ORNAMENTAL SIGN LANGUAGE IN THE FIRST ORDER TRACERY BELTS

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Abstract

We consider an ornamental sign language of first order where principles of sieve displacement, of asymmetric building blocks as a base of ornament symmetry, color exchangeability and side equivalence principles work. Generic aspects of sieve and a genesis of ornamental pattern and ornament signs in it are discussed. Hemiolia principle for ornamental genesis is introduced. The discoverer of most of these principles were artist Modris Tenisons [4, 5, 6, 7 (refs. 23, 24), 8 (ref. 65)]. Here we apply a systematical research using simplest mathematical arguments.

We come to conclusions that mathematical argument in arising ornament is of much more significance than simply symmetries in it as in an image. We are after to inquire how ornament arises from global aspects intertwined with these local. We raise an argument of sign's origin from code rather from image, and its eventual impact on research of ornamental patterns, and on research of human prehension of sign and its connection with consciousness.

Key words: binary coding, binary matrices, ornaments, asymmetry, sign coding, sieve in ornamental pattern, first order complexity, hemiolia principle

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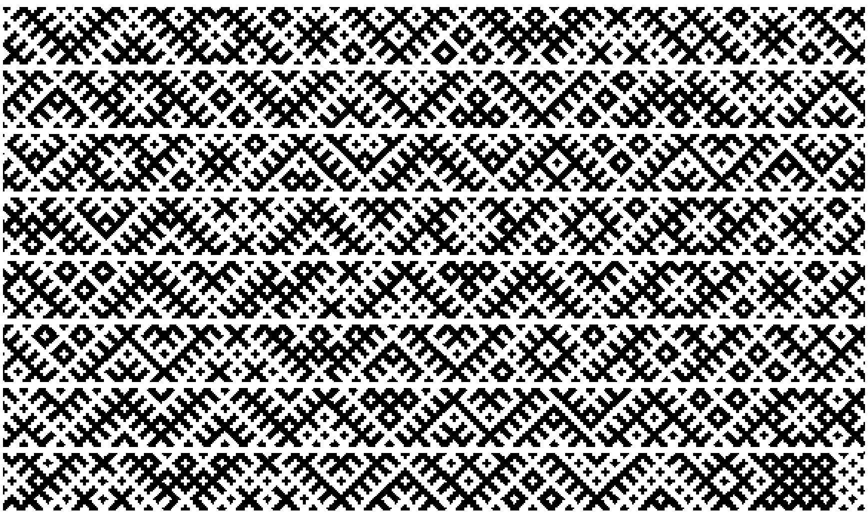
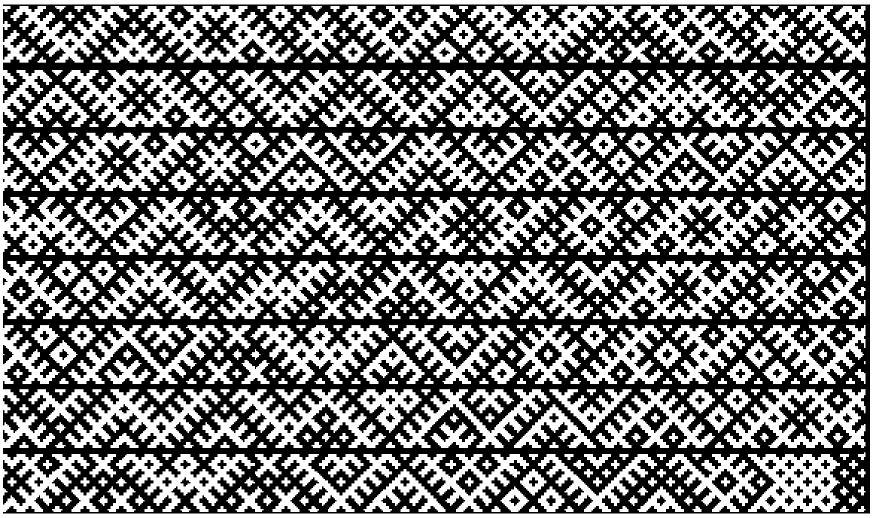
Introduction

Ornaments and ornamental patterns are a part of both historical and cultural richness of different nations. What message they convey? Can such question be justified scientifically? Either, has such question legible meaning what concerns exact sciences? In order to answer such and similar questions we must study them. In this article we study mathematically one type of ornament pattern found in ornamental belts of Baltic countries: for that reason we introduce notion of the *first order complexity ornamental sign language*.

Latvian national ornamental tracery belts, or, simpler, ornamental belts has been sufficiently widely studied in the past, e.g., [4,8,9,10]. The best known example is the belt of Lielvārde (little town in Latvia) [4,9,10], that has attracted enormous interest of different researchers, but less from side of mathematicians. Evident reason for that is the fact that this type of belts has very complicate ornamental tracery. However there are some sufficiently rich patterns of belts that are much simpler, e.g., belt of Nica (small rural district in Latvia) (see 1.pict.)[3]. Just similar to this type of belts we are going to study in this article.

In this article we systematize an experience of <u>many</u> years of Modris Tenisons in the area of the research of Latvian ornamental belts [4, 5, 6, 7 (refs. 23, 24), 8 (ref. 65)]. Next to the experience of Latvian artist and ornamentalistic researcher Modris Tenisons, we come across with researchers from other Baltic countries, namely, Lithuanian researcher Vytautas Tumėnas [7,8,9] and Estonian researcher Tõnis Vint [10].





Picture 1. The belt of Nica [3] in two settings. The ornamental tracery should be read linearly from left upper corner to the right lower corner. See in the appendix the binary code of this belt. Length of the code is 751 rows. The image of the belt here was created by computer program. In the lower part is given the belt of Nica with the opposite coloring. One of main principles in the first order ornamental tracery is that both colors are as if in equilibrium in respect of amount of elements in it both globally and locally.

