

# The design features of the body of the portable electrocardiograph «ECG-EXPRESS»

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**Abstract.** The sequence of the industrial product shaping is specified, the main modeling characteristics of the configuration and some of its parts are designated subject to the electrocardiograph design and the technologies used for the production of its body.

## 1. Introduction

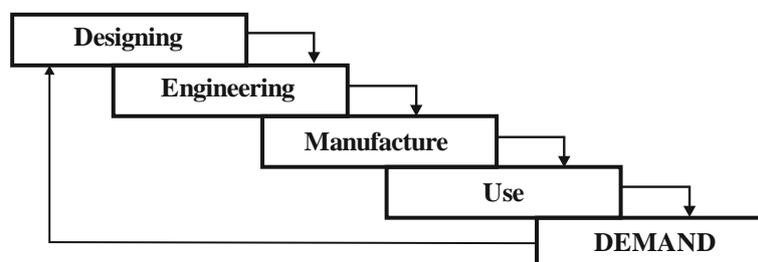
Currently the industrial design is a fundamental tool for the development of the competitive product, while the manufacturers experience much difficulties to stand among the competitors and amaze the customers with the modern and esthetically attractive design of the industrial products.

The relevance and potential of this trend is confirmed by a variety of the industrial products configuration introduced to the market. The quality, usability and ergonomics of the designed product is largely caused by the consistent regular shaping, which is dependent on the advanced materials and technologies, relevant configuration, stylistic and color solutions, that in general excludes the design errors and defects at the various stages of design [1].

## 2. The process of the product development and use

The main process stages of the product development and use are presented in Figure 1, including the following product design stages:

1. The preparatory stage
2. The draft design of the new product
3. The technical specifications
4. The engineering proposal
5. The basic design
6. The volume visualization
7. The engineering design (modeling, design, prototyping)
8. The working design documentation
9. Support [2]



**Figure1.** The process scheme of the product development and use

In the configuration development of the industrial medical device, in particular electrocardiograph, it is important to know its working principle and the scope of application: the self-control of the heart rhythm disorder and the ECG data storage for the subsequent analysis and study. This device is operated by sensors, which receive and convert the incoming signals, and then register them as a curved line on the paper.

The portable electrocardiographs are the terminated devices being often equipped with the screen which allow making a rough analysis immediately after the measurement, as well as, if needed, sending the recording for the detailed interpretation. These devices are wireless, and the measurement is made using the body built-in electrodes. The standard application scheme requires putting both thumbs to the electrodes on the surface of the device and wait for 30 seconds.

### **3. The types of the portable electrocardiograph**

A key advantage of the hand-held electrocardiographs is their portability and the diagnosis ability wherever and whenever possible, that is particularly important for the people suffering from the heart disease. The hand-held electrocardiographs became available only 2-3 years ago, and there are only a few analogues on the market. Their comparative analysis is given in Table 1.

Of these devices currently the cardiograph Armed only is certified and sold in Russia, while being a Chinese development of Easy ECG, certified and imported in Russia by Armed. There are also attempts to adapt HeartCheck PEN to Russia. The strengths of these analogues, in particular, of the device Armed are their low price, achieved due to a significant reduction in the technical characteristics, and the huge advertising campaign.

As compared to the analogues, at the current reasonable price the electrocardiograph ECG-Express offers a wider range of functions (not only the diagnosis of the heart rhythm disorder, but for other diseases as well). And its innovative features will allow maintaining its competitiveness and attractiveness for the customer during several years, required to enter the market (figure 2).



