Method of price formation of amber samples on the basis of gemmological-consumer indicators

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Abstract. Analysis of existing systems for expert grading of amber samples showed that their main disadvantages are, in general, consideration of only standard quality criteria (weight, colour, inclusions), as well as the lack of evaluation of rare and unique samples. Today in Ukraine there is, in fact, a state monopoly of pricing in the form of an official price-list for raw amber, developed by the State Gemmological Center based on the global market prices. The authors believe that this document does not fully take into account the costs associated with exploration, mining and taxation on the amber market. This deprives the direct users of the amber-bearing areas themselves of the opportunity to determine the criteria for the quality of rough amber and to develop the corresponding price lists. The created method of gemmological-consumer indicators allows for a transparent and understandable formation of the cost of individual amber samples. The value of raw amber determined in this way corresponds to the consumer values of the product, not taking into account processing costs. The sum of consumer properties of amber in items (shape, size, colour, transparency, presence of inclusions, quality of processing – polishing, artistry, etc.) is taken into account, thus satisfying the physiological and aesthetic needs of consumers for the product. To make the consumer properties of amber identifiable, it is necessary to provide the sample with a marketable condition. The criteria for the quality of amber in products have been developed. It is shown that each type of product is characterized by a set of properties that are criteria for product quality. In fact, this is a tool with which one can determine the type of product in the raw material, having previously determined its quality. Comparing the obtained data on the quality of raw materials with the criteria for the quality of products, it is possible to predict the type of product. The operation of the technique is illustrated by examples of two samples of amber containing inclusions. A method for determining the cost of individual samples of amber has been developed, the essence of which is the sequential fixation of gemmological and consumer properties of the sample with their subsequent transformation into an alphanumeric code, the total value of which forms an individual indicator of the sample (a set of individual qualities of the sample), which correlates with its cost. During the expert assessment of rare and unique samples of amber, their scientific, collection, aesthetic and artistic features must additionally be taken into account, establishing the uniqueness of these objects of examination. The method is designed for the symbiosis of individual natural (gemmological) parameters of the sample (size, beauty, presence of inclusion) with a set of consumer properties: shape, size, weight, colour, transparency, fracturing, presence of inclusion, presence of inclusions, polishability, value for science, collection, artistry, etc. The method covers the entire life cycle of amber from raw material to the final product, for which the sample is chosen as optimal in terms of economic, technological and gemmological-consumer indicators.

Keywords: amber, grading systems, gemmological examination, consumer properties, inclusions, value
Describing the problem

Amber is one of the valuable natural resources of Ukraine. According to experts, the country is assessed to have the world’s second largest deposits. But instead of stimulating incomes to the state budget and local employment, the amber industry has become a source of bribery and organized crime. Numerous recent publications indicate certain legal achievements, though the methods of evaluation of amber are extremely imperfect, mainly based on sizes and weight of samples.

Analysis of recent studies and articles

Legal, industrial, ecological and economic issues, improvement of existing legislation, fluctuations in prices on the global market, ways and methods of extraction of amber, and smuggling of extracted raw material as well as how to effectively fight against it – from such specific angles, most scientific studies (Besser, 2020, Potikha, 2016, Myskevych, 2020, Kovalevskyi S.V., & Kovalevskyi S.S., 2019, Matsui et al., 2019, SBU nakryla, 2021, Svitovi tsiny, 2019), in particular foreign articles, have complexly analyzed this problem. However, even after the introduction of changes to the corresponding laws (Law of Ukraine, 2019, December 19 № 402-IX) and establishment of auctions organized by the State Service of Geology and Subsoils of Ukraine for selling licenses for extraction in amber-containing areas, the issues of objective economic evaluation, determining quality and price of samples of amber for the most part have still no solutions.

