the diffraction. He scrutinised the question of light polarisation. He studied their reflection and refraction by using various mirrors and prisms...

As you can see, the analogy between light and electromagnetic 'rays' is now referred to as radio waves - Hertz attributed it to several phenomena.

Example 82: Rutherford proposed the planetary model of the atom - the electrons orbit the nucleus like planets around the Sun. Later, to explain some of the properties of the electron, its analogy with the planet was extended by an assumption of the electron's rotation around its axis - this phenomenon was called spin.

Example 83: Let us go back to Vysotsky's song 'We are spinning the Earth'. The advance of the Soviet soldiers is shown trough the Earth's rotation. Then, Vysotsky extends this analogy to other aspects. The retreat at the beginning of the war: *"Although, we remember how the Sun was going back and nearly appeared in the East"*. The transition to offense: *"We have moved the axis of the Earth without a lever, by changing the impact direction".* The local troop movements: *"During the march our replacement squadrons are simply rotating the Earth wherever they want"*. The heroic deed of self-sacrifice: *"Someone out there, in front, fell on the dot - and the Earth for a moment got frozen"*. Finally, the optimistic triumphant generalisation: *"Today the Sun in the sky is going its normal way, as we are relocating to the West".*

Generally, true artists differ from scribblers precisely with this extensive and internally consistent metaphor, which is not a simple message.

Example 84: Developing a mathematical way to determine the volume of barrels, Kepler presented it in the form of small figures, the calculation of which were already known. After that he extended this comparison to the body of any form, that is, on the whole supersystem.

As the ancient Greeks, analogy is the limping goddess. It is always partial. By mentally transferring some properties from one object to another, we do not transfer the other properties.

Example 85: By shifting the electronic properties of the planet on to its axis of rotation, we cannot transfer the property of hardness. Elementary particles do not have the properties of macroscopic bodies, so there is no point speaking of their hardness. Moreover, when a new model was built, the particles were not spheres but packets of waves - an analogy with the planets started to limp.

There is a contradiction.

5.7. The limping goddess

To solve the contradiction, the analogy needs to be changed. During the process of concept development, these changes occur continuously; after all, the new models lose any resemblance with their original analogy.

[8] Now it is called electromagnetic radiation.

Example 86: The astronomer Kepler put forward the suggestion that the planets orbit the Sun and don't fly away from it because they are held by some sort of power that draws them to the Sun. He even assumed that this force is directly proportional to the masses of the planets and the Sun and is inversely proportional to the distance between them. In addition to that, they do not fall off the planet to the Sun because the moving body has a property to continue its uniform motion in a straight line (Kepler called this property inertia).
Later, physicist R. Hooke transformed this assumption. He believed that the attraction of the Sun does not extend in a straight line, but as an expanding sphere. Therefore, the force of gravity is proportional to the masses, but inversely proportional to the square of the distance (and not just the distance, as Kepler believed).
I. Newton continued these transformations. He suggested that this force is applicable not only to the Sun and the planets, but to all bodies in the Universe. This is why his conclusion is called the law of *universal* gravitation.

Example 87: The first variant of the storyline of A. S. Pushkin's novel 'The Captain's Daughter' was rather clichéd and reminiscent of all the similar stories of other romantic novels. Pushkin consequently transformed this storyline 8 times. He was happy with only the ninth variant, which turned into a novel. However, the story is quite different from its romantic predecessors.

Example 88: Epicurus and Lucretius drew attention to the fact that the atoms do not look like the objects that they compose, but what we see is the objects. In doing so, they slightly modified Democritus' concept of nature. Objects do not emit atoms, but their own images, which then, strictly according to Democritus, get into the pores of the eyes and reach the heart.

Example 89: Nagaoka's atom, built by analogy with Saturn, did not fit the experimental results of Rutherford. Therefore, he decided to change Nagaoka's model. Rutherford's atom was built by analogy with the Solar system – where at large distances very small electrons are spinning around the massive core.
This model also faced a contradiction. When rotating the electron should radiate energy. However, if it radiates energy, it quickly falls into the nucleus, which we never observe.
To solve this contradiction N. Bohr introduced a new change in the analogy. He suggested that when in orbit, the electron is in some stationary condition and during rotation does not radiate anything. Bohr believed that electron radiates or consumes energy only during the transition from one stationary orbit to another.
On the other hand, this model did not explain the nature of the stationary condition, and did not show exactly what happens during the change of the stationary orbits.
Louis de Broglie proposed a new model change to address the problem. Earlier M. Planck suggested that radiation waves are continuous, but behave as individual particles - photons. Why, on the contrary, for the particles not to behave like waves? – thought de Broglie, meaning, that the electron is not just a particle but also a wave. Now it became clear that Bohr's stationary orbits are orbits, at which the wavelength of the electron is an integer for a number of times.

As we can see, the new models have almost nothing in common with the first analogy, like a pudding with raisins or Saturn with its ring. Nevertheless, we must understand that without these first naive analogies, there would be no future. There would simply be nothing to change.