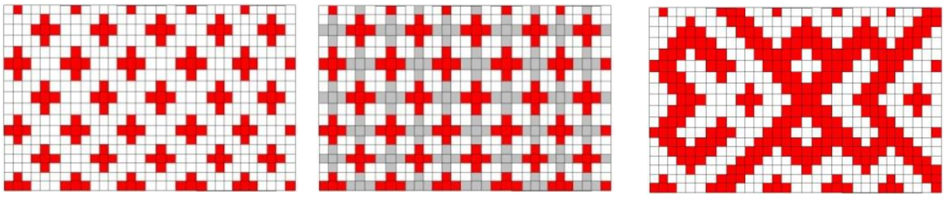
The principle of removal of sieve in the first order belt and the code of the ornamental belt

Analyzing different kinds of ornamental belts Modris Tenisons came to persuasion that there may be distinguished one type of belts that may be called *first order belts*. The ornament in these belts may be divided into two parts, scilicet, the part of the sieve, and the part of the code. We research in this article just this type of belts called *first order belts*. The language of ornamental signs used in theses belts we call *first order complexity ornamental sign language*.

First order belts may be characterized by property that there can be *removed a sieve* in them leaving a code alone. The principle of sieve removal or separation from the code, and then coding in this sieve has been described in the article of Modris Tenisons and Armands Strazds [3]. The principle has been fixed also by patent of Modris Tenisons [4].

If ornamental tracery in belt such as Nica belt is considered as two colored squared pattern, where checks in it has two colors, then there is the part that doesn't change, and the changing part. The permanent part is called *sieve*, and the changing part – *code*. The sieve consists from two dual parts, where each is a lattice of *cross elements*, that is called *cross lattice*. Each cross element consists of five checks, naturally forming the sign of the cross. See two dual cross lattices in pict. 3 in the middle image, where the cross elements of the cross lattices are correspondingly of red and grey color. The changing part, that we call *code*, consists from $2 * 2$ checks, where each such stands for one code unit. An ornamental tracery is built filling (coloring) places of code with the color of one (or other) cross lattice. More precisely, assuming the code to be *binary code* consisting from *zeros* and *units*, choosing by coding for zeros one color of cross lattice and for units other color of code lattice, we get an ornament as an image of an *ornamental code*. On the spot, we get first fundamental property, videlicet, there arise eventually two traceries from one fixed ornamental code, interchanging the color of the code or the cross elements. We would have as if four choices here, but further we are to see that opposite coloring of all ornamental pattern didn't give different ornamental tracery. For the coding it would mean that the opposite code, i.e., interchanging units and zeros, doesn't give other ornamental pattern for the human prehension, though mathematically does. In the pict. 3 we see ornamental pattern with six places for the code in one row. We say that this is the *belt of breadth six,* as is the case of Nica belt. We consider in this article only ornamental traceries and belts of breadth six, which is anyway minimal nontrivial belt, as we should see, but sufficiently complex and problematic, as seen from Nica belt.

In the example in pict. 3, ornamental code by fixing only half due to suggested symmetry might be 011, 010, 100, 010, 011, 011, 010, 011, 010, 100 or in octal number system, 3242332324.



Picture 3. A pattern of ornamental trasery on right, that is coded in the sieve that stands on the left. In the middle picture sieve is divided into two dual parts, cross lattices, where each is colored distinctly, red and grey resp. Places for coding are clearly seen as $2 * 2$ check elements, accordingly in white.

Hemiolia principle – one and a half principle in the ornament genesis

We may try to specify the sieve and the part of the code by some generic aspect with some inquiry where from it could arise. Let us assume in the foreground of the sieve be "tracery" of checkerboard with $3 * 3$ checks with arbitrary, white or red, coloring, and the code checks being as if shrinking of this foreground by the scale by $2/3$ at the same time, namely, the shrunken $3 * 3$ squares are just $2 * 2$ checks. By this approach we have as if two grounds for the ornament to be enacted, scilicet, non changing background with $3 * 3$ checks, with the coloring of chess-board, and changing by code foreground, and displaced by half-check, giving after 2/3 shrink the code with $2 * 2$ checks and the whole ornamental pattern. To see this, say in the picture 3 in the middle, imagine the grey (or red) places to be $3 * 3$ squares where corners are overlapped or partly covered with 4 places of codes, $2 * 2$ squares, where white places have shrunken by scale $2/3$. In this play of enacting ornamental tracery some places are as if belonging to non-changing background part, say, red, but some to code-colored and shrunken foreground – say, white.

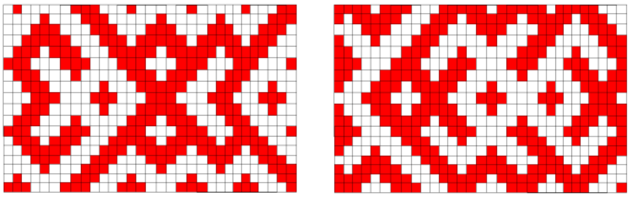
We see that here the ratio 3/2 plays a decisive role. Besides, this ratio is significant in some mystical teachings.

We call this principle of arising ornament from 3^2 volume parts of background and 2^2volume parts of code as if interplaying between themselves that we describe here *hemiolia principle*. In Greek ἡμιολία – one and a half.