Distinguishing earlier unsolved parts of the general problem

As with quality of amber, we should note that there currently is an official document that regulates quality of rough amber: National Standards DSTU 8847: 2019 “Amber Raw Material. General Technical Conditions” (Belichenko et al, 2018), where the following classification groups are distinguished: - unique samples weighing over 1,000 g; - massive (11 weight fraction from +2 to 1000g); - layered; - cloudy; - foamy; - unsuitable. In our opinion, the abovementioned document needs additional work and elaboration, not only regarding its content but also form. We should state that it does not take into account price-forming consumer properties (shape, size, colour, transparency, presence or absence of inclusions), while the cost of amber is impossible to determine without taking them into account. Likewise, terms in that document have ambiguous interpretations, which are unacceptable for expertise. In addition, on 16.10.2020, changes to some legislative acts of Ukraine came into force after adoption of the Law of Ukraine “On standardization”. In particular, in passage 13 of Article 1 of the Law (Law of Ukraine, 2019, September 20 № 124-IX): 1), the words “according to the world standards” have been excluded; in paragraph 1.21, the phrase “state standard” has been replaced by the word “parameter”; in passage 27, the phrase “state standards, technical conditions” has been removed; 2) in parts 2 and 3 of Article 22, phrase “state standards” has been replaced by “current legislation”. That is, exclusion of the notion “standard” from gemmological legislation.

Current problems in legal regulations of the sphere of gemmological expertise were analyzed in more detail by the authors in earlier publications (Baranov & Kirin, 2021, Kirin et al., 2021).

The main characteristic of distinguishing high-quality groups in existing methods (Burmite Amber, 2021, Grading Amber, 2021, Dyshlova, 2015, Selection of important amber, 2019) is also weight, but this parameter is not a consumer property and is not taken into account when designing, projecting and creating artistic goods made of amber, and is therefore important, but not comprehensive for expertise analysis of some samples of amber, especially unique products.

The general disadvantage of the vast majority of existing systems of expert appraisals of amber is absence of methods of evaluation of rare and unique samples. The objective of this study was creating a system of gemmological-consumer indicators (hereinafter – GCI), which could be used for formation of the cost of individual (rare and unique) samples of amber.

The main material of the research

We propose using the GCI method and method of valuing individual samples of amber based on GCI. The method is consistent recording of gemmological and consumer properties of samples with their further transformation into alphanumerical code, the total value of which forms the individual sample indicator (set of
individual qualities of sample), which correlates with its cost.

The method identifies the criteria of consumer quality of goods made of amber and the algorithm of gemmological expert analysis of amber samples. The proposed method of valuing individual samples of rough amber is based on correlating consumer qualities and gemmological characteristics of raw material. The algorithm includes four stages:

Stage I. Determining consumer properties and consumer quality of goods made of amber.

Stage II. Gemmological characteristics of rough amber.

Stage III. Possible variants of goods that could be made from the amber.

IV. Determining the cost of amber according to two variants.

As consumer properties, we consider a sum of properties of amber in goods (shape, size, colour, transparency, presence of inclusions, quality of treatment (polishing), artistic quality), which satisfy physiological and esthetic needs in the process of use. Therefore, we shall further analyze the consumer properties of some items made of amber.

On the global market, amber has an honorable rank among other gemstones. The spectrum of goods made from it is being expanded by collector samples with inclusions. They bear unvalued scientific data about fauna and flora which existed tens of millions years ago. Goods made of amber are represented by a broad spectrum: necklaces, tumble finishing, artistic carving, balls, collector samples, intaglio engraving, interior items, etc. To exclude inaccuracies and inconveniences in the analysis of the market, we used amber items without additional materials (metal, wood, etc). Also, the initial data were adjusted to a single system of identification, i.e. cost of one gram of amber in dollar equivalent.

Amber necklace is the most popular amber good on the global market. So far, over 200 models of amber necklaces have been designed, varying in colour, order of arrangement of beads, etc. Cost-wise, three groups are distinguished: expensive, not very expensive and cheap. Their price is determined by the shape and size of the beads, colour and quality of processing.

The first kind is a necklace of ball-shaped beads, made of milk-white (royal) amber. One gram of amber in those goods costs $10 to 25. The broad range of prices depends on the size of the beads, tones of the amber, optical effects, length of thread, quality of processing (polishing). The low translucency of milk-white amber provides an aesthetic effect — absence of through opening and invisible fastening (thread is not seen).

