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Aksiniya Peycheva

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A Transdisciplinary Approach in Art

Translating Physical Trauma into a Geographic Map

AKSINIYA PEYCHEVA

ABSTRACT

A transdisciplinary exploration has allowed the author to combine art, hematology, computer science, and geography to attempt the visual translation of physical pain. Research subjects are stray animals that have experienced traumatic events (such as shooting) which have a lasting impact on their lives or, at times, prove to be fatal. By applying different computational geometry methods, the author creates geographic maps, which reveal the scale of the damage to the body. Thus, the application of transdisciplinarity allows a deeper understanding of complex events.

The research described in this paper is an inquiry into abstract entities such as physical injuries, which would lead to pain, to explore their visual manifestations. One approach is to apply different scientific methods that explicitly entail visual information, such as using microscopy in different samples, for instance. Such attempts could be defined as a translation process whose foundations can be traced to abstract art at the beginning of the 20th century. A significant part of the discourse included “translating music into painting” and vice versa [1].

In contemporary art, translation can be further extended to the domains of science and technology, where the boundaries between these fundamentally different aspects of human knowledge are shattered to fulfill an artistic idea. “A . . . characteristic of transdisciplinarity . . . is the tendency to think . . . creatively not only about solutions to problems but to the combination of factors that need to be considered. Inputs from the arts and humanities can transform research and education in sustainability or other topics traditionally viewed as scientific into an entirely new kind of product” [2]. In *Genesis*, for instance, Eduardo Kac creates a gene by translating a sentence from the biblical book of Genesis into Morse Code and converting the code into DNA base pairs

according to a conversion principle specifically developed for this work [3].

In contemporary art discourses, trauma has often been a subject of interest. It has been explored through the lenses of deliberate self-infliction, infliction by others, and psychological trauma arising from an artist's background (Marina Abramović, *Rhythm 0–10* [1973–1974]). It has also been examined through the aesthetics of the raptured flesh (Anish Kapoor, *Internal Object in Three Parts* (2013–2015) or communal trauma such as that experienced by Black communities (as seen in the New Museum's exhibition *Grief and Grievance: Art and Mourning in America* [2021]). Sometimes these artistic explorations are interdisciplinary and combine medicine, cultural history, and psychology, such as in the exhibitions *Pain* [4] and *Trauma* [5]. However, the subject of physical trauma has not been explored through the prism of visual translation in a transdisciplinary perspective.

THE TRAUMA MAPPING PROJECT

In Bulgaria, a small post-Soviet country, the problem with stray animals is rooted not so much in the effects of a political agenda but rather in a social mentality. *Trauma Mapping* counters an anthropocentric worldview. It focuses on the suffering of animals and not that of humans. It is an attempt to create a path for making visual sense of the injuries experienced by these animals. The trauma for them is sometimes the result of deliberately caused harm, and in other cases, their etiology is unknown. However, the concept of continuous suffering and the visible results that they leave behind can still be traced. The project seeks to explore the inner processes of suffering, to look for visual artifacts left by these events—their projection on the body, the reaction of the organism towards it, and the way the cells are being damaged.

Three scientists helped create *Trauma Mapping*: Eric Osborn, a U.S.-based software engineer; Siyana Petrova, a Bulgaria-based molecular biologist; and Alexander Penkov, a Bulgaria-based geographer [6]. The project focuses on eight different animals and the story of their injuries (or illnesses).

Aksiniya Peycheva (artist, researcher), National Academy of Arts, Fine Art Department, Shipka 1 Str., Sofia 1000, Bulgaria. Email: peichevaaksiniya@gmail.com. Website: aksiniyapeycheva.com. ORCID: 0000-0002-0286-1790.

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VISUALIZATION AND VISUAL TRANSLATION

Since the 1980s, information society has been one of the key terms used to describe the modern world. It is used in various ways as a social, cultural, economic, and technical vision and is usually seen as due to technological and scientific progress [7]. This creates new media in the art world and new concepts. Visual translation can be attributed to those complex phenomena that arise from those processes, in which the flow of information is the primary paradigm. Transdisciplinarity allows the creation of a bridge between fields that are considered fundamentally different and, ergo, could enable more productive results not only because of the opportunity to look beyond the limits of the disciplines but because of the possibility to raise new questions and embrace hidden information, which could not be extracted otherwise.