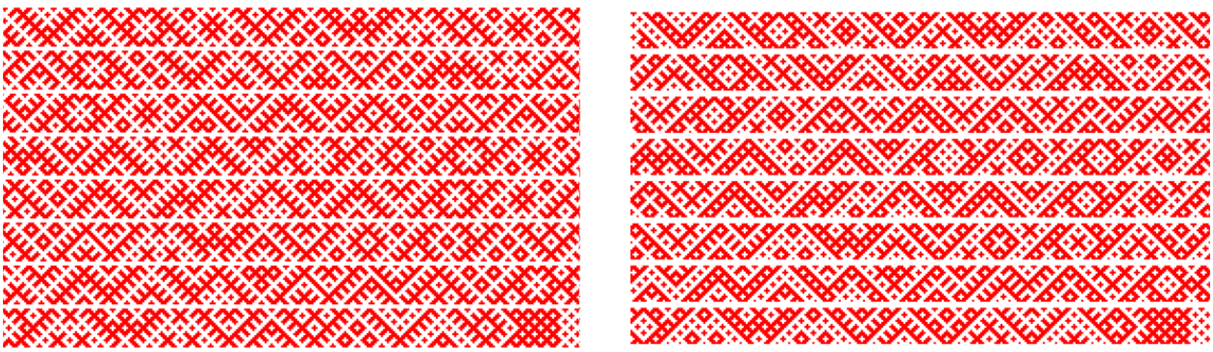
Sieve displacement

The notion of sieve displacement arises by observing that displacing the sieve by three checks or, what is the same, displacement of code by one row gives different ornament pattern that is equivalent of the exchange of colors of cross lattices. Thus, if we add empty code line in the ornament coding, we get quite a new ornamental pattern, that what we were to obtain by sieve displacement.

Mathematically, the things we consider here are almost trivial, but they effect on human imagination not in the least sense in a trivial manner. The discussion in this direction see below. Anyhow, let us bear in mind that ornamental belts' weavers who are directly connected with these belts, because just they are who have invented them, don't know these simple facts as clearly as they stand in any mathematical setting and nevertheless they were and are able to obtain miracles quite in literal sense, like in the case of Nica belt, not even to speak about the belt of Lielvārde.



Picture 4. Two ornament patterns from the same ornamental code. We may say that one is obtained by other using sieve displacement. We can see that we can't fix the exact difference by "mathematically non equipped eye" as some simple trick. Neither did most prolific masters as weavers of the most wonderful belts, who only "knew" the rule by some "instrumental" sense, that they couldn't formulate directly.



Picture 5. The belt of Nica in two variations. On the right sieve displacement is performed by adding empty code row at the beginning giving another pattern of Nica belt tracery. Visual effect is such as if we had quite another sample of Nica belt.

In pict. 4 we see two ornament patterns from the same ornamental code. We may say that one is obtained by other using the sieve displacement. We can see that we can't fix the exact difference by "mathematically non equipped eye" as some simple trick. Neither did most prolific masters as weavers of the most wonderful belts, who only "knew" the rule by some "instrumental" sense that couldn't formulate directly.

Modris Tenisons discovered the sieve removal and sieve displacement principle in the late seventies of the previous century. The discovery is fixed in a patent as an intellectual game [5].

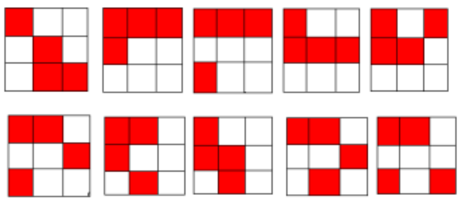
Creation of ornamental tracery from asymmetric elements

Modris Tenisons developed an idea that the code of the belt should be built from asymmetric elements, i.e., that in the base of the supposed symmetric ornamental tracery should stand asymmetry. In order to illustrate this idea, let us characterize a type of ornamental belt that is built from asymmetric $3 * 3$ elements that are called *seeds of chaos*.

Let us consider element – $3 * 3$ two-colored matrix where four checks are painted asymmetrically with respect to the middle row, middle column and both diagonals. How many such elements exist that are not equal with respect to these already named symmetric transformations? It turns out that – ten, see pict. 6. This simple but not trivial mathematical fact we formulate as a theorem (Modris Tenisons).

Theorem 1 (Modris Tenisons). There are exactly 10 $3 * 3$ binary matrices with exactly four units that are without automorphisms and not isomorphic with respect to reflections versus middle row, middle column and both diagonals.

Proof. The theorem may be checked by direct enumeration. See in picture 6 all these 10 possible matrices where units are designated by red checks and zeros by white checks.



Picture 6. Ten asymmetric $3 * 3$ elements named by M. Tenisons *seeds of chaos*. Each of them characterize equivalence class of eight elements – matrices which are asymmetric versus vertical and horizontal and diagonal reflections. Together there are 80 such elements because their asymmetry doesn't allow the number of elements to „break down" due to symmetries. However, there are 46 symmetric elements in 12 equivalence classes. Factorization as simple as in case of asymmetry is "broken down" by two extra symmetric elements that are symmetric versus all allowed symmetries, i.e., 12 doesn't divide 46.

The next theorem is very relevant for the building of ornamental traceries in the first order belts.

Theorem 2 There are exactly 80 $3*3$ binary matrices with exactly 4 units that are without automorphisms with respect to reflections versus middle row and middle column and both diagonals.

Proof This theorem differs from the previous that the condition of non isomorphism is removed. Because elements are asymmetric in the mentioned sense they factorize in 10 classes of equivalence where each class has $2^3 = 8$ elements. Altogether we get $10 * 2^3 = 80$ matrices.

Let us try to get this number 80 without reference to previous theorem. In total we have $\binom{9}{4} = 126$ binary matrices with 4 units. Let us subtract the symmetric ones. We have symmetric matrices with respect to middle row 12, accordingly, with no unit in middle row – 3, and with two unites – 9. This number should be multiplied by 4. Two matrices were with all units in all corners, and no unit in corners. These came in the count with repetition because of excessive symmetry, thus they we should re-subtract. Thus, we get $126 - 4 * 12 + 2 = 80$. ■

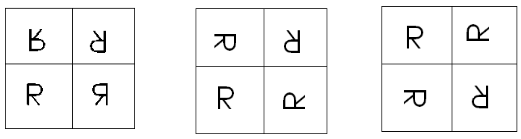
Let us try to build ornamental tracery from these asymmetric elements we call *seeds of chaos,* that are in total 80 factorized in 10 clases of equivalence. Let us first try to count how many ornamental signs we may build in the most simple ornamental tracery from these asymmetric elements.