The second kind is necklace made of noble cognac-coloured amber. The price range is small, one gram of the goods costs $3.29 on average. The relatively low price is explained by the high transparency of the amber, allowing one to see the inner structure of the bead, specifically the opening, thread. Therefore, the reduced esthetic effect and price of this product. Thus, in our opinion, this is not a good variant of using cognac amber. There are designs that highlight the colour and perfect transparency of this type of amber more effectively.

The third kind is necklaces of irregular-shaped amber. They have a relatively low price, though there is a certain advantage over expensive necklaces. First of all, they are made of low-quality amber, which is always available on market in great amounts. Secondly, the yield of amber that is appropriate in this case is no lower than 80%. By comparison: the yield of amber that could be used for ball-beaded necklaces is 30% (even lower would be economically unprofitable). Thirdly, the low price and broad assortment are aimed at a broader range of buyers, whose collective purchasing power is higher than that buyers of more expensive amber, causing an economic “easy-money effect”.

According to designs, there are several kinds of necklaces. Below, are descriptions of some characteristics that are most popular on the market:

1. Necklaces of irregular unprocessed samples of amber. Esthetically, they look rough and unattractive, but their natural form and absence of improvements allow them to be presented as “medicinal”. Demand for such goods is high. Therefore, we can state that “the medicinal effect” of amber (unproven however) should be considered as its consumer property. Prices of such necklaces do not exceed $1 per gram of amber.

2. Necklaces of small polished pebbles or pebbles with such defects as caverns, pores, small fractures, inclusions of organics. Their prices range within $1. Sometimes, the price of such a necklace is over $2 per gram (because of the bright cognac colour).

3. Necklaces composed of beads shaped as irregular balls, made using diagonal pliers, so called ball-cutters. Price of one gram of amber in such goods varies $1.58 to 2.49. These are likely workpieces for preparing perfect balls, but due to some technological reasons, they are inappropriate for further processing.

4. Droplet-shaped beads that are selected from natural samples of amber which appear as droplets. These are quite rare samples, i.e. they are classified to authors’ works. Therefore, their price accounts for over $5 per gram.

5. Chip-bead necklaces – selected plates of amber of irregular elongated shape. They are also classified to the category “medicinal”. It is interesting that because of even a slightest movement they produce sound (rattle), as if communicating with each other. This exceptional effect is used in commercials as a unique pecu-
liarity, and sometimes the amber is even presented as having a «magic» colour.

6. «Candy» beads are well polished transparent pebbles that somehow really resemble candy. The necklaces attract people by their strong glassy glistening with sparkling effect and high degree of transparency, looking rich and beautiful. The price is quite high, ranging $3 to 5 and more.

7. Barrel-shaped beads. Beads, made according to principle of cut-balls, and the only difference is the barrel shape.

8. Flat beads. They are made of samples of low-quality amber, the main criterion being their flat shape. It should be irregular and flat, ratio of sides equaling 1:2:3. They look quite impressive because of area elongation, which causes a dynamic effect of movement and flow. The price of such necklaces, similar to the previous, is low, but they also are in demand on the market and to some extent expand the assortment.

Thus, consumer properties for the considered types of beads is form, size, colour, transparency, esthetic effects, and – as strange as it sounds – «medicinal» properties. Skills of utilizing consumer properties in design of goods and commercials can make even poor-quality amber profitable.

Intaglio from amber is a new type of goods on the global market. Without going into details of technologies of preparing intaglio – it may be both manual and using ultrasound devices, – we should note that price of such goods range $30 to 60 for one item (weighing 2–2.5 g), i.e. price of one gram of amber in such an item is $15–30, sometimes being more expensive than a high-quality necklace. The main consumer properties are perfect transparency, absence of fractures, inclusions and other various defects. The distinguishing quality of this amber is its colour saturation – cognac, yellow, yellow with greenish tint. Because of the small sizes of these products, measuring 2 to 5 cm, the required raw material is easier to find. We should note that the cost price of transparent amber is much less than that of milk-white.

Inclusions in amber are another kind of item in high demand among collectors, scientists and jewelers (Fig. 1). They increase the price of amber greatly, depending on preservation, size, amount of inclusions. The price of some specimens with numerous inclusions equals $700 and more. At the same time, there are samples worth $6. The average price is 23.99 $ per gram. In addition, inclusions in amber products at least double the price of the items themselves.

