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LAWS OF DEVELOPMENT OF NEEDS

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Abstract
The article contains a description of trends of needs developed by the author and the methodology for using them.
Keywords: Ideallization, Law, Needs, Dynamization, Coordination, Integration.

Introduction

The distance from the generation of an idea of an engineering system to the implementation of this idea and to the business success from the said implementation is rather great. It is known that only one out of 3000 ideas[1] gets developed to the stage of business success.

In connection with that it is important not only to select the right idea, which corresponds to the trends of engineering system evolution, but also to correctly identify the need for this idea and the demand for it.

According to the research performed by Clayton Christensen and described in his book "Innovator's dilemma"[2], the demand for new marketable product changes in the following sequence:

1. First the consumers are ready to pay for better **functioning** (bold type supplied by V.P.);
2. After that they don't pay for better functioning, but they are ready to pay for the enhancement of **reliability** (bold type supplied by V.P.);
3. At the next stage they don't want to pay for reliability, however they are ready to pay for the **convenience of use** (bold type supplied by V.P.);
4. Further on, they don't need any conveniences, however they will readily buy a **cheaper** product (bold type supplied by V.P.).

Christensen writes that it is of great importance for the manufacturer to get complete understanding of what the consumer wants at the given moment and not to try to offer the consumer reliable goods when the buyer is ready to pay for the convenience of use.

Thus, for the business success the manufacturer of the product should exactly determine, when the consumer is ready to pay for the enhancement of functionality, when - for the enhancement of reliability and when - for the enhancement of convenience of use, and when the consumer wants to get a cheaper product. These issues are very important for the forecasting of need. The laws of evolution of need are not analyzed in this article.

Analysis according to the diagram of Noriaki Kano[3] (Fig.1) is widely known. It is a model of studies of three different types of needs which can be expressed by the consumer with regard to goods and services. These three groups include: one group of "spoken" needs and two groups of needs, which remain "unexpressed" and which could remain unnoticed in the course of study.

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[1] Greg A. Stevens and James Burley, "3000 Raw Ideas = 1 Commercial Success," in May-June 1997 Research Technology Managhement review. This information was kindly made available to me by Mr. Leonid Kaplan (USA).

[2] Clayton M. Christensen. The Innovator's Dilemma, Harper Business, 1997. This information was made available to me by Mr. Leonid Kaplan (USA).

[3] The presentations were made at the annual meetings of Japanese Quality Control Society, N.Kano and F/Takahashi "Motivator and Factor of Quality Hygiene " October.1979; N.Kano, Sh.Tsuji, N.Seraku, "Attractive quality and obligatory quality" (1), (2)" October. 1982.

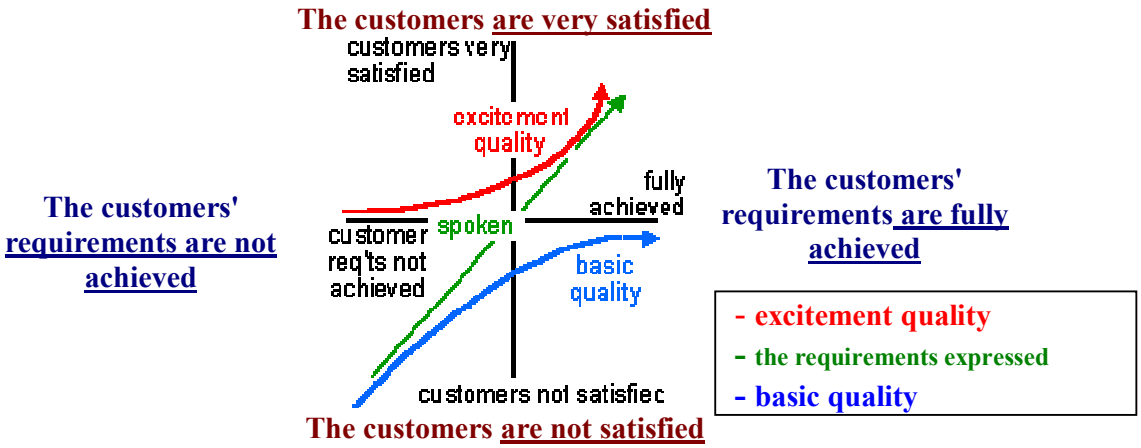


Fig. 1. Kano's diagram

"Spoken needs" are rather evident. They refer to such aspects of goods or services, which can be determined fairly distinctly.

The second group includes the first direction of "unexpressed" needs – these are the needs for "basic quality". They are also fairly explicit, however, they can be easily missed – especially when the consumer and the supplier relate to different "cultures".

The third group are "unexpressed" needs, about which the consumer even never thought. Kano called them excitement quality needs. They are characterized by features, which make the marketable product or a service more valuable for the consumer.

Kano's diagram enables to take three indicated kinds of needs, which makes it easier to develop a strategy of relations with consumers, however does not offer any way and tendency of needs evolution and first of all of "excitement qualities" evolution.

In this article we shall analyze the laws of needs evolution.

Based on the laws of needs evolution it is possible to determine the needs of the future and to identify, what functions and systems could be used for satisfying these needs. It also includes the identification of essentially new directions of engineering system evolution (pioneer solutions).

The most detailed description of human needs was proposed by Abraham Maslow [4]. He analyzes seven groups of needs:

1. Physiological needs (for food, clothes, lodging, relief from pain, etc.).
2. Need for safety (reliable protection from premature death, from physical injuries, loss of means for satisfying physiological needs, etc.).
3. Need for love and heart attachment to other people (friends, beloved, wife, children).
4. Need for respect of other people and for self-respect.
5. Need for self-expression and manifestation of individual endowments.
6. Need for learning and understanding the surrounding world, which contributes to satisfying the needs 1-5.
7. Aesthetic needs.

A.Maslow arranged the groups of demands in the order of their priority. According to his study the satisfaction of needs moves in the direction from group 1 to group 7. If the needs of the lower level, for example, the needs of group 1 are not satisfied, the human does not think about the needs of the next level. The pyramid of needs according to Maslow is shown in Figure 2.

[4] Maslow A.H. Motivation and personality. Brandeis university. New York. Harper and Brothers, 1954. 411 p.

Fig. 2. Pyramid of needs according to A.Maslow

William Tally[5] uses the hierarchy of needs developed by Maslow, however, he asserts that there is no such dependence of needs. The needs of lower levels can be compensated for by the needs of upper levels. He proposed a meta-model of needs and a cartogram of personality, which can be used for the evaluation of needs. An example of cartogram is shown in Fig. 3.