Example 90: In 1881, P. Johnson and L. Taylor discovered a new type of chemical compounds of boron hydrides. These are compounds of boron and hydrogen. All the 'normal' chemical compounds obey the principle of valence, that is, each atom is connected to a certain number of other links. Hydrogen's valence is 1. This means that it can only connect to a single atom of hydrogen or other monovalent substance. The valence of boron is 3, so it can attach only three atoms of hydrogen. However, it turned out that there are too many boron hydrides. Diborane

B_2H_6, two pentaboranes – B_5H_9 and B_5H_{11}, hexaborane B_6H_{10}, decaborane $B_{10}H_{14}$, etc. In diborane each boron atom is connected to another boron atom and three hydrogen atoms. That is, its valence is not 3 anymore. In hexaborane each boron atom must connect with the other five atoms of boron and 1.7 atoms of hydrogen, which is totally inappropriate.
To solve this contradiction it has been suggested that under certain conditions, hydrogen can form half-connections. Thus, one part of its only compound is used to connect to a single atom, and the second part - to another.

Example 91: There is an ancient Greek legend of the Trojan priest Laocoon. He tried to warn about the danger of the Trojan horse. To stop him, the god Apollo sent two giant snakes that killed Laocoon and his two sons.
Ancient Greek sculptures Agesander, Athenodoros and Polydorus decided to reflect the stage with snakes in a sculpture. They needed to show the terrible tension of Laocoon and his sons, struggling with the snakes. In sculpture, it can only be shown via muscles. Hence, the character's body should be open. On the other hand, according to the legend, the snakes completely coiled around their bodies. The contradiction: the character's body should be open, and be coiled by snakes.
The sculptors solved this contradiction in a manner, similar to the previous solution. Their body parts (legs, parts of hands) are almost completely coiled and the other part (biceps, chest, and abdomen) are left open with terrible muscle tension.

Example 92: Probably everyone had seen how mortar is moved up to the top of a building which is under construction. There is a special tub – a hollow metal cube at the bottom of which there is a tapered section with a damper. One side of the cube wall is missing. When the tub lies at the bottom with the open side up, the solution is poured into it. Then the crane lifts it vertically so that the narrowed part is at the bottom. At the top this narrowed part is directed to the solution tank, then the valve is opened and the solution itself flows into the tank.
However, the solution is also needed in finished rooms to fill the floor. Then the tub is raised to the level of the window and ... a problem arises. It is impossible to tap it into the window by using a crane. It is also impossible to push it using hands from the inside, as the tub with the solution is too heavy. In addition, it cannot get through the window. If the tub is horizontal, then it can be inserted into the window, but then the solution will not emerge from it.
This contradiction is solved in the same way. Cubic part of the tub remains vertical. However, its narrow part is tilted almost horizontally. The 'nose' is inserted in the window, and the solution flows under pressure of the vertical part, and inside the premises.

When a contradiction is solved, the concept of the original object is changed. This is the way the concept of indivisible valence bonds was changed. The concept of naked sculptures and tensed muscles, the concept of the straight tub, were changed in the same way. The initial concept is no longer needed, as it was replaced by a modified one.

The new concept will also face contradiction in the future. We may see how it will happen. Now we need to understand that: the first analogy will not stay eternal and unchanged. It is developing and being replaced with new, more adequate ones that describe more properties of the object or the phenomena that we are currently studying.

After a series of changes to the analogy, it becomes completely unrecognisable – complicated, confusing and almost impossible to use.

Example 93: The analogy of the sky and the sphere was clear and simple. However, after studying planetary motion, the Sun and the Moon, its simplicity disappeared. Calculation of all cycles, epicycles of first and second orders, eccentricities and other amendments, deviations and changes have made it incredibly complicated. In addition, it still did not provide the precision of calendars that were compiled according to the stars.

Example 94: Vehicles for centuries looked the following way: as a cart in front of which is a harnessed animal. The first draft animal was an ox. The cart was hooked on its hump with a leather belt (the yoke). After a horse was tamed, for many years, people could not change the familiar idea of the harness, and tried to fix the yoke directly on the horse's back.

Example 95: Until relatively recently, artists created paintings in the following way: at first they drew the shape and then painted it. In the Middle Ages, the examination for painters included a test where the applicant had to draw a thin line contour, without lifting the brush from the canvas. With the invention of the linear perspective (F. Brunelleschi) and aerial perspective (L. da Vinci), the task was to show the layer of air between the figure and conditional spectator. The contour did not allow doing this.

Then comes the understanding that the old analogy is best to be discarded and replaced with a new one. Copernicus changed the perception of the universe - it's not the Sun and the planets that revolve around the Earth, but the Earth and planets that revolve around the Sun. Around the 5^{th} century AD China invented a horse collar, which is put on the horse's chest and shoulders. Leonardo da Vinci discharged the contour on the background of a painting, and later Goya also discharged it on both the foreground and background.

New analogies, new ideas will go the same way. In the end, they will be dropped again and replaced with a new, yet very plausible analogy.

We have analysed only two of the eighteen qualities of talented thinking. However, we can already make a preliminary conclusion: these qualities are not given and are not achievable by just anyone. Only determination and due diligence can lead to its achievement. The same can be said for any other qualities: a person either continues to develop and achieve unlimited possibilities of the mind, or stops, and then all the previous training loses its sense.

As the Queen said to Alice from the Looking-Glass "Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!" This corresponds to the country of Talented thinking one hundred percent!

May your success be creative!