Collector samples are another kind of product in high demand on the global market. They are presented both in unprocessed and processed forms. The main advantage of those samples is the rarity of their natural form, colour, pattern, transparency, optical (esthetic) effects. In any case, rarity or uniqueness should be described and confirmed by specialists in a particular scientific sphere. The price of some specimens reaches $2 thousand and more. At the same time, the average price of 1 gram of amber is $10 (Belichenko & Turova, 2019).

One of rare samples of amber is a stagnant droplet that has preserved both natural form and oxidized crust (outer layer). In this case, it is a consumer property for such a particular sample, it is in demand on the market and is especially popular among collectors.
and museum workers. Also, on the market, one can find processed samples with interesting and unusual colours and texture pattern.

The beauty and artistic craft of all those samples evoke esthetic emotions. Oftentimes, collector samples are attributed medicinal and magic properties. As a result, there is a segment of the market trading exquisite samples of amber and community of creative people who are sensitive to beauty. In this case, priorities are consumer properties of amber which are related to jewelry and stone carving arts.

Artistic carving on amber is presented as pieces of art such as small sized sculptures, cameos with different motifs. Usually, the artistic image is inspired by the sample itself, more specifically its properties. At the same time, the main consumer properties of amber are colour, artistic quality of the product and skillful harmonizing of the stone’s properties. However, some disadvantages are accepted (fractures, presence of pores and inclusions), but they can be so skillfully hidden by form, facture, that those disadvantages become advantages. Thus, the cost of black amber as raw material is relatively low, but in the mini-sculpture “Toad” (Reznaia fyhurka «Zhaba», 2021) it has significantly increased because of how harmoniously an amphibian has been embedded in the decorative properties of the amber. The cost of 1 gram of amber in carved goods varies from $4 to $24, the average being $7.5/g.

The wide range of cost of one gram of amber in carved goods is first of all determined by the colour of the stone. For example, the “Hotei” figure is made of high-quality and expensive amber of milk-white colour with yellowish (honey) tone (Fig. 2). The work is characterized by high quality and artistry. The amber is almost entirely transparent in thin parts, and non-transparent in thick regions. All of this provides the item with an air of ease, the figure looks lively, as if breathing from the inside. The product combines the quality of raw material and artistry, and therefore costs $2,380, weighing 30 g, i.e. cost of one gram of amber of the item is $71.4.

Criteria of quality of amber products. Each of the indicated types of items has specific properties of amber, which are the criteria of their quality (Table 1). Peculiarities of colour, form, size, qualities of processing allow for distinguishing one product from another, and, as evidenced, vary in price. Fluctuations in prices within one type of product are mostly marketing methods, which expand economic possibilities of manufacturers and consumers.

Table 1 demonstrates that every type of product is characterized by total number of properties that are the
criteria of their quality. In fact, it is a tool one can use to determine the type of product which can be made from a given raw material by previously determining its quality. By comparing the obtained data of quality of raw material with the criteria of quality of goods, one can predict the appearance of finished products. Let us demonstrate this using concrete examples.

Amber sample № 1. Weight: 107 g., Size: 113x46x38 mm.

The form of the sample is elongated with numerous protuberances and cavities. Two groove-like cuts divide the sample’s thickness in halves. The surface of the groove, similarly to the entire surface of the sample, is covered by a thick crust, indicating their natural origin. The grooves have been likely caused by a mechanical obstacle (fragment of wood bark), around which the resin accumulated (Fig. 4).

The colour of the crust of the sample ranges dark brown to black. On the surface of the sample, the crust is dark brown to black, becoming bright orange with depth. Crust thickness is over 1 mm in places of deepening. The crust is solid, but crumbles. It could be easily scratched with a knife. In a polished “window”, transparent yellow amber can be seen.

The sample’s surface has many pits, is cavernous, with signs of disintegration (physical-chemical ruination), the other side is relatively flat and less ruined, resembles the effect of old leather. In such condition, the quality of amber is impossible to determine. Therefore, we decided to bring the sample into a marketable condition and make it possible to study its qualities.