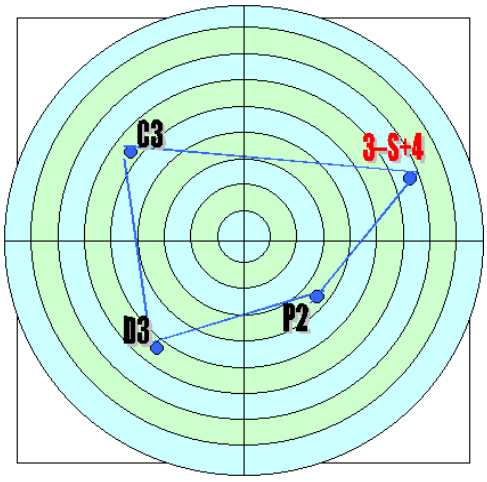


Fig. 3. Personality cartogram according to W.Tally

The laws of needs evolution are subjected to the **Trend of growth of needs.**

The general tendency of needs evolution develops from the satisfaction of **primitive needs** to the satisfaction of aesthetic needs. A.Maslow did not describe one more category of needs - **intellectual and creative needs**. We refer these needs to the highest needs of the human. The need for the elimination of human involvement in the processes of creating goods and offering services. As a consequence the process of constant increase in the amount of spare time of the humans and the need for occupying this spare time.

To primitive needs relate a need for food, sleep, protection from acts of elements and other humans, sex. The evolution of these needs leads to the increase in the number of different methods of satisfying them and to the enhancement of their quality.

Each of the types of needs is also characterized by hierarchical structure. One type of needs causes the appearance of another type, which in its turn, causes the appearance of a new one.

Example 1. Satisfying the needs for food led to the appearance of another need – for food procurement. This need caused the appearance of a need for procurement of food and cooking it. In its turn, it triggered the need for different

[5] W. Tally, Motivation and Personality, Rew. Ed. Van Nosiran, 1982.
W. Tally, Tally Needs Inventory, Monterey, Calif. Brooks/Cole, 1986.

methods of getting food from nature (hunting, search for plants and gathering them) and independent cultivation of food products (agriculture). Each of these kinds of needs leads to the appearance of next needs. Hunting requires the development of hunting methods and the appearance of means for hunting. They lead to the appearance of separate industries, producing means for hunting, which causes the appearance of another "embranchment" of new needs. The development of agriculture caused the foundation of specialized scientific centers and industries.

Individual kinds of needs often get integrated and a new branch appears.

Example 2. Thus, the consumption of food was integrated with the branch of spending spare time. Restaurants and other institutions of this type (dining places) appeared. Special rooms were required for them as well as equipment, entertainment programs, etc.

Therefore, the laws of needs evolution follow two directions: **appearance of essentially new needs and the development of existing needs.**

Example 3. The growth of the need "occupation of spare time" led, for example, to the creation of industry of entertainment. It includes different shows, game-playing machines, computer games, etc. All this leads to a need for developing appropriate engineering and technology, i.e., to secondary needs. Thus, the performances of modern pop-musicians caused the necessity not only for the modification of sound-reproducing equipment, but also to create new light effects. Now lasers and devices creating smoke effects are used alongside ordinary color organs.

It is possible to suppose that in future the equipment will appear which will be able to act upon other sensor channels, for example, the equipment generating odor, sensation of vibration and movement, variation of temperature, etc. with frequency and amplitude modulation. The performance of the described functions could imply the engineering systems which already exist and besides, new efficient systems will be created, which will use other physical, chemical, biological and geometrical effects.

Example 4. An example of a new need can be the generation of any sensations according to the human wish. This need could be satisfied using known means (hypnosis, alcohol, drugs). These actions don't always lead to adequate results and are not safe for health. The same need could be satisfied using new means, for example, the action of electromagnetic fields upon certain zones of the human brain.

This approach will enable to effectively control human health and mood and could become a new trend in the system of education, in art, etc. The information will be more versatile, since not only visual and oral sensor channels are going to be activated. Even today tactile information is extensively used for communication with blind people, since they cannot decipher information by the movement of lips and by the gestures.

In mobile phones it is possible to use vibration signal instead of sound signal ("ring"). Based on the same principle, it will become possible to create "phones" for deaf and blind humans. The information will be transmitted by changing the frequency and/or amplitude of vibration or dynamic modification of the surface, which will correspond to certain letters or words.

The use of odor can become revolutionary in the dissemination of information, in teaching, in the appearance of new kinds of art, different amusements, medicine, etc.

These needs will cause the appearance of new engineering systems. At the initial stage known engineering means will be used. Then new features of the existing engineering devices will be identified and these devices will be used in new functions. Further on, specialized and, maybe, essentially new means for satisfying these needs will be created.

Example 5. Delivering odors through E-mail.

British company Telewest Broadband and American scientists from Trisenx developed a device connected to a computer, which generates an aroma, "associated' wit the E-mail message and this aroma may vary from the odor of a violet, smell of the beach and coconuts to the odor of juicy beef steaks, which are being roasted on coals, etc. (Fig. 4).

Fig. 4.

Fig. 5.

Example 6. "On-the-phone" odor.

Scottish company Electronic Aromas developed a technology for delivery of odors through mobile phone (Fig. 5). The apparatuses are equipped with chambers filled with molecules of different substances. The corresponding phone call will stimulate the formation of certain molecular combinations.

Example 7. Problems and potentiality of transmitting odor information.

The delivery of odor information will most probably face certain difficulties. The odor spreads throughout the entire room. To substitute it for a different odor it is necessary, first of all to eliminate the existing odor, which also needs the

application of certain engineering means or definite chemical agents, and besides it will need time consumption. It leads to the fact that such system is rather inert and consequently the transmission of information will be rather long.

As a rule, such contradiction is solved in space. The source of information should be as close to the "receiver" of information as possible. Consequently the odor should be delivered directly to the nose. Then it will take little time to eliminate one odor and to deliver another one. Besides, only diffusive odors should be used.

Example 8. Modern perfumes.

Use of diffusive perfumes is a tendency in modern perfumery. It was assumed earlier that the more stable the scent was, the higher its quality was. Modern ladies would like to use different scents at different times of the day. The perfumes are changed depending upon the type of activity or contacts with different people. In connection with that perfume manufacturers started producing diffusive perfumes.

Example 9. Tactile information.

Tactile and temperature information could be delivered, for example, through special gloves, which could include built-in sources of temperature, oscillations, modification of shape, surface, rigidity and other features of materials, which could be perceived through tactile sensations. Thermal pipes, piezo-materials, materials with shape memory effect, etc. could be used here.

Example 10. Action upon the human brain.

Action effected directly upon certain sections of the human brain obviously require additional research so that different people should experience adequate sensations. From the standpoint of engineering such devices could take the form, for example, of a helmet with a versatile system of electrodes and sensors. Different electromagnetic fields acting upon the brain and causing definite sensations, transferring specific information will be delivered through these electrodes. The sensors are required for the control of developing virtual processes.