Definition 1 Let us call *first level ornamental sign code* or, simpler, *ornamental sign code* or *sign code to be a* $2*2$ element that is built from 4 asymmetric $3*3$ elements which are symmetric either with respect to both vertical and horizontal reflection, or with respect to a rotation of $3*3$ elements, all versus the center of the $2*2$ element, (see pict. 7).

Definition 2 Let us say that two sign codes are equivalent if they are $2*2$ element's reflection of rows, (see pict.7).

Definition 2 introduces a simple principle of right and left side equivalence in the belt, namely, according which belt is readable from both sides equally. This principle has more deep methodological meaning in the making distinction between human prehension and mathematical, see below.

Let us consider allowed sign codes by definition 1 (see in pict. 7).



Pict. 7. The illustration of definition 1. Let us assume in the place of symbol „R" whatever asymmetric $3*3$ element with whatever orientation. On the left, $2*2$ element shows how the code of a sign may be built using two orthogonal reflections of $3*3$ element. On the right in two pictures the code of a sign is built using two possible rotations, clockwise and anticlockwise respectively, of $3*3$ element. Two depicted cases by definition 2 are dealt as equivalent. This equivalence doesn't affect the first way of building of a code of sign because the code in this case is already symmetric, say, with respect to the vertical reflection.

Theorem 3 (Modris Tenisons) There are 120 nonequivalent codes of signs.

Proof Let us show that only 120 different codes of signs can be built with allowed operations by definitions 1 and 2.

Let us consider the way to build code of sign using definition 1 where asymmetric element $3 * 3$ should be symmetric with respect to vertical and horizontal reflections, (see pict. 7 left side). In place of asymmetric element $3 * 3$ we can place 80 elements according the theorem 2, which all should give different codes of signs. We get 80 codes of the sign.

Let us consider second way of how to build code of sign by rotation (see pict. 7 middle and right side). There similarly we get 80 codes of sign, but half of these codes would be symmetric with respect to vertical reflection and according definition 2 should be excluded as being equivalent. In the result we get only 40 non equivalent codes of signs. Together we get 120 codes of sign as stated by theorem.

Other ways of building code of sign we do not have. Thus, the theorem is proved. ■

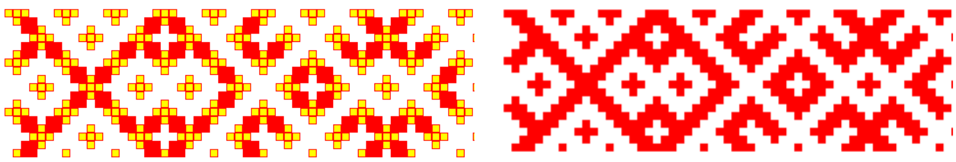
The doubling of ornamental signs by displacement of sieve

We already considered sieve displacement that gives another ornamental tracery. As we saw sieve consists from two dual lattices of cross elements that may be interchanged by displacement by three checks. Having two colors, say, white and red, let one lattice get white color and other red color: using by coding white color we get one ornamental tracery, and red colored code would give another, different ornamental tracery. The same may be attained by displacement of sieve, that could be performed, say, by entering the empty line of code. But this consideration gives us way to build from one code of sign two different ornamental signs. This gives us right for the next theorem.

Theorem 4 (Modris Tenisons). 120 non equivalent codes of sign give 240 distinct ornament signs using sieve displacement.

Proof If signs are divided into two classes with respect to sieve configuration, then no sign from one class may be equal with sign from other class, because the sieve itself plays decisive role: sieve in one class is as if displaced versus other class. This argument completes the proof of the theorem. ■

See pict. 9 for illustration, where the same code gave two different signs which become interchanged by sieve displacement. In order to get succession of two equivalent signs we had to divide the code of signs by the empty line of the code.



Pict. 8. Sieve displacement with respect to the same code. Sign „Fish” or “*zivtiņa*”.

Pict. 9. Changing colors in an ornamental tracery we get another one. However this change does not effect to the same extent than by sieve displacement: we may discern previous ornamental tracery by our imagination.

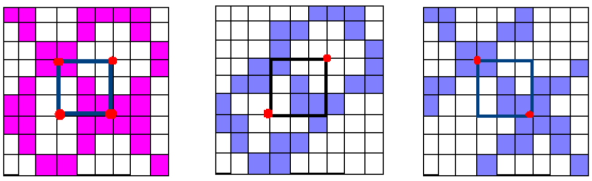
Pictures 9 and 10 show that sieve displacement and color interchange work in different way in ornament building.

Actually we could introduce one more feasibility to double number of codes of signs, scilicet, in place of asymmetric code allowing to be its dual element, namely, asymmetric $3*3$ element with five units. But this would lead to some disbalance of colors or brightness of colors in ornamental tracery, scilicet, 5-unit elements would give more colored tracery that 4-unit elements and coming them alternately would give place to disbalance of brightness of ornament. Thus, here we see where pure mathematical argument may come in conflict with some artistic principle and human prehension: mathematics would say that we may have 480 sign codes whereas artistic principles would force us to restrain only to 240 sign codes.

The principle of the opening of field information

Modris Tenisons came to building ornament signs in a little different way, namely, using principle of *the opening of field of information*. Let us try to consider his approach, using some systematic argument.

Let us first consider a little different proof to the theorem 3. Let us consider pict.8a on the left where we use two orthogonal reflections of $3*3$ elements, getting in this way 8 ways of building a code of sign. Similarly let us do rotation of $3*3$ element according the schema in pict.8a on right: we do rotation of each corner getting 4 codes of signs. Two signs are to be excluded to escape repetitions. Together we get 12 schemata that for 10 asymmetric elements would give 120 different codes of signs. In this way we didn't even use the definition 2. Why? It turns out that the performance of rotation only in one direction is equivalent with the use of the definition 2 that introduces equivalence of left and right sides of ornamental tracery. Allowing rotations in both directions would result in getting repetitions of code that the definition 2 excludes.