**Figure 2.** The portable electrocardiograph «ECG-EXPRESS»

**Table 1.** The types of the portable electrocardiograph

Name	Description
<p data-bbox="164 425 367 470">Armed PC-80A</p> 	<p data-bbox="686 425 1407 515">Manufacturer «Armed» (there are wire-based and built-in electrodes)</p> <ul data-bbox="686 515 1407 896" style="list-style-type: none"> <li>- the light cardiograph, weight 78 g;</li> <li>- the compact size;</li> <li>- the handy packaging;</li> <li>- the speed rate of the results generation;</li> <li>- ease of use;</li> <li>- the possible data transfer into PC;</li> <li>- the possible record onto a memory card;</li> <li>- the recording memory of 24 and 300 measurements;</li> <li>- the display backlight;</li> <li>- the automatic shutdown;</li> </ul> <p data-bbox="686 896 1407 940"><i>Design:</i></p>
<p data-bbox="164 940 367 985">Armed PC-80B</p> 	<ul data-bbox="686 940 1407 1097" style="list-style-type: none"> <li>- the simple design;</li> <li>- the asymmetrical configuration;</li> <li>- the blank shaping;</li> <li>- the dull color scheme</li> </ul> <p data-bbox="686 1097 1407 1142"><i>The target audience:</i></p> <ul data-bbox="686 1142 1407 1254" style="list-style-type: none"> <li>- women and men (from 30 to 50 years);</li> <li>- the seniors (55 and up)</li> </ul>
<p data-bbox="164 1254 367 1299">2. HeartCheck PEN</p> 	<p data-bbox="686 1254 1407 1344">Manufacturer «HeartCheck» (2 built-in available electrodes)</p> <ul data-bbox="686 1344 1407 1590" style="list-style-type: none"> <li>- the light cardiograph;</li> <li>- the compact size;</li> <li>- the speed rate of the results generation;</li> <li>- ease of use;</li> <li>- the possible data transfer into PC;</li> <li>- the display backlight</li> </ul> <p data-bbox="686 1590 1407 1635"><i>Design:</i></p> <ul data-bbox="686 1635 1407 1702" style="list-style-type: none"> <li>- originality and usability of the configuration;</li> <li>- the limited color scheme;</li> </ul> <p data-bbox="686 1702 1407 1747"><i>The target audience:</i></p> <ul data-bbox="686 1747 1407 1881" style="list-style-type: none"> <li>- the youth (from 18 to 30 years);</li> <li>- women and men (from 30 to 50 years);</li> <li>- the seniors (55 and up)</li> </ul>

### 3. ECG Monitor MD100B



- the light cardiograph;
- the speed rate of the results generation;
- ease of use;
- the possible data transfer into PC;
- the display backlight

*Design:*

- the configuration usability;
- the incompact size;
- no color options

*The target audience:*

- women and men (from 30 to 50 years);
- the seniors (55 and up)

### 4. ECG Check – the peripheral equipment for iPhone with the built-in electrodes



- ease of use
- the automatic analysis in seconds
- the local storage of ECG data, reports and analysis
- the compatibility with the web portal for the long-term storage, analysis, communication and reporting
- the heart data accessibility at any time from anywhere globally

*Design:*

- the configuration usability;
- the iPhone style;
- the black and white cover piece for the body

*The target audience:*

- the youth (from 18 to 30 years);
- women and men (from 30 to 50 years)

### 5. AliveCor Heart Monitor - the peripheral equipment for iPhone with the built-in electrodes



- ease of use
- the local storage of ECG data, reports and analysis
- the compatibility with the web portal for the long-term storage, analysis, communication and reporting
- the data accessibility at any time

*Design:*

- the configuration usability;
- the iPhone style;
- the black cover piece for the body

*The target audience:*

- the youth (from 18 to 30 years);
- women and men (from 30 to 50 years)

The analysis of the analogues configuration allowed identification of the most ergonomic configuration of the cardiograph ECG-EXPRESS with the choice of the color scheme, thereby not

only expanding the target audience, but also detecting the only competitive analogue not presented on the Russian market, i.e. ECG HeartCheck PEN.

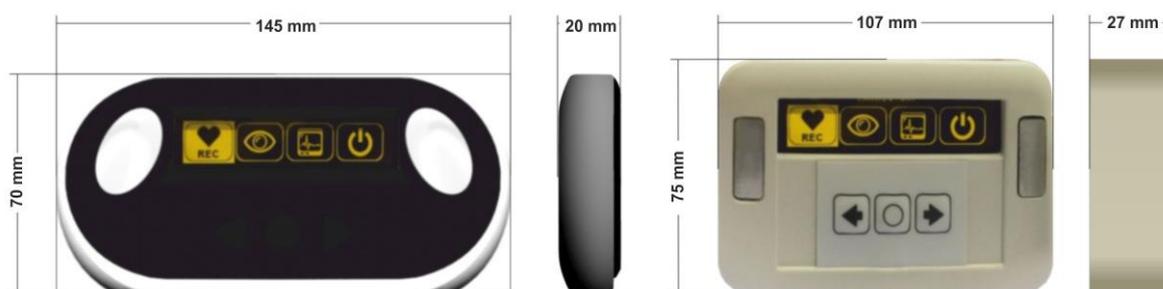
#### 4. The working principle of the electrocardiograph

The basic device with a fundamentally similar working principle is the joypad for the games console, since the position of the hands when playing is the most practical from an ergonomic point of view. The position of the hands and fingers has determined the location of the main electrodes on the body panel of the product, that meets the functionally ergonomic criteria (figure 3).



**Figure 3.** The working principle of the electrocardiograph

The weight of this device is about 108 grams, the length is 145 mm, the height is 70 mm and the width is 20 mm (figure 4). The cardiograph takes a little space in the bag and in spite of its small size the cardiograph is handily placed in the hand and does not slip. The required minimum number of buttons is located on the central part under the monitor, the plugs are on the lateral side. The electrode-buttons used to record the measurements are located on the front and lateral sides. The slot for convenient removal of the back cover, which is very tight to the body, is located on the rear side. The mini-USB plug, which is designed to charge the cardiograph or to PC connect, is located on the bottom. The extended round configuration of the device is caused by the ergonomics criteria, the working principle and the configuration of the modern phones and gadgets used every day [4, 5].