Table 1. Criteria of amber quality in goods

<table>
<thead>
<tr>
<th>Types of goods</th>
<th>Price g/$</th>
<th>Criteria of quality of amber in the products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ball-shaped beads</td>
<td>10–25</td>
<td>Ball shape, 1.5–5 cm size. Milk white. Mirror finish polishing</td>
</tr>
<tr>
<td>Ball-shaped beads</td>
<td>2.4–4.9</td>
<td>Ball shape, 1.5–5 cm size. Cognac colour. Flat surface, mirror finish polishing</td>
</tr>
<tr>
<td>Pebble beads</td>
<td>0.83–2.21</td>
<td>1.5–5 cm. Mirror finish polishing</td>
</tr>
<tr>
<td>Beads of unprocessed amber</td>
<td>0.28–0.73</td>
<td>Natural form, medicinal properties</td>
</tr>
<tr>
<td>Intaglio</td>
<td>30–60</td>
<td>Saturated colour. Perfectly transparent. 1.5–5 cm. Mirror finish polishing</td>
</tr>
<tr>
<td>Samples with inclusions</td>
<td>12.1–205.8</td>
<td>Presence of inclusion, preservation, amount, observable</td>
</tr>
<tr>
<td>Artistic carving Figures</td>
<td>4–24</td>
<td>Irregular shape, exotic, with artistic image, possible fractures, pores. 7 and more cm</td>
</tr>
<tr>
<td>Collector Samples</td>
<td>2.4–41.9</td>
<td>Natural exotic shape, unusual colour, esthetic effects</td>
</tr>
<tr>
<td>Polishing tumble finishing</td>
<td>0.6–2.1</td>
<td>Varying in shape, with no fractures, pores. 1.5–5 cm. Mirror finish polishing</td>
</tr>
<tr>
<td>Jewelry finishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polished pebble haberdashery</td>
<td>0.2–1.2</td>
<td>Varying in shape, 1.5–5 cm. Mirror finish polishing</td>
</tr>
</tbody>
</table>
The weight of the sample after the processing (crust removal) accounted for 80.33 g (output of appropriate material – 75%). Colour is yellowish with brown-greenish tone (swamp green). Shape of the sample resembles a silhouette of a dog that is standing on hind legs (as the authors see it).

Inclusions are presented as fragments of organics with black torn margins, of no more than 2 mm size. They accumulate along the long side of the sample, causing unevenness in transparency: some areas are darker with brownish tone, which are hardly see-through, while others are more transparent.

The other group of inclusions comprises numerous fluid vacuoles with small concentrations of gas, measuring up to 20%. Inclusions of fluids concentrate in the zones of organic accumulation.

Concentrations of gas inclusions and their sizes are completely appropriate for studying the content and reconstruction of the atmosphere that existed many millions years ago. On the surface of the sample, we see cavities of perfectly round shape – those are vacuoles of inclusions, brought to the surface by grinding and polishing. Such an amber with rare colour and presence of organics has the commercial name Meteorite. Necklaces made of meteorite amber are original and in demand on the market.

Rounded fractures have emerged as a result of internal pressure around certain organic inclusions. There is seen orientation along the long side of sample, which correlates with the orientation of flow slabs of the resin.

Thus, the sum of rare properties of this amber sample – form with artistic image, color and tones, which change, and inclusions – make it especially attractive, mysterious and to some degree artistic. According to Table 1, this sample is identified to collector stones, the cost of which ranges $2.4 to 41.9 / g. Therefore, the predicted cost of the sample equals $192 to 3,366. Further processing is not taken into account, and therefore expenses for other types of production are not included.

**Amber sample № 2.** Weight of sample: 114.7 m
Size of sample: 10.2x6.5x5.6 cm.

The shape of the sample is irregular, pouring. There are sharply protruding ribs, varying in height, above which there is a “tail” of yellow non-transparent amber. On the other side, there are several flow slabs, oriented in one direction. The sample is brown because of the oxidation crust. In the regions of natural grinding, there can be seen a milk-white colour with yellowish tone. On the chip, the amber is yellow and transparent.