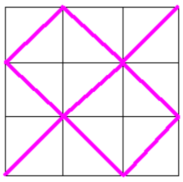
Pict.9. An example of the building of the code of sign. On the left one asymmetric element gives four codes of sign, correspondingly in each corner, with asymmetric element in the center. In the picture in center and on the

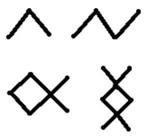
right from the same asymmetric element we get codes of sign only by twos in two pictures because of repetitions. Clearly is seen the occurence of double overlap by rotation symmetry.

Let us try to follow the idea of Modris Tenisons about the opening of field of information. If in place of asymmetric elements we had symmetric, then the number of different elements would be less because every symmetry tends to reduce corresponding number at least by 2. Some analogy may be the fact that $3 * 3$ symmetric elements with five zeros give 12 classes of equivalence that do not factorize as simple as in case of asymmetry, namely, when number of all matrices is 46. Two exceedingly symmetric matrices, with units in corners and no unit in corner, breaks down simplicity of count, e.g., $12 * 4 = 48$.

Let us try to reason how Modris Tenisons does it in his *workshops of ornament creation* (see [1]). Let us take asymmetric element and open it in all direction with reflections, filling corner squares too as in pict. 9. Going on with such „opening" *we wouldn't get new information* because of repetitions. If in place of asymmetric element we had taken something symmetric we didn't get even this amount of information, but we had already repetitions. Speaking informally, information for us is that that *do not repeat*. But, let us imagine in place of what we see to be dimensions in some subspaces: repetitions there would mean no information already directly. In place of information here we might use term – *access to information*, and quantity – *degrees of freedom*, and that would give us more justification for the use of these notions in way Modris Tenisons do.

Let us consider how many unrepeatable information we might get. We have 10 equivalence classes of asymmetric elements and 80 elements. Informally we might say that theorem 3 counts number of information occurrances or degrees of freedom in the generation of code of first level.

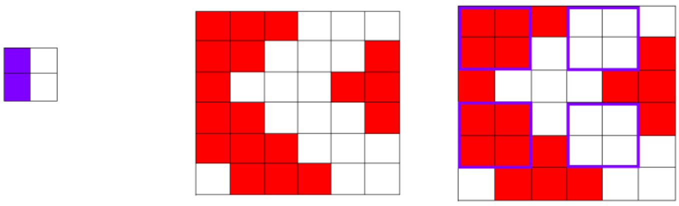




Pict. 9. $3 * 3$ field where each of them is $3 * 3$ matrix for building code of sign where with slash is depicted imaginable asymmetric $3 * 3$ element. Such slashes in the language of building of ornamental signs denotes their generic elements that artists are used to. On the right some examples of such sign buildings: the sign of Māra ("Māras zīme") that arises from the union of any two opposite, masculine and feminine, elements; „eternity"; „fish sign"; „crayfish sign" or „cancer". See other examples in [7,8,9]. All these signs except the last may be placed in this $9 * 9$ field of code. The slash works as if a variable that may have received 80 possible values. For example, we may form 80 samples of „Māras zīme", etc.

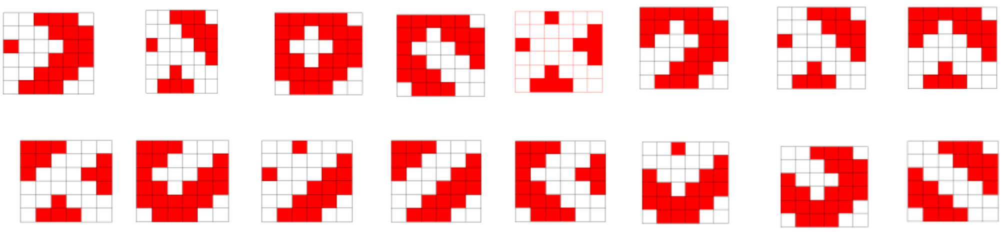
The sign language alphabet

Let us consider a simple idea of how from sieve displacement and ornament coding we may come to sign alphabet in the first order (complexity) belts. Two following rows in the code in case when ornament code width is, say, six may be divided into 3 $2 * 2$ binary fields. Each such field may be considered as a letter in the 16 sign alphabet. For a binary code of such form it would be a trivial step with trivial such an alphabet. But in case these binary fields "work" together with the sieve, they make 16 signs for ornamental sign language alphabet. Actually we get two such possible alphabets using sieve displacement. Every belt of width 6 may be cut into such square elements standing for ornamental sign alphabet letters because we should get invariantly only 16 such alphabet letters by simple binary code argument.



Pict. 9. Illustration how sign alphabet arises from simple binary code. On the left example of two binary columns from two rows – binary matrix $\begin{pmatrix} 1 & 0 \\ 1 & 0 \end{pmatrix}$. Putting this code into the sieve we receive one alphabet letter of the sign alphabet, as in the center, and on the right where places of code are marked. Every belt of width 6 may be cut into such square elements standing for ornamental sign alphabet letters because we should get invariantly only 16 such alphabet letters by the simple binary code argument.

Modris Tenisons patent [5] actually is for this sign alphabet, that in indirect way contains ideas of sieve displacement and ornamental coding.

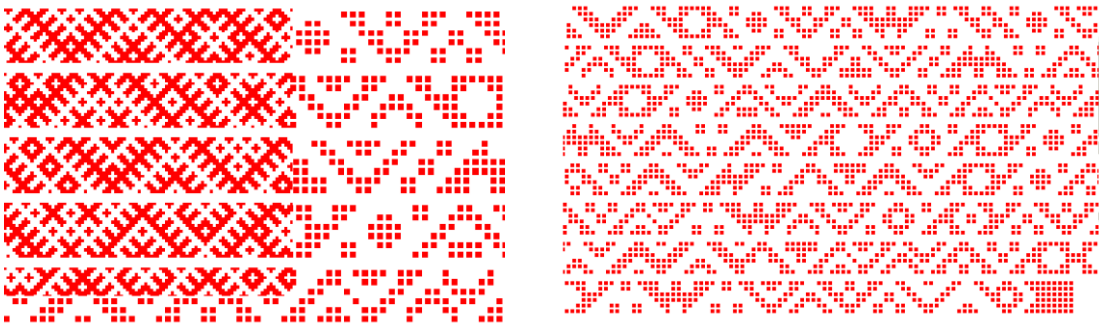


Pict. 10. 16 letters of the ornamental sign language alphabet. Would this alphabet of Modris Tenisons be sufficient to code belt of Nica? ... in sense how any first order ornamental pattern may be composed by these squares as puzzle? Mathematically it is trivially if we only notice that this is the full binary code in the sieve. By the sieve displacement we get another such alphabet that is different from this one.