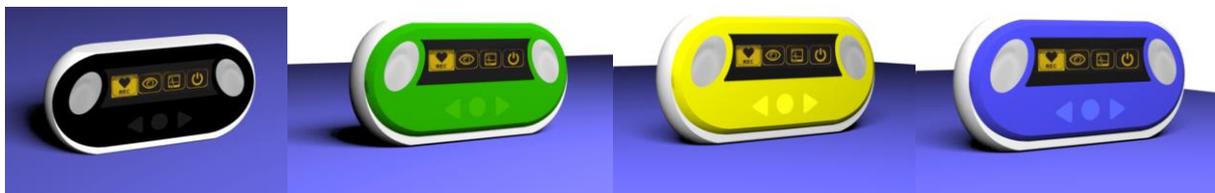


**Figure 4.** The modified configuration of the portable hand-held electrocardiograph «ECG-EXPRESS»

The available color scheme for the cardiograph body is offered subject to the common gadgets and their colors (figure 5). The significance and originality of the cardiograph configuration is determined by the balanced ratio of brightness, color, size and location of the various components. The main categories of the composition are the tectonics and the volume-spatial structure. The cardiograph

configuration reflects the characteristics of its construction, the force distribution, the material behavior, that is characterized by the phenomenon of tectonics. The cardiograph shape also communicates with the environment, in this case it can be referred to the one-piece structure with the built-in hidden mechanism [6].

The color scheme is determined based on the configuration composition of the industrial product and the product color matrix, established in 1994 by Weinberger, Campbell and Brodie, according to which the selected colors are referred to the low-risk group in connection with their dyeing. The main characteristics of the visual perception are given in Table 2 [7]. By physiological and psychophysiological effects on the humans the yellow color initiates the brain function, green and blue cause a sense of freshness, remove excitation, calm, reduce the blood pressure, slow down the pulsation. The green colour is disciplinary making people self-control. Blue, green, yellow have an overall positive psychoactivity effect, improving the working ability [5].



**Figure 5.** The options of the color scheme of the electrocardiograph body

Different plastics are used for the manufacture of the body frame, i.e. ABS, HDPE, LDPE, polypropylene, polyacetal, polycarbonate and polyamide. Most often ABS plastic (acrylonitrile butadiene styrene) is used in the production. It is a good material to manufacture the body frame of the electronic systems, which is used under low temperatures and if the high ductility properties are required. Most often, this material is used in the manufacture of the body frame components [8].

**Table 2.** The psychology of the visual perception

Color	The visual perception of			
	the distance	the temperature	the mental feeling	the hygienical effect
green	neutral	very cold	too mild	fresh
yellow	close	very warm	fascinating	-
blue	far	cold	mild	clear

The body frame is made of the ABS plastic or two-component polyurethane plastic by casting method in a silicone mold under the ambient pressure (the autoclave molding), or by vacuum casting method, depending on the configuration, the dimensions of the component and the set task. The two-component plastics are not "standard" plastics, which are casted under pressure into the mold, and there are some restrictions on use, such as the wall thickness (the wall thickness of the piece can not be less than 1 mm), it is prohibited to use the polyurethane plastic under temperatures above 100-120°C. Other characteristics are similar to the common thermoplastics.

All materials used for the manufacture of the products from plastic, are painted in a variety of colors and combinations by adding the dye (pigment). The technology of the plastics production with different colors has a small weak point, that is the colouring of the plastics requires the specific equipment, which only a few manufacturers possess, thus very often it turns out that the color shades

of the plastics depend on the suppliers. The highly concentrated plastic granules are used to facilitate the technology and avoid the dependence on the pigments' suppliers. About 2% concentrated plastic granules are added in the uncolored plastic to produce the desired color. The choice of the available colors of the super concentrate is highly diverse, but still limited, that should be taken into account for the plastics molding.

The superficial coloring is used to make the plastic parts of the body frame in the silver or metallic colors. It is the manual painting of the details with the standard spraygun followed by drying process in a special chamber. A layer of the protective varnish is applied on top of the paint, which increases the coating resistance and assures the extra shine of the surface. The major processing complexity of the superficial coloring is the requirement to work in the clean rooms with the minimum dust.

### 5. Conclusion

Thus, the modern portable devices for the diagnosis of the cardiac rhythm have become the most relevant means of the cardiovascular disease prevention and entered in our life, that generally affects their configuration and appearance. The ease of use, ergonomics, functionality and appearance of the cardiograph prevail in the development of its configuration.

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