1. Structure of Trends of Needs Evolution

Satisfying the needs can be implemented through **known and new functions** (Fig. 6), the change of which is subjected to definite trends.

Known functions can be performed **by existing systems** or **by newly created systems.**

New functions can be performed **through the use of available systems for new purposes** or **through the creation of qualitatively new systems.**

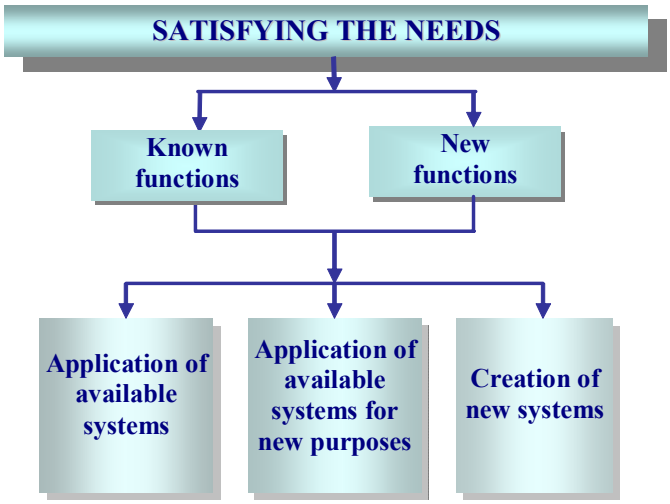


Fig. 6.

The evolution of each kind of needs is subjected to definite trends.

The author formulated the following **trends of needs evolution**:

- **Idealization of needs.**
- **Dynamization of needs.**
- **Coordination of needs.**
- **Integration of needs.**
- **Specialization of needs.**

Idealization of needs **is performed** through **dynamization, integration or specialization** and the subsequent **coordination of needs** (Fig. 7)**.**

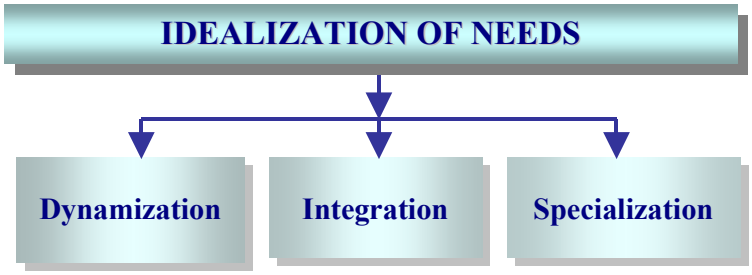


Fig. 7.

2. Satisfying the needs using functions

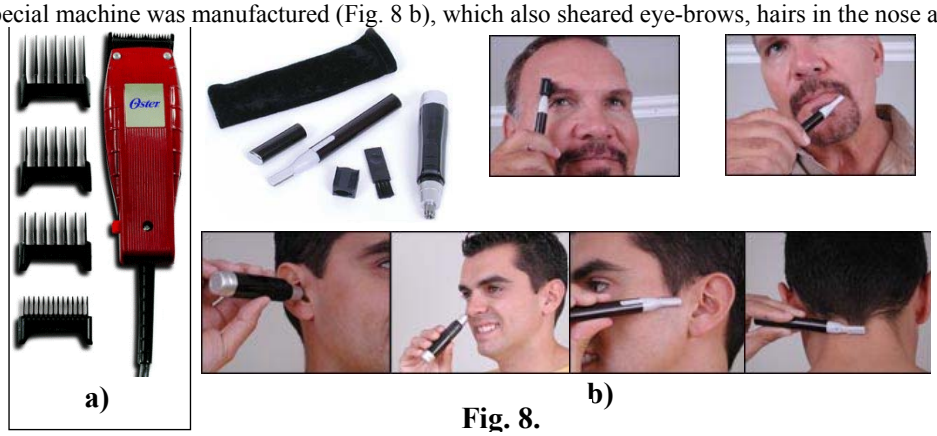
As it was noted above, satisfying the needs could be performed through **known** and **new functions** (Fig. 6).

2.1. Satisfying the needs using known functions

To perform known functions it is possible to apply **existing systems** or to **create new systems**.

2.1.1. Use of existing systems

Example 11. A need for shaving beard and moustache with an electric razor appeared. Similar function was originally performed by a hair-cutting machine, which was used for shearing hair on the head (Fig. 8 a). After that a special machine was manufactured (Fig. 8 b), which also sheared eye-brows, hairs in the nose and in the ears.



a) **b)**

Fig. 8.

Fig. 9.

Example 12. "Boeing-747" will be equipped with a battle laser.

Boeing corporation modernized the transport aircraft 747-400, installing a battle laser on it (Fig. 9).

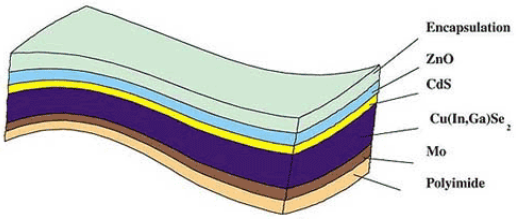
Further on, a **special carrier** of battle laser will be created. First **a ready-made aircraft** was used.

Example 13. Solar batteries can be printed on a jet printer.

Scientists Ghassan Jabbour and Yuka Yoshioka from Arizona University in Tascona used an ordinary jet printer for the manufacturing of semi-conductor devices. They made use of an **old cartridge**, filling it with a fluid organic substance from which a polymer with features of a semi-conductor is generated afterwards.

So far this technology was used only for development of relatively simple semiconductor systems - photodiodes and photoelectric cells. The developers think that in future it will become possible to use it for manufacturing of different devices. The new method is a multi-purpose method: semi-conducting polymer can be applied practically over any kind of material from fabric and plastic to silicon plate or glass and the polymer film remains practically invisible for the human eye.

The next step will be construction of a **special printer**.



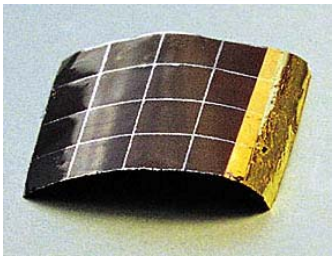


Fig. 10.

2.1.2. Creation of new systems

To satisfy a new need, first of all it is necessary to find, if there are systems performing similar functions. If such systems don't exist, new systems are developed.

Example 14. Solar batteries of nano-tubes.

In California University (Berkeley) photoelectric cells were developed, which are manufactured of carbon nano-tubes applied over the plastic substrate. Due to miniature dimensions of nano-tubes quantum effects act and the degree of absorption of rays of a certain part of spectrum is increased approximately two times.

2.2. Satisfying the needs using new functions

To perform new functions existing systems can be used **for a new purpose** or **qualitatively new systems** can be **generated**.