There is a distinction between information visualization and visual translation. Information visualization (or InfoVis) seeks to augment human cognition by leveraging human visual capabilities to make sense of abstract information [8], providing means by which humans with constant perceptual abilities can grapple with increasing hordes of data [9]. Information visualizations are interactive visual externalizations of abstract data [10] that can assist users in making sense of large amounts of information because they exploit our natural perceptual abilities [11]. The visual translation process is different because it includes a stage of deep analysis—what the data is, how it works, and how it affects its surroundings.

Applying transdisciplinary methods as a tool for visual translation can transfer visual information to a different field of knowledge, searching for hidden or unapparent meanings. According to D. Hofstadter, “translation is but the challenge of communication rendered crystal-clear . . . communication is but metaphor, and . . . metaphor is but analogy.” He states that translation is at its core “analogy at its most sublime and enchanting” [12]. A piece of information taken out of its context is no longer bound to its limits. This allows it to be linked backward or forward to a completely different mindset and environment—analogy between other systems of knowledge can be used as a basis for transdisciplinary attempts. Connecting hematology, computational geometry, and geography, for instance, can give us a perspective of how the animal body reacts to physical trauma in ways similar to a human’s. Human blood under a microscope does not differ much from a cat’s. This reflects upon the complexity of physical suffering and gives us an idea of the scale of the damage to the animal body and the traces they leave, a process which has most likely led to a great deal of pain.

Dino

Dino—a stray dog, shot at the beginning of 2018—was found in the woods near Voynegovtsi, a small village near Sofia, just a few minutes after the shooting. Unfortunately, despite the treatment, the shooting left his back legs paralyzed. The bullet had passed through his spine, breaking one of his vertebrae. The entrance wound was about 1.5 cm, and there was

a small amount of blood. I found it particularly interesting that he was lying calmly on the medical table and didn’t feel any pain, indicating a neurological problem. A radiograph showed that the spine was full of small bullet pieces that could not be removed. Veterinarians were unable to help him walk on four legs again.

The man who found Dino decided to foster him. He built a separate space in his home where the dog could live, and he bought him a wheelchair, which he subsequently chewed (due to his fondness for chewing plastic and wood). Despite his injury, Dino leads a joyful life. He can play, and he doesn’t pay much attention to his disability.

Step One: Hematology

The bullet’s trajectory was evident, and the way it ripped the flesh apart was obvious, so I decided to investigate that same entrance wound in search of the traces it left behind while entering the body. Perhaps this was an urge to dissect the situation and the motivation. I took a sample from the wound—a blood smear. In hematology, the branch of medicine involving the study and treatment of the blood, blood samples can be prepared with a glass slide placed on top of the damaged tissue. A blood film report can provide helpful information about a patient’s condition rapidly and at a low cost [13]. When the glass touches the wound, many cells are transferred to the surface of the slide, and the sample can be further examined under a microscope (Fig. 1).

After the sample was taken, it was stained using the hematoxylin and eosin stain staining method. Hematoxylin is a dark blue or violet stain. It binds to basophilic substances such as DNA and RNA, which are acidic and negatively charged. White blood cells are stained purple. Eosin is a red or pink stain that is acidic and negatively charged. It binds to acidophilic substances, such as positively charged amino-