The oxidation crust creates an effect of old leather, being covered by a thin network of fractures. It is easily separated from the main body of amber, uncovering the frac-
tured zone, with greater size of chambers. It can only be removed mechanically, that is by prolonged grinding. This zone of fractures gradually transitions into the main body of amber, and at the same time, the brown tone disappears and the amber becomes yellow. Dense crust completely covers the inner structure of the amber sample, and thereby prevents grading its quality and price.

After the crust had been removed, the weight of the sample accounted for 103.2 г (appropriate output being 89.9%). As a result, bright yellow, brown, and white colours were uncovered (Fig. 5-6). Also, three genetic types of fractures were found: inter-slabs, mechanical, and pressure-caused.

*Inter-slabs fractures* constitute borders between two flows of resin, which are often traced by external inclusions of fluids, gas and their combinations. They run to a great depth. There is seen a notable peculiarity of inter-slabs fractures – tortuous form, often pinching with transition into a barely noticeable line.

*Pressure-caused fractures* are rounded formations which do not emerge on the surface of the sample. They occur as a result of local inner pressure around alien bodies, first of all, inclusions.

*Mechanical fractures* are divided into old and contemporary types. All types are open fractures. Old are mainly smoothened and are traced by mechanical material (dirt). Contemporary are distinctly different from them by absence of inclusions and shelled surface.

*Inclusions* are alien substances, preserved during accumulation of pine resin; they are divided into three types: insects and other invertebrates, organic and inorganic substances.

A subject of special interest is a piece of amber which contains a piece of wood. The amber has completely submerged the wood sample, and its ends are broken.

The surface of the piece has completely preserved the structure and texture of wood: well noticeable motes, swellings, hollows. Transversal section is slightly oval.

The amber that had substituted wood is dark-brown, with two bright grey inclusions. The spread of amber inside the impression of wood is slightly reminiscent of tree rings with pith. Annual rings are distinct layers of amber, between which there is seen a border along the entire length of the sample – there are five such flow slabs.

Another notable detail is that the external surface of the piece is non-homogenous. One part of the surface is smooth and light-yellow, resembling texture of wood. The other part of the piece’s surface is brown, and is covered by small fractures. Between two various surfaces, a clear border is seen.

*Fig. 5.* Tree trunk penetrating the main mass of the sample
Fig. 6. Macrophotograph of sample with tree trunk. On the left, there can be seen a border between smooth and fracture surfaces of the item. On the right, the view from the opposite side, where the surface of the item has a fractured crust.

The amount of inclusions of both flora and fauna which occur in amber is really large. One of the recently published bibliographies is focused on Coleoptera trapped in amber and copal – over 300 species were found.

Beetle of up to 1 mm size, black, with six legs, large eyes (Fig. 7). It got stuck in amber while alive, as evidenced by signs of struggle against undesired captivity.

Spider, light, opaque – as we see the imprint is hollow (Fig. 7). Crossed legs are the typical position of a dead spider, indicating that it was trapped in amber when already dead.

Harvester. Size of the inclusion is 2 mm. Distinctive feature of those invertebrates is that the legs are long, compared with the torso, which extend if needed (Fig. 7). In the photo, we can see how the legs are quite far from the body. Judging by the trajectory of the invertebrate, it was struggling for its life.

Fig. 7. Invertebrates in amber, left to right: beetle, spider, harvester.

From this angle, it looks as if it is swimming in a swimming pool. In this case, it is a hollow imprint piece. The invertebrate has eight quite long legs (Fig. 8), opaque.

Inorganic inclusions are represented by gas and liquid gas phases. Ratio of the fluid to gas equals 20:80 %. Inclusions are confined to the smoothened border between two flow slabs. They look as they trace the smoothened zone of the contact between two resin flows. Some inclusions contain snow-white crystals, most likely salt, and fluid – marine water.

Fig. 8. Spider inclusions
Collector and scientific values are represented by inclusions, and first of all wood imprint which has no analogues so far. Therefore, this sample may be identified as unique. As rare inclusions, we can consider small crustacean slightly above the wood.