2.2.1. Use of existing systems for new purposes

When a new function appears, first attempts are made to perform it using existing systems, which performed this function previously or which had this function, however it was used as a secondary one, was not used at all or was treated as needless or even harmful.

Example 15. When the electric contacts are circuited, the spark generated thereby spoils the contacts (leading to erosion of metal). This phenomenon was soon used for metal processing (processing of metal through electric erosion).

Example 16. Wounds and cuts were covered with sponges and bandaged. The function of glue sealing of wounds did not exist. In 1920 Earl Dixon proposed the idea of bactericide plaster, which was manufactured by the company "Johnson and Johnson".

In the USSR the workers used insulating tape for glue sealing of cuts.

Some workers glued the cuts with an alcohol-based glue (in the USSR such glue was called BF-2). After than glue of similar kind with antiseptic additives began to be used for gluing the wounds (in the USSR such glue was called BF-6).

2.2.2. Creation of qualitatively new systems

Example 17. New function of laser.

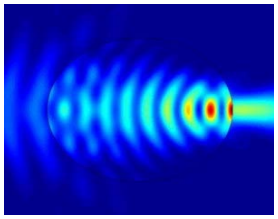


Fig. 11.

Queensland research center developed a laser tweezers (Fig. 11), which is used for seizure of micro-particles.

Micro-particles move to the place, where the light ray "is stronger". When the laser beam is not uniform, the particle is attracted to the area of maximum intensity of radiation. Translating the focus of the beam it is possible to move 'captured" objects and make them perform complicated movements.

The tool is used for studying DNA cells, mechanisms of delivery of medicines to thick organs of the human body, penetration of medicines through the membranes, diagnostics of cancer.

Using a laser of high illuminating power it is possible to study chemical reactions which last for billion portions of a microsecond. Optical tweezers enables to measure very small forces, of the order of magnitude 10-12 H and rotation force. Measuring of rotation forces is important for the evaluation of dynamic features of biological elements and solutions.

Example 18. A robot could be mixed up with a real woman

Kokoro Dreams and Osaka University created the prototype of an anthropomorphic robot of new type - a woman , who can imitate human speech and wink (Fig. 12).

Fig. 12.

The robot is able to realistically reproduce facial gestures of the human.

Example 19. Mobile phone for dogs.

Fig. 13.

Finnish company Benefon, Arbonaut and Pointer Solutions company created a mobile phone for dogs (Fig. 13).

Pointer dog-GPS consists of two parts. The main part is a modified Benefon Esc - two-range GSM-phone with a 12-channel receiver GPS. It can contain maps and routes of movement, SOS signal with exact coordinates, etc. The module can maintain communication with three dozens of transmitters, which are carried by the dogs.

Another part is secured on the dog's collar. It enables to trace and to memorize the route of the dog. The body of the device is water-resistant and shock-proof. The phone can function in hot weather and in severe cold and the collar itself is equipped with light-reflecting elements. If the dog stays in the zone of coverage of GSM-operator, it is possible to obtain connection to the microphone which is carried by the dog .

Example 20. Detector of love

"Detector of love" is being created, enabling to identify and to analyze the emotional state of the interlocutor during the conversation (Fig. 14).

Fig. 14.

Example 21. 3-dimensional display for mobile phones

Fig. 15.

South Korean company Samsung developed the first-in-world-history display for portable devices, which enables to see 3-dimensional images without using special spectacles and practically at any angle (Fig. 15).

Users of mobile phones, communicators or pocket computers, equipped with 3D displays, will have an opportunity of switching between 2D and 3D modes. Besides, it will be possible to view 3-dimensional images even in such cases, when the screen is turned by 90 degrees.

3. Trend of idealization of needs

Trend of idealization of needs presupposes the improvement of the needs' quantity, needs' quality, decrease of time consumption and means intended for satisfying these needs as well as the reduction of harmful actions (payment factors).

Degree of idealization of needs could be presented in the following form:

$$I = \alpha \frac{\sum_{i=1,\ j=1}^{\infty} Qn_i\ Ql_j}{\sum_{k=m}^{0} C_k + \sum_{l=n}^{0} \beta_l H_l} \Rightarrow \infty;$$

Where:

I – degree of idealization of needs;
Qn – number of needs;
Ql – quality of needs;
α,β – coordination coefficients;
C – consumption of time and means for satisfying needs;
H – harmful actions (payment factors);
i – index number of need *Qn*;
j – index number of need quality *Ql*;
k – index number of expenditure *C*;
l – index number of harmful action (payment) *H;*
m – maximum amount of expenditures *C*;
n – maximum number of harmful actions *H*.

Features of ideal need.

Ideal need is a need, which is satisfied at the required moment in the required place at required circumstances.

Ideal need is a need, the requirement of which is not a necessity. The need has become needless or it gets satisfied all by itself.

Example 22. The need is satisfied at the required moment in the required place through the use of different folding or inflatable objects.

Example 23. Let us analyze the satisfaction of need for food. Initially the human ate everything, what he could obtain (as a rule, the food was always the same) and wasted much time on it. Modern age is characterized by a huge versatility of different kinds of food, the cooking of which either don't require any time whatever (food is ready for eating) or everything is cooked very quickly Сегодня (ready-to-cook foods). Therefore, the need for food "procurement" disappeared.

Example 24. Let us analyzer the process of need idealization on the example of washing dishes.

Earlier the dishes were washed manually. The places, which are especially dirty had to be scratched with a brush for a long time. Scratches were left on the dishes. After that the evolution of this process took several directions.

Different detergents appeared, which accelerate and improve the washing process. The only thing to be done after the application of these agents is to wash away the dirt.

The next step for idealization of this need – the need gets satisfied itself – *the dishes get washed themselves* – a dish-washing machine.

Further idealization of the need – *rejection of need* (need for dish washing became useless), i.e., the function of washing dishes became useless with the appearance of disposable dishes. Another method is to make the dishes edible. The foodstuff is put into salad leaves, cabbage leaves or pita.

Example 25. There is a need for heating or cooling of foodstuff or drinks. This need is satisfied through heating on gas (electric) stove or in microwave oven, while the food gets cooled in the frosting chamber.

The idealization of this need – rejection of necessity to heat or to cool. Self-heating (Fig. 16) and self-cooling (Fig. 17) containers.