The belt of Nica and its investigation

Modris Tenisons has proposed idea that the belt of Nica is built from asymmetric elements too, similarly as we described higher [4]. But it turns out not to be so simple. If we directly search after $3 * 3$ asymmetric elements in the belt of Nica, we do not get them sufficiently many to get complete cover of all the belt. We come to a question how the code of the belt of Nica is built if we want to stick around the ideas of Tenisons about asymmetry as basis of symmetry in ornamental tracery of belt?

We may now ask. How weaver could come to belt that is as rich as the belt of Nica? One interpretation is sufficiently simple. Together with the experience by weaving instrumental experience heaps up. Weavers better remember „instrumental" experience than, say, visual, namely, they remember technological and instrumental information how they do anything by weaving rather in some other way. In much simpler case, *exempli gratia*, knitter remembers combinations of stitches rather than anything else. The same but in more complex setting applies for weaver of belts. The belt of Lielvārde shows that this assumed instrumental experience that might be incredibly complex may produce real wonders. Widely used allusion to an information from the Cosmos in this context [1] might have some ground, though not subject to direct scientific argument up to now.



Pict. 10. The code of the belt of Nica and its ornamental tracery.

But what to say with respect to the belt of Nica when we want to discover asymmetry in its ornamental tracery? Here we may be forced to attack this question from another side and ask: don't we have to deal here not so much with local code but volume or distributive code? To find distributive function (or pieces of holograms) if any in the structure of code might be much harder task than code's investigation locally. If so, just distributive function would be real code maker of the belt of Nice, in case we were successful in its discovery. At present first author is working in this direction too.

"The belt of Nica teaches us": the aesthetics in the belts of first order

First order ornamental belts are convenient object of investigations because we may speak about some level of aesthetics that may be characterizes sufficiently simply by quantitative argument. Firstly, belt is readable equivalently 1) changing colors to opposite; 2) changing sides to opposite (with correction of right side turn argument). Secondly, belts are coded in an asymmetric coding. Thirdly, ornamental pattern has balanced color ratio, i.e., already the seeds of chaos incarnate relation 4:5, and the sieve consists from two dual lattices of both colors. Fourth, signs in ornamental patters are inseparable, i.e., sign transforms to other sign, signs overlapping form signs, and so on.

The interchange of colors in ornamental tracery of belts says that belt is readable in both ways equivalently, leaving space for some aesthetic or artistic difference, with reference to human psyche. But there is a way to read belt in both ways simultaneously, namely, when we see as if a belt in both ways. Then we may start to see belt as if border between two colors, namely, we do not see „red on white" or „white on red" but the sign as a border between both colors. After all that is what we are after: belt is the union of two elements, masculine and feminine. In Latvian tradition this says that belt is the sign of Māra, „Māras zīme". Christian tradition may say „sign of Christ".

Modris Tenisons as an artist uses rather a different way of expression, saying, what we encounter as an aesthetics in the belt of Nica we must attribute to what the belt of Nica teaches us [4]. Thus we must say "*The belt of Nica teaches us*." "The belt of Nica teaches us – In all should prevail simplicity. The belt of Nica teaches us – Nothing excessive. ... Colors should be in equilibrium. ... Belt should be read between colors ... And so on."

What concerns a partial equivalence of sides of belt, left and right sides in belt are equivalent in sense they are readable in both ways, but right side remains prevalent over left side as right side (hand) is prevalent over left side (hand) in the human nature settings: we discern right and left side as *homines sapientes*, but nature above us might have some indifference against this distinction. This same message we see in mathematics and physics. Lorentz transforms and right and left glove non-interchangeability are guided by the same signature of quaternion [5]. Double cover of $SO(3)$ by $SU(2)$ don't care of prevalence of right over left, but makes space for such prevalence. What we have in case of belts is two dimension case in mostly convenient three dimensional case. It is nice to see that 2-dimensional case leaves over these characteristic two points „left" and „right" of unit circle in complex plane that would be actual for three-dimensional and higher cases. That we see in ornamental belts incarnated in the principle of partial equivalence of sides of belt.

Pict.11. Piece of ornamental tracery got from one *seed of chaos*.

12. The belt produced from 10 asymmetric elements, using random number generator to choose between different seeds of chaos, according principles explained in this article. How about aesthetics in this example? We don't have that simplicity that in case of Nica belt. Do we lack some more simple aesthetic principle here?

Genesis of ornamental pattern: sign from code or *vice versa*

In this article we explained genesis of the ornamental sign from the side of code rather than from the side we perceive it as an image. Moreover, we may conclude that ornamental code may creep in indirectly in other way too, e.g., via instrumental experience of weaver. Now we may question on more general level asking: how ornamental pattern arises? Via code or as an image? This question is not so redundant, because researchers of ornamental patterns use so much effort to explain where from one or other pattern could have arisen, basically using "image approach"[2,7,8,9], because "code approach" would require some understanding, how code generates sign. If we acknowledge that the code can generate an ornamental pattern as if from itself, the picture or this type of research changes cardinally. A new aspect comes before researchers – *instrumental experience* as source of producer of ornamental patterns.