To artistic qualities, we can identify the shape of this sample. Expressiveness of the shape depends on its position. If the sample is placed vertically, it reminds one of a spaceship that is setting off. If the sample is placed horizontally, it reminds a chicken or a duck, which is sitting on eggs.

Presence of well preserved wood imprint, five types of inclusions, inclusions of gas, fluid and their combinations, allows us to classify this sample to the unique category. Such samples are usually sold at specialized exhibitions, auctions, and thus the sample’s actual cost is formed there. Starting price of the sample is $ 4,324.

**Discussion**

Consumer properties of amber products are formed as a result of processing rough amber, known to humanity for thousands of years. It has been studied at high scientific level, is used in many industrial spheres, ornamental arts and jewelry.

From the perspective of expertise, consumer properties should be considered as the overall concrete properties of amber for any type of product. They determine the consumer cost of the item (value, benefit for people).

Quality criteria of the products are qualitative characteristics of amber taking into account shape. At the same time, shape is the result of artistic process, which allows harmonizing amber properties, whereas grinding and polishing increase colour tones, transparency, i.e. the whole processing entails changes in shape, making amber esthetically attractive.

Color of amber is determined using the International etalon collection, which contains 324 tones of amber (Belichenko & Turova, 2019, Srebrodolskyi, 1988). However, only polished amber can be valued this way, having access to corresponding collection.

This means that quality of amber in items corresponds to quality of amber in raw material taking into account corrections for geometric parameters. This has been successfully demonstrated on concrete examples.

In order to determine quality of raw material, we should remove the crust, providing the sample with a marketable look. Thus, we know the amount of material that is appropriate for further processing, i.e. output of appropriate material is evaluated.

The possibility of studying the properties allow one to determine the decorativeness, and also scientific, collector and artistic values. At the same time, the sample looks marketable, allowing consumer to see its beauty. Accompanying data about peculiarities of the amber sample also promotes awareness of its value.

Technologically, processing amber is not difficult and does not require great energy-consuming technologies. Because of low degree of solidity, hard-alloy tools and simple materials are used, and because of the irregular shape, samples need to be sorted and processed manually. Thus, the cost of processing amber is low and depends on the craftsman’s skills. The main factors of amber price are natural peculiarities and successful designs. Usually, the cost of processing amber does not exceed 30% of the product’s cost.

Cost of raw material may be determined by two variants. The first is characteristic for common samples. Cost of rough amber corresponds to consumer cost of products, not taking into account costs for processing. The second method is characteristic for rare and unique stones (Baranov et al., 2021). In that case, owner of a particular sample determines its starting cost. Residual value is determined at auction. At the same time, expert appraisal of rare and unique samples of amber should take into account scientific, collector, esthetic and artistic peculiarities, which prove the uniqueness of the object.

**Conclusions**

1. We developed a method of grading individual samples of amber, the essence of which is consistently determining the gemmological and consumer properties of the sample, which are then transformed into alphanumeric code, the total number of which forms the individual indicator of the sample (set of individual qualities of the sample), which correlates with its price.

2. The GCI method allows one to obtain the predicted cost of the raw material, comprehensively and clearly attached to the existing market, at the same time, in order to make it possible to determine the consumer properties of stone, the sample has to be given a marketable appearance. The cost of rough amber determined in such a way would correspond to the consumer cost of the product, not counting the expanses for processing. Expert appraisal of rare and unique samples of amber should additionally take into account their scientific, collector, esthetic and artistic properties, which would prove the uniqueness of the objects.

3. Compared with analogical methods of cost formation of amber samples, the proposed method is characterized by the following specifics:
   - the method is universal – developed not only for separate natural (gemmological) parameters of sample (size, beauty, presence of inclusions), but also for their symbiosis – total sum of consumer properties of the
sample (formation, size, weight, colour, transparency, fractures, presence of inclusions, degree of polishing, significance for science, collecting, artistry);

The method is complete – covers the whole cycle of existence of this semi-precious stone: from rough amber to final amber product, for which an optimum sample had been chosen according to economic-technological and gemmological-consumer properties.

The method, developed based on GCI, is comprehensive and requires confirmation and possibility of facilitation of further analysis of study results, their mathematical analysis, and also development of software.

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