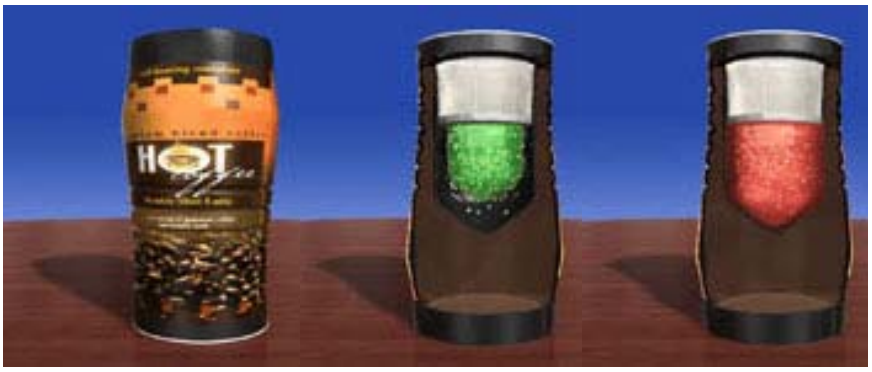


Fig. 16

Fig. 17

3.1. Increase in number of needs and improvement of their quality

3.1.1. Increase in the number of existing and newly appearing needs

Increase in the number of needs could take the form of **appearance of new needs** and **diversification of available needs.**

1. Appearance of new needs.

Example 26. Implantation of electronic microchips

A need appeared to identify animals, especially expensive ones. A microchip was developed (Fig. 18), which is implanted into the body. All data on this animal and its owner is recorded on a microchip. The information is read using a special device.

Consequently the microchips were implanted into human bodies. Using a microchip I is always possible to identify a human and to know about his (her) location. It will enable to prevent the kidnapping, to monitor his (her) state of health, etc.

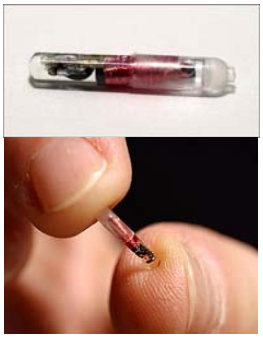


Fig. 18. A microchip to be implanted

2. Diversification of existing needs.

For example, through specialization of needs or invention of additional means.

Example 27. When soap was invented, it was used for all cleaning procedures. Nowadays there is special soap for face, individual detergents for washing dishes, individual detergents for washing oily dishes, etc.

Example 28. First scissors were used for shearing (Fig. 19 a). Then mechanical machines for shearing appeared (Fig. 19 b). They were substituted by electrical machines for shearing (Fig. 19 c). Later on, specialized machines for shearing eyebrows, hairs in the nose, in the ears, etc. were developed (Fig. 19 d).

a). **b).** **c).** **d).**

Fig. 19.

3.1.2. Quality improvement of existing and newly appearing needs

It is possible to improve the quality of needs through **development** and/or **use of more progressive means** or **the invention of essentially new means,** satisfying newly appearing needs.

Quality improvement of existing and **newly appearing needs** can be implemented through:

1. Development and/or **use of more progressive means.**

Example 29. Need for improvement of TV image quality was satisfied by transition to digital transmission of images.

2. Invention of additional or essentially new means, satisfying newly appearing needs.

Example 30. Hair cutting machines were equipped with caps, regulating the length of the remaining hair (Fig. 20).

Fig. 20.

Fig. 21. Toothbrush – iones

Example 31. Toothbrush - ions

The stick of the toothbrush (Fig. 21) is manufactured of titanium dioxide (TiO_2). When exposed to light, this stick releases electrons, which due to conducting saliva while contacting with acid contained in the dental plaque generate positive ions of hydrogen, destroying dental plaque and bacteria. Teeth get cleaned due to photo-catalytic features of titanium stick. Need for toothpaste and even for water disappears.

This is an example of creating **an essentially new means**.

3.2. Decrease in consuming time and means on satisfying needs and decreasing the number of harmful actions

3.2.1. Decrease in consuming time and means on satisfying needs

Reduction of expenses of time and means on satisfying needs ois implemented through:

- **Concurrent satisfying of several needs;**
- **Satisfying of several needs using one means only;**
- **Satisfying of new means using available resources.**

Concurrent satisfying of several needs.

Example 32. Need for travel in space, for example, driving a car and concurrent obtainment of information was satisfied, when a radio set was incorporated into a car. A similar example - the use of cellular phones in cars.

Satisfying several needs using one means only.

Example 33. Computer can perform several types of work concurrently .

Example 34. Video-camera can be used not only for shooting, but for viewing as well.

Satisfying new needs through available resources (of existing systems, processes, services, etc.).

When new needs appear, first the available engineering means are used, and the existing technological processes are used for manufacturing of new products. New types of services are first offered by the available companies. At the next stage specialized products, processes and services appear.

Example 35. A need for extinguishing fires on water appeared. This function was first performed by ordinary vessels, then special fire-fighting vessels appeared.

3.2.2. Decreasing the number of harmful actions (payment factors)

Decreasing the number of harmful actions could be implemented via preliminary analysis of needs with the involvement, for example, of elements of TRIZ and "failure anticipation analysis".

Some ways of decreasing the number of harmful factors:

1. **Use of non-waste and balanced technologies**
2. **Use of resources**
3. **Use of effects, first of all, biological**

Example 36. Jet printing of circuit boards.

Seiko Epson company developed a technology for jet printing of circuit boards, the size of which amounts to 27x24 mm, which consist of 20 layers and the thickness of which without substrate amounts only to 200 microns (Fig. 22). It is possible to locate 30000 transistors on such circuit board.

Methodology of photo-lithography is currently used for the manufacturing of printed circuit boards. This is a rather expensive and labor-consuming process, consisting of several main stages: development of photo-masks for individual layers, formation of electric connections, etc. And it is **necessary to use special chemicals, utilization** of which creates **additional difficulties**.

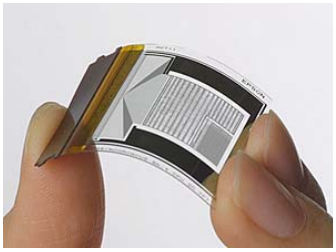


Fig. 22. Printed circuit board

Technology of jet printing of circuit boards is destined to significantly **reduce the expenditures** on manufacturing of microcircuits and **to reduce noxious emissions** into the environment.

4. Trend of dynamization of needs

Trend of dynamization of needs presupposes the change of needs:

- **in time,**
- **in space,**
- **in structure,**
- **according to a definite condition.**

The needs get adapted for:

- definite location,
- a group of people or a particular person.

The needs are satisfied at the time, in the place and in the form, which is required.

The needs can take into account specific features of:

- national peculiarities,
- occupation,
- age,
- sex,
- level of education,
- religious convictions,
- season of the year and time of the day, etc.

Needs for elimination of human involvement in labor processes (mechanization, automation, cybernetization) can also be related to dynamization of needs.

Example 37. The most explicit manifestation of dynamization is clothes. It changes depending upon the season, time of the year, upon its function. There are many types of labor clothes. For example, clothes for firemen, aviators, medical workers, etc. Outer clothing is very versatile - ball dresses and dinner jackets, wedding clothes. The fashion constantly changes and every person can choose his or her own style.

Example 38. Another example could be a need for creation of living conditions, for example, temperature. Different heating devices were created, which heat not the entire room, however, could generate a flow of warm air, which is directed to the required place.