Belts of higher order and their eventual investigation

We have already mentioned the belt of Lielvārde, that is much more complex than, say, the belt of Nica. In order to research this type of belt it isn't sufficient to remove sieve and apply asymmetry on some simple level. Belt of Lielvarde is build as if on several levels, a sieve if discernible, is used on several levels, scilicet, at least two. However, Lielvārde belt is produced by human beings, with their hands, though of very skilful masters. How to imagine investigations of these belts with exact methods similar we try to use in this article? Our answer is simple enough: we must first research first level belts, then maybe nearest samples that step outside this first level. Moreover, we step as if in new typology of genesis of belts, scilicet, based on arising sign from code rather than as image. To support this approach we must apply new mathematical methods along with these already used in researches, as in [2]. Modris Tenisons attributes Lielvārdes belt to fifth or even higher level of complexity, but he has no exact means to say what specifically; all this is still as if in the field of artistic estimation, not in reach of exact scientific criteria. All this shows necessity to do researches and typology of ornamental patterns in gradual way, from simpler to more complex.

Making research in field as complex as of Lielvārdes belt researchers face question: is this only problem of artists or, say, researches of the Living Ethics? Many speak about information from the Cosmos. What is this? Are these things subject to research or only area of religion or mystics? Exact sciences tend to say that they do not want to have anything shared with the Living Ethics? But they may have common area of investigations, scilicet, belt of Lielvārde. Now, when question may has become even more complex we may have for this a new justification: we may ask – the Cosmos provides us with visual or instrumental information? See [11].

Does there exist first order complexity in the nature?

The research of belts is not only recreative entertainment that doesn't have anything in connection with research in nature or mathematics. Question about what is primary – code or image – might be more actual than we assume, and not only in ornamentalistic but in nature too.

Ornamentalistic might play important role in different areas of science, arts, where these areas may intertwine. We may use language of artists and try to unite with precise language of mathematics similarly as we tried to do in this article. Ornamentalistic would be the branch where without this synthesis were hard to get along. But here may come other areas into touch too, say, physics, biology, psychology. The last is mentioned in very interesting aspect in the movie „The belt of Lielvārde. On hypothesis of Tõnis Vint". Let us take look into the message of Tõnis Vint (Estonia) (transl. by D.Z.):

> „Through times and lands signs unite us and narrate. For example, these Mexican temple walls hide about the world three layers of information: everyday objective, facts about events, and phenomena in nature description. Gifted for this last epistemology were only some chosen people. Several notions for a single symbol were present also in Chinese tables of I-Cin : heaven – virility, earth – femininity, and parallel notions: heaven – creation father, earth – submission mother, water, moon, danger, fire, light, sun, and other meanings.
>
> To sun, moon, fire and water our ancients attributed magical signification. In this way geometric ornaments already long ago were used for practical reasons.
>
> American Indians lived in precisely created circles, that afterwards were called medical circles, because, how archeological excavations indicated, in these settlements living Indians of Siu tribe didn't know illnesses. According a legend, each child for this tribe had a sage, or a philosophical father specially chosen. Taking away a child into the wild nature, having explored his character and biophysical features, Indian sage draw

> individual symbol for a boy or a girl that served as a singular person's code or card. Using these cards youth got acquainted, families united in friendly contacts, and all lived in a great friendly family in the psychological concordance, and illnesses for harmonic balanced people went past. Using this circle there was possibility to influence human's psyche more directly too."

This was said before the year 1980. What we have now? Have we solved problem that was not problem for Indians of Siu tribe? I don't think so? Why? The main problem is about ourselves who consider such evidences as legends that are not much worth for direct research. But why after finding Rosetta Stone there came investigators, and Champollion himself, to decipher the script? Doesn't the script of Nica, or Lielvārde, look like a script that could be deciphered or deserves to be deciphered? We here maid an attempt to show that maybe we heavily err.

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References

1. Lounesto, Pertti (2001) *Clifford Algebras and Spinors*. London Mathematical Society, Second Edition, Lecture Note Series, 286, Cambridge University Press, 2001, 338pp.

2. Milašius, Vytautas; Neverauskiené, Dalia; Katunskis, Jurgis; Kazlauskiené, Ilona (2002) *The Mathematical Basis of Ornamentation of Patterned Woven Fabrics.* FIBRES & TEXTILES in Eastern Europe, October/December 2002.

3. (1990) *Ornament Letton. Art vestimentaire, textile, architectural, céramique etc, d'après de documents officiels et privés.* Edition "Le Livre Letton", Paris, 1990.

4. Tenisons, Modris (2010) Ornaments and Symmetry: Language of Signs of Ornamental Tracery (interview with Modris Tenisons), scireprints.lu.lv/62/, 2010.

5. Tenisons, Modris (2001) *Intellectual game*, patent of design pattern, patent Nr. D 10 577, LOC kl. 21-01, 20.05.2001.

6. Tenisons, Modris; Strazds, Armands (2003) *ZĪMES anatomija (in Latvian) The Anatomy of ZIME (in English).* Project Report. www.zime.lv, scireprints.lu.lv/61/

7. Tumėnas Vytautas (2002) Contemporary folk art in the centre and in the province: changes of values. Tautodailė centre ir periferijoje: vetybių perkainojimas. Liaudies Kultūra, 2003, 3(90), pp. 26-40.

8. Tumėnas Vytautas (2003a) Research into the Baltic sashes symbol system: from the scientific interpetation to the authentic traditional folk typology. Baltiškų Juostų simbolių sistemos paieškos: Nuo mokslinės intepretacijos iki autentiškos tradicinės liaudiškos tipologijos. Acta Academia Artium

Vilnensis, Daile, Istorinė tikrovė ir iliuzija: Lietovos dvasinės kultūros šaltinių tyrimai, Vilniaus Dailes akademijos leidykla, 31, 2003. pp. 21-38.

9. Tumėnas Vytautas (2002) Ornament of Lithuanian traditional pick-up woven sashes: typology and semantics. Vilnius, Piemedžio, 2002.

10. Vint, Tõnis (1980) *The belt of Lielvarde. On hypothesis of Tõnis Vint*. „Rīgas kinostudija", documental movie, producer Ansis Epners, 1980.