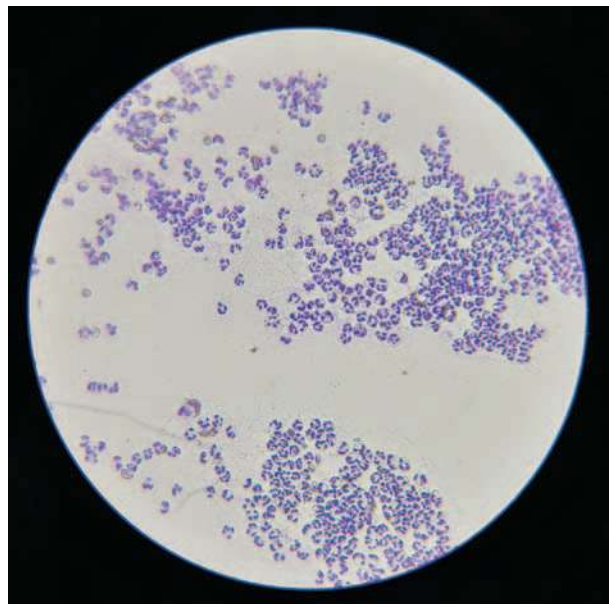


Fig. 1. Part of the sample from the bullet wound under a microscope. © Aksiniya Peycheva

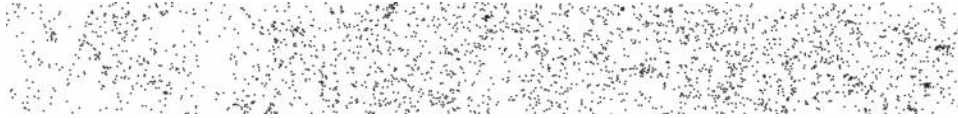


Fig. 2. Part of a graphic image showing the positions of the white blood cells. (© Aksiniya Peycheva)

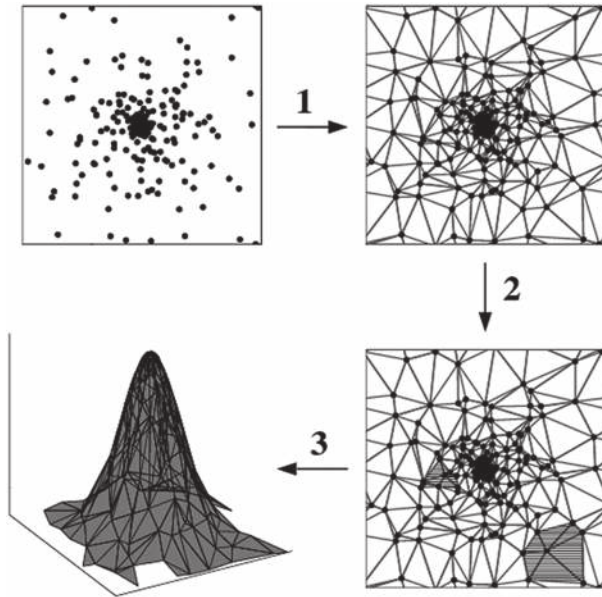


Fig. 3. Overview of the Delaunay Tessellation Field Estimator (DTFE) reconstruction procedure. (© Willem Schaap)

acid side chains (e.g., lysine, arginine) [14]. Red blood cells are stained dark red. These color differences make it easier to distinguish between blood cell types such as the leukocytes, the white blood cells that fight infections, and antigens that have entered the body. In the case of Dino, it was clear where the infection had taken hold by the leukocyte count in some areas. This allowed me to study the bullet’s movement on the flesh, trace the organism’s reaction towards it, and the way the cells were being rearranged by what had happened. After assembling the whole picture of the wound, I located the positions of the white blood cells that fight with the infections the organism experiences during tissue damage—the reason they are dangerous. I then converted their locations in the sample into a simple dot graph (Fig. 2).

The dot graph was like an image with no shape. The dots were spread around in a seemingly random pattern. However, it wasn’t arbitrary—it reflected the places where the bullet wound was causing the most extensive damage to the body; it was a guide to the wound’s behavior, but it didn’t make any sense yet. I wanted to extrapolate more information about the tissue damage and its values, to look for more visual data so that I could analyze it further.