Modern air conditioners not only generate different air temperature in different rooms. They can also change it according to selected or specially composed program, they can generate specific temperature in the selected point. The conditioners can regulate humidity and generate definite odors.

5. Trend of coordination of needs

Coordination of needs can be implemented according to:

- **the needs proper** (coordination of needs between themselves)**;**
- **parameters;**
- **structure;**
- **conditions;**
- in **space;**
- in **time.**

In particular, **coordination** could be **dynamic**.

Non-coordinated needs often lead to disappointment, conflicts, bankruptcies, different cataclysms, wars, ecological catastrophes, etc.

Coordination of needs is also understood as dis-coordination of needs induced intentionally (intensification of maximum difference between the needs).

Example 39. Many people like to eat much and to eat delicious foods. It often leads to fatting, which not only makes the figure less attractive, but also negatively tells upon the human health. Another need - to have a beautiful figure and to be healthy, is the opposite to the preceding need. To preserve the figure it is necessary to eat little and not always delicious food. Special subcaloric food was invented for the purpose of coordination of these needs, for example, different kinds of soy foodstuff. Different additives reducing weight were proposed. Special kinds of physical loads were developed.

Coordination of needs according to parameters was described in the example with an air conditioner. Temperature, humidity and odor perform the function of coordinating parameters in this example. This is an example of dynamic coordination.

Example 40. Imagine a situation, which occurs very often. People, staying in one and the same room can have diametrically opposed needs. For example, one person would like to enjoy silence, while another would like to listen to pop-music at the full volume, which the music center can offer. Coordination of these kinds of needs can be resolved in time –one person has his or her rest, while another person does not disturb him (her); in space - it is possible to listen to

the music in one room and to have rest in another one; in structure – the place where they listen to the music or have rest has sound-insulating interstices, or earphones are used (Fig. 23).

Fig. 23.

Example 41. At a certain place a manufacturing plant is erected, which contaminates environment. The inhabitants of this region would like to live in ecologically pure environment. The needs are not coordinated. One of the ways of resolving such contradiction – to coordinate the needs of the plant's owners and of the inhabitants of this region. A law is passed that the owner of the plant should pay a large amount of money as a fine for contamination of environment and it appears to be more profitable for him to install a purification system.

Coordination of needs can be implemented, in particular, through the **integration** of these needs or through selection of a **special** need.

6. Trend of integration of needs

The integration is performed in such a way that the useful (necessary) features are summed up and intensified, while harmful features are either mutually compensated for or remain at the former level.

There are several ways of integration:

1. Integration of **similar** (identical) needs.
2. Generation of **similar needs with shifted characteristics**. Needs with shifted characteristics are understood as similar needs with different parameters, features and characteristics.
3. Generation of competing (**alternative**) needs.
4. Integration of **heterogeneous** needs.
5. Integration of antagonistic (**opposite**) needs.

Example 42. It happens often that identical shops, for example selling furniture or lighting devices are located in close proximity one to another. It is convenient for the buyers. This is an example of integration of **similar needs**.

Example 43. In great trade centers there are several clothes shops, however, these are the shops of different trade companies. This is an example of integration of similar needs with shifted characteristics.

Example 44. A sports car is transformed into a high-speed cutter through pressing a button (Fig. 24). The machine can develop the speed of up to 180 km/hour on land, in a floating variant its speed can attain 50 km/hour. The amphibian is equipped with an engine, the power of which is 175 horsepower and it has a fuel distance without refueling amounting to 80 km. This is an example of integration of **alternative needs.**

Fig. 24

Example 45. An air conditioner integrates several needs at once: to cool and to heat air (integration of **opposite needs**), generate certain level of humidity and certain smell (**heterogeneous needs**).

Example 46. A restaurant integrated a need for food and a need for amusement (integration of **heterogeneous needs**).

Example 47. Integration of needs for doing sports and obtainment of information led to the appearance of players and radiosets in the form of earphones (Fig. 25). This Example illustrates the integration of **heterogeneous needs.**

Fig. 25. Radio-earphones

Example 48. Toothbrush.

Fig. 26.

The American company OHSO developed a toothbrush (Fig. 26), in which the toothpaste is collected using a special piston. During the process of teeth-cleaning the paste is pressed out using this piston.

It would be ideal, if the need for toothpaste disappeared. It was described above, in example 31 (Fig. 21).

Integration of needs often leads to the creation of **multi-purpose** objects.

Example 49. Multi-purpose halls are constructed, in which different concerts and sports competitions can take place. These halls can be divided into different rooms or, vice versa, integrated into a big complex. They are quickly transformed.

Therefore, integration can take place:

- **in space,**
- **in time,**
- **in structure.**

Example 50. One and the same person can have a need for possessing an ordinary car and a jeep. An ordinary car has good aerodynamic characteristics therefore, it wastes much less shell than jeep. However, an ordinary car cannot move along wood, mountain and village roads. Jeep has a higher suspension mount and a more powerful engine. It is not only expensive to have two cars, but also it is necessary to have a large garage.

Fig. 27.

AUDI company started manufacturing a combination of a car and a jeep Audi Allroad Quattro (Fig. 27). Its body has wonderful dynamic characteristics. The body can be raised and lowered down.

In parking the body is always pressed up as far as it can go (it is raised) – in order to make getting into the car and out of it more convenient.

Special tires and many other innovations enable to create a car of high passing ability.

It is an example of integration of **homogeneous needs with shifted characteristics**.

7. Trend of specialization of needs

Trend of specialization of needs is directed at the selection of one "narrowly understood" need, which satisfies the available need more accurately and at a higher quality level.

The improvement of need specialization is performed in the following sequence:

1. To select the most important part of need;
2. To develop this part of need;
3. To provide for better conditions of satisfying this part of need.

Example 51. The need for separation of special kinds of food appeared, for example, kid's food, kosher food, food for healthy nourishment. Or in a narrower sense - diet food, etc.

Example 52. There are special halls for concert-goers – philharmonics. Special sports-oriented edifices exist for individual kinds of sports (swimming-pools, basketball, volley-ball and football fields, etc.).

Example 53. Toyota company developed a car for one person - Toyota-PM-Personal-Mobility (Fig. 28). This is an electromobile (battery vehicle), which is embodied as a drop-shaped structure. The body of the automobile can acquire three positions: high-speed movement – the body acquires horizontal position and is pressed to the road, attaining the best aerodynamic characteristics; for driving in the city the body is raised to a certain extent, providing for a better observance; when people get into or out of the car, the body should be closer to a vertical position and the seat is moved forward providing for more convenient getting into or out of the car. Front wheels are able to turn irrespectively one from another to provide for more convenient parking. If they are turned inwards, the car will be able to rotate on the spot. The control is effected using a computer, equipped with a holographic interactive display. The display of the computer shows all the data, including the location of other private cars. Personal cars exchange information between themselves, enhancing safety and convenience of travel.