11. Zeps, Dainis (2010) *Our Ability to Research Comes Before Understanding of What We Research*. Journal of Consciousness Exploration & Research, Vol 1, No2, 2010. 9pp.

Appendix. Code of the belt of Nica

We add here code of the belt of Nica in the table with 8 columns and 100 rows. Code starts from first the column and the first row and goes down along a column and then proceeds from the first row of the next column. The code consists from 751 code rows, or 6 binary units numbers.

111000	001100	100001	100111	000110	000011	000011	100111
110001	011001	100001	100111	100011	000111	000011	110011
100011	110011	110011	001110	110001	001111	001110	011001
000111	000111	111111	011100	111000	011100	001100	001100
001110	001100	011100	111000	111100	111100	111000	001100
011100	011100	001100	110000	001110	001111	110011	011001
111000	111111	000111	100011	001111	001111	100011	110011
111000	110011	110011	000011	111100	111100	001111	100111
011100	100001	110001	110000	011100	011100	001111	001100
001110	100001	000000	110000	001111	001111	100011	011100
000111	110011	001100	000011	000111	000111	110011	110011
100011	111111	011110	100011	000011	110011	111000	110011
110001	001110	011110	110000	110001	011001	001100	011100
111000	001100	001100	111000	110000	001100	100110	001100
111000	111000	000000	011100	000011	001100	110011	000111
110001	110011	100011	001110	100011	011001	110011	110011
100011	100011	110011	100111	110000	110011	100100	110001
000111	001100	011000	100111	111000	000111	001001	001100
001100	001100	001100	001110	001100	001100	110011	001100
011100	110001	110110	011100	001110	011001	110011	110001
111111	110011	110011	111000	000011	110011	011001	110011
110011	000111	110011	110001	000011	110011	001100	000110
100001	001110	110110	100011	001110	011001	100111	001100
100001	011100	001100	000111	001100	001100	110011	011000
110011	111001	011001	000111	111000	000111	011001	110001
111111	111001	110011	100011	110011	110011	001100	110001
001110	011100	100100	110001	100011	110001	001101	011000
001100	001110	001100	111000	001111	000000	011011	001100
111000	000111	001100	001100	001111	001100	110110	000110
110011	100011	100100	001110	100011	011110	101100	000011
100011	110001	110011	111111	110011	110011	001100	100001
000000	011000	111001	110011	111000	110011	100110	110000
001100	011000	011100	100001	011100	011110	110011	110000
011110	110001	001110	000000	001110	001100	111001	100001
011110	100011	100111	000000	100111	000000	001100	000011
001100	000111	100111	100001	100111	100011	001110	000110

000000	001100	001110	110011	001110	110011	110011	001100
110001	011100	011100	111111	011100	111000	110011	011110
110011	110000	111000	011100	111000	001100	001110	110011
000111	110000	110011	001100	110001	001110	001100	110011
001100	011100	100110	000111	100011	111111	111000	011110
011100	001100	001100	110011	000110	110011	110011	001100
110011	000111	001100	110001	000110	100001	100011	100001
110011	110011	100110	000000	100011	001100	001100	110011
011100	110001	110011	001100	110001	001100	001100	111111
001100	111100	111000	011110	111000	100001	100011	111111
000111	111100	001100	110011	001100	110011	110011	111111
110011	110001	001110	110011	001110	111111	111000	111111
110001	110011	110011	011110	111111	011100	001100	111111
001100	000110	110011	001100	110011	001100	001110	111111
001100	001100	001110	000000	100001	000111	111111	111111

110001	011001	001100	100011	100001	110011	110011
110011	110011	111000	110011	110011	110001	100001
000111	110011	110011	111000	111111	001100	100001
001111	011001	100011	001100	011100	001100	110011
011100	001100	001100	001110	001100	110001	111111
111100	000110	001100	111111	000111	110011	001100
001111	110011	100011	110011	110011	000111	001100
001111	110001	110011	100001	110001	001100	111111
111100	001100	111000	100001	000000	011100	110011
011100	001100	001100	110011	001100	110011	100001
001111	100011	100110	111111	011110	110011	100001
000111	110011	110011	011100	011110	011100	110011
000011	111000	110011	001100	001100	001100	111111
110001	111100	100100	000111	000000	000111	011100
110000	001110	001001	110011	100011	100011	00110
000011	001111	110011	110001	110011	110001	000111
000011	111100	110011	000000	111000	011000	000011
110000	111100	011001	001100	001100	011000	110001
110001	001111	001100	011110	001110	110001	110000
000011	001110	000111	011110	110011	100011	000011
000111	111100	110011	001100	110011	000110	000011
001100	111000	011001	000000	001110	000110	110000
011100	110000	001100	100011	001100	100011	110001
110011	100011	001100	110011	111000	110001	000011
110011	000011	011011	111000	110011	111000	000111
001110	110000	110110	001100	100011	011100	001111
001100	110000	001100	001110	001100	001110	011100
111000	000011	001100	110011	001100	100111	111100
110011	100011	100110	110011	100011	100111	001111
100011	110000	110011	001110	110011	001110	001111
000000	111000	111000	001100	111000	011100	111100
001100	001100	111100	111000	001100	111001	011100
011110	100110	001110	110011	100110	111001	001111
011110	110011	001111	100011	110011	011100	000111
001100	110011	111100	001100	110011	001110	000011
000000	100110	111100	001100	100100	000111	110001
110001	001100	001111	100011	001001	100011	110000
110011	111000	001110	110011	110011	110001	000011
000111	110011	111100	111000	110011	011000	000011
001100	100110	111000	011100	011001	011000	110000
011001	001100	110011	001110	001100	110001	110001
110011	001100	100110	100111	000111	100011	000011
110011	100110	001100	100111	000011	000111	000111
011001	110011	001100	001110	110001	001110	001100
001100	111000	100110	011100	110000	011100	011001
000111	001100	110011	111000	000011	111001	110011

110011	001110	111000	110001	000011	111001	110011
011001	111111	011100	100011	110000	001100	011001
001100	110011	001110	000110	110001	001110	001100