Step Two: Connecting the Dots

I imagined the wound surface as a terrain or architectural setting where an action took place. The cells that were tracing the damage were already set, so, in a way, it was already a terrain, but only in two dimensions. It lacked its third dimension, which would reveal more information. This is where a computational geometry method was put into practice. “Connecting the dots” is probably the most important aspect of computational geometry. Many models deal with how and why a particular set of dots are internally connected. Thus, I applied the most suitable method—the Delaunay triangulation [15]. A Delaunay triangulation (also known as a Delone triangulation) for a given set (P) of discrete points in a plane is a triangulation $DT(P)$ such that no point in P is inside the circumcircle of any triangle in $DT(P)$. Delaunay triangulations maximize the minimum angle of all the angles of the triangles in the triangulation. This image shows the inner connections between the bullet and the cells.

The Delaunay triangulation method is the foundation for other methods, including one used for locating galaxies called the Delaunay Tessellation Field Estimator (DTFE) method [16]. The DTFE (Fig. 3) is a mathematical tool for reconstructing a volume-covering and continuous density or intensity field from a discrete point set. The DTFE has various astrophysical applications, such as analyzing numerical simulations of cosmic structure formation, mapping the large-scale structure of the universe, and improving cosmic structure formation computer simulation programs. When applied to the set of dots from the visualization of leucocytes, the result was an image that resembled a relief—the more elevated the terrain, the more leukocytes were present, indicating the presence of severe injury (Fig. 4).

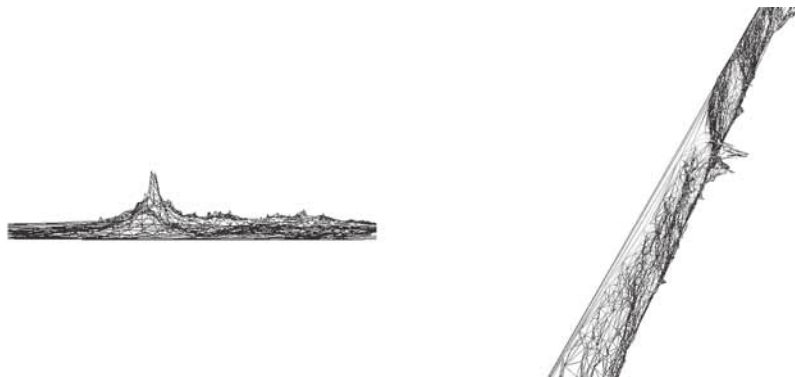


Fig. 4. Applying the DTFE method to the set of dots taken from the bullet wound. (© Aksiniya Peycheva and Eric Osborn)

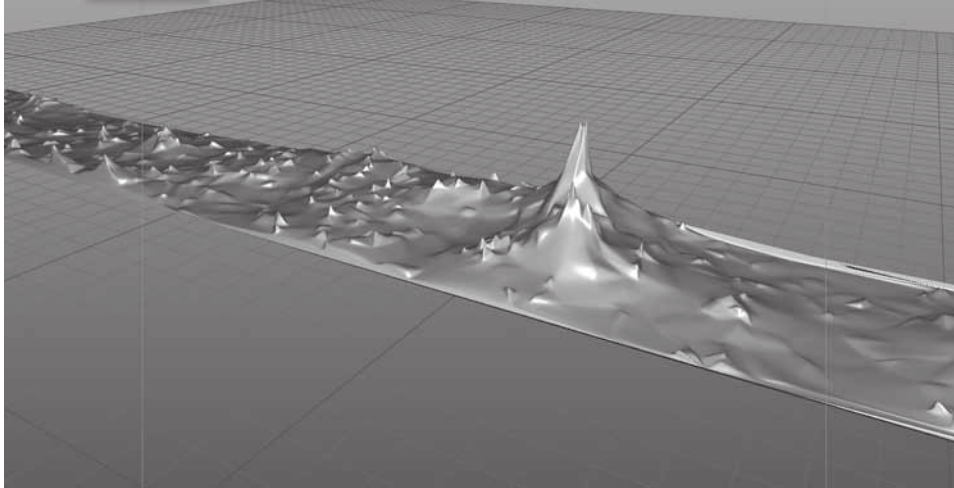


Fig. 5. A 3D relief of Dino’s bullet wound. (© Aksiniya Peycheva and Eric Osborn)

GENERATING A PAIN MAP

The final stage of the project was importing the relief into the geographic information systems