Fig. 28

8. Development of new needs

8.1. Stage of identification of new needs

Based on the trends of **needs** evolution, it is possible to identify the needs of the future and identify, what functions and systems could be used for satisfying these needs. Also it will be possible to identify cardinally new directions in the engineering systems evolution (pioneer solutions).

The stage of identification of new needs is performed by the author in three stages:

1. Identification of latent needs
2. Identification of new needs
3. Forecasting future needs (identification of tendencies for development of future needs).

8.2. Methodology of identification of latent and essentially new needs

First all non-identified disadvantages of the analyzed system as well as potential disadvantages, which can appear in future are identified using this methodology. After that follows the identification of non-satisfied wishes, which the clients have today and latent wishes, about the existence of which the client does not even know yet.

The analysis is performed in stages.

1. Latent (non-identified) disadvantages are identified using the elements of TRIZ and "failure anticipation analysis".
2. Future disadvantages are identified using the trends of systems and needs evolution.
3. Systematization of existing and future disadvantages.
4. The forecast of future needs is performed based on the methodology of needs forecasting, which, in its turn, is based on using trends of needs evolution.

5. Special inquiry. The goal of the inquiry is to identify latent needs. It is performed according to special methodology, involving the recruiting of a relevant group and a series of specialized questions aimed at identification of latent needs of the clients.
6. The comparison of data of inquiry and analytical research. As a result, a tree of latent and radically new needs, which will appear in future, is constructed. These data serve as material for development of new goods and services.

Let us demonstrate the methodology of latent needs identification.

Example 54. Object of research is pantyhose.

First the **disadvantages of pantyhose** are identified. They are as follows:

1. Pantyhose is easily torn;
2. Defects of skins are visible (spots, roughness, pimples);
3. With some ladies synthetic pantyhose is a source of skin irritation;
4. Pantyhose are not air-permeable ("they don't respire");
5. Pantyhose conduct water (water-permeable);
6. Pantyhose require washing.

Known methods for elimination of disadvantages.

1. Ladies have a spare pantyhose in their handbags. However, there are cases, when the spare pantyhose also gets torn.
2. Skin defects are hidden by wearing colored and fashion pantyhose. The ladies often want to have flesh-colored and transparent pantyhose.
3. Silk pantyhose don't cause irritation, but they are much thicker and less beautiful.
4. In order that pantyhose should conduct air, they are made net-like. Such pantyhose does not protect from external environment.
5. All known types of pantyhose are waterproof.
6. Pantyhose can be disposed of instead of washing it, however, this is expensive.

Demands to pantyhose, which are put forward.

1. Pantyhose should not tear, or there should be a possibility of changing pantyhose several times, but they should not occupy too much place.
2. Pantyhose should hide the defects of skin, bit they should be transparent.
3. Pantyhose should no cause skin irritation.
4. Pantyhose should conduct air (should "respire") and they should not conduct water (should be waterproof).
5. Pantyhose should be disposable and inexpensive.

Solution. Nagoya company started manufacturing spray stockings - Air Stocking (Fig. 29). A thin silky layer is sprayed over the legs. There are several color shades of spray. The coating conducts air and does not conduct water. Skin defects are covered several times and they are not visible. The coating is washed away in soapy water. There are 20 pairs of stockings in a spray container.

Fig. 29.

Example 55. Object of research is – protection of humans from hooligans and bandits.

There are protection means: battle pistols, gas pistols and aerosol containers with tear-gas, shockers.

Battle arms can kill the attacker. This is inhuman. The human should also have enough time to take the protection means out.

It is desirable that the hooligan should not be able to touch you or you could shock him distantly At that the protection means should be always ready – no time should be wasted on taking it out.

One of the solutions - shockers are masked acquiring the shape of other objects, for example, of mobile phone (Fig. 30).

Fig. 30.


Fig. 31.

Solution. Shocking clothes was invented - contact-less jacket – it is but an elegant jacket. If the owner of the jacket has a feeling that she is threatened by something, the jacket will be immediately converted into a ferocious arms of self-defense. Anybody, who touches the jacket, will get a shock of 80 000 Volt.

The jacket is powered by a 9-volt battery. It is completely insulated, and the owner of the jacket is not threatened by a danger of electric shock.

Another solution. A ring with tear-gas (Fig. 31).

8.3. Methodology for development of new needs

Development of new needs includes a stage for construction of tree of needs, which is performed in compliance with the methodology of constructing the tree of goals, developed by the author[6].

Let us describe the possible sequence of steps for development of new needs.

1. **Identification of field, in which a new need should be found** (one of the primitive needs, a need for creation, etc.)
2. **Construction of trees of methods for satisfying needs**
   - **2.1. Formulation of need**
   - **2.2. Description of methods for satisfying the given need.** All imaginable (real and fantastic) methods of satisfying needs in this field should be described.
   - **2.3. Analysis of methods for satisfying needs.**
     - **2.3.1. Definition of completeness of methods description**
     - **2.3.2. Identification methods which are currently applicable and non-applicable.**
       Note. A method of satisfying needs which was non-applicable earlier, can constitute a new need.
     - **2.3.3. Identification of disadvantages in the methods of satisfying needs.**
       Note. Identified disadvantages – these are the needs, which should be satisfied.
     - **2.3.4. Identification of existing means, which can eliminate the disadvantages of described methods.**
     - **2.3.5. Extension of methods, described in paragraph 2.3.4** (extension can be also performed through invention of new methods and means providing for the implementation of these methods)**.** The entire inventory of TRIZ tools can be used for invention of new needs.

The same tree of needs is constructed for applicable and non-applicable methods of satisfying needs. Analysis of such trees of needs enables to identify new needs.

Let us quote an example of using the above-described sequence of steps.

Example 56. Let us select the need– **travel in space.**

Let us describe the methods of **travel in space**.

It is possible to travel:

- **On the ground,**
- **In the ground (under the ground),**
- **On water,**
- **Under water,**
- **In the air,**
- **In space.**

As of today, there are methods for travel on the ground, on water, under water, in the air and in space.

It is possible to travel underground only through specially constructed tunnels, for example, by tube. Free underground travel does not exist nowadays. Ice-breakers partly travel in ice, but the largest portion of the vessel travels in air 9above the ice) and underwater (under the ice). The travel inside ice does not exist, for example, in Antarctic or during ice falls inn the mountains. Therefore, free travel underground and in ice are **new kinds** of **needs,** which are not yet satisfied.

First of all, the disadvantage of underground travel should be identified. Let us imagine that there are means for free underground travel. Then the main disadvantage is that they can "dig through" large spaces of land and the ground surface will fall through. Consequently, such vehicles should either repair these tunnels or reinforce them. Though it is possible to move underground in a bulk (like the airplanes move in the air), however we cannot make use of this analogy because of the disadvantages identified. Therefore, let us use the analogy with land transport. Underground tracks can be laid under the earth. These tracks can be one-way only. The tracks should be located at different levels, in this case they will no cross. In order that the vehicles moving at different speeds should not run one against another, it is possible to have only one speed at each track, for example, to create something like an escalator. Then there is no necessity to

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[6] Methodology for construction of tree graph of goals was developed by V.M.Petrov in 1975-76 for a course of lectures on system analysis. This methodology is published in:

V.M.Petrov. system analysis of selection of engineering problems.- Methods for solving inventive and design problems. - Riga, 1978, p.p.73-75.

V.M.Petrov. Principles of composing high-quality scenario – Methodological problems of engineering creativity. Abstracts of scientific papers. (Riga, December, 13-14,1979). - Riga, 1979.

V.M.Petrov. Identification of interconnections in the process of engineering systems development. – Problems and practice of teaching euristic methods of solving scientific and engineering problems. Materials of scientific and practical seminar of March 10-12. - L: LDNTP, 1981, p.p.51-52.

V.M.Petrov. Principles of constructing the model of controlling the process of scientific research. - Scientific organization of labor and management: results, problems, perspectives. Abstracts of scientific papers read at branch scientific and practical conference on April 15-17, 1981. - L: Central research institute "Rumb", 1981, p.p. 219-223.

organize a new kind of "road" police. There will be intercontinental high-speed tracks. The transport will move in them at speeds, which are close to the speed of an airplane. The system of traffic movement will be entirely automated. Selection of kind of transport will be performed by a computer depending upon the requirements, which are put forward by the passenger.

However, in order to provide for such movement it is necessary to develop the minimum of all required parts: means for energy supply, repair stations, etc. Existing means can be used or special means can be invented.

Example 57. Let us analyze one more type of need – the struggle for safety of traffic. It takes several directions: improvement of roads, improvement of cars, control of road traffic, including regulation, etc.

Special shock-absorbers are installed on the roads in places of turns, separation barriers, special strips, warning the driver that he pulls off the road (the tires begin to squeak and vibration is generated - so that the driver wakes up), etc.

The brake system of the car is improved, which enables to significantly decrease the braking way even on a slippery road, safety belts and safety cushions were introduced, car is automated, etc.

Radars appeared, which measure the speed of car movement, automated cameras appeared, which record the violation (over-speeding). With the appearance of radar the drivers developed a need for knowing, when the police records the speed of movement of their cars. Detectors appeared, which inform about that. Besides, means for prevention of over-speeding appeared. For example, in USA a silhouette of a police car is installed on the roads, which is made of plywood. The driver, who has noticed such a silhouette, reduces the speed to the permissible level. First the police took measures against the persons who acquired radar detectors. Of late, it does not only permit it, but even insist on the acquisition of a detector. Generators were installed on the roads, which imitate the radar signal. The drivers, who have heard this signal, immediately slow down.

Example 58. A special computer has been created, which helps to control the car. The destination point is entered into it through the indication of a point on the map, or through oral or written message in the language selected by you. The computer prompts the route and indicates it on the map. It warns the driver about over-speeding and other violations.

Рис. 32.

A car, which does not need any control at all, also exists. It has no steering wheel (Fig. 32). The only thing you have to do is to name the destination point and the machine will carry you itself. There are built-in sensors in it, which issue information on the situation on the road. Besides, there is a connection with satellites. The car moves along the road, taking the general traffic situation into account. It lays the optimum route and drives along the tracks which are least loaded. The car has a much better reaction than the human. Therefore, it is much safer to travel in such a car.

Example 59. There is a kind of unsatisfied need – the majority of people want to have their personal car. The buyer wants to have a car with wonderful consumer properties. As of today, industry is able to satisfy this need. However, not all buyers can afford to buy a car and there is a lack of high-quality roads.

Fig. 33.

Currently the car producers have started to manufacture cheap cars of small cylinder capacity. A tendency appeared to create a class of inexpensive cars (Fig. 33).

To reduce the cost of a car and to make its operation easier, a disposable engine has been developed. It will be inexpensive enough (no more than $300), while it will be operating for the same period of time as modern engines prior to overhaul. The substitution of such engine will take no longer than 10-15 minutes. Other parts of the car are being gradually developed according to the same principle.

Other ways of satisfying the described need.

The cost of car and the cost of its operation should not exceed the cost of travel by social transport, then it will be accessible to everyone.

Disadvantages of the social transport are as follows.

It functions according to time-table, which is not always suitable for a particular person.

It does not reach the place which is exactly required.

The number of people using social transport is greater, than that of people using private transport, which does not suit everybody.

The level of comfort is lower than in private transport.

Disadvantages of private transport.

High acquisition cost and cost of operation.

It is necessary to serve the car and to have a place where to store it.

It is necessary to control the car.

The car stands idle, when it is not in operation.

Of course, there are taxies, which meet the majority of demands, however taxi is also rather expensive.

Let us proposed a project of the future, which would meet all requirements.

It is necessary to develop an automated transport system. Each vehicle is completely automated and is connected to the united transport system. It moves in strict compliance with the general movement. All cars moving along one and the same way at the same speed, so that the crashes are impossible. Strains of movement is eliminated to say nothing of traffic jams, since the movement is directed along the roads, which are located at different levels above the ground or underground. The roads on the ground are either not used at all or used only for the purpose of providing an ability for the car to reach a particular building. Access routes will also be located either underground or above the ground. Then the lifts and escalators are used.

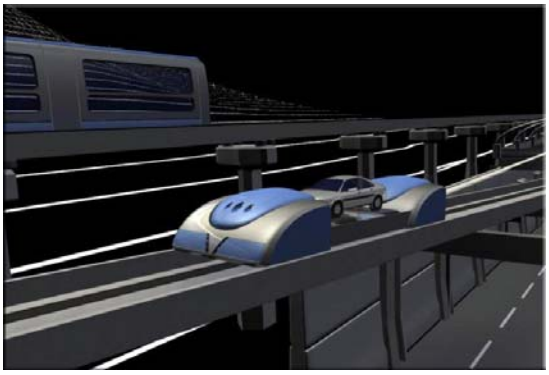

Fig. 34.

To use this transport system, it is necessary to order a corresponding car and to enter the time of arrival and the destination point. Automated system of transport control will lay the optimum route itself. At high-speed tracks the car will move in a high-speed "train". (Fig. 34). At the final stage it will travel independently and connected to another vehicle.

Operational expenditures will be borne by the company, which will maintain these cars.

Conclusion

The trends described here enable to predict future needs and the tendencies for changing them. Satisfying the identified needs will lead to the appearance of new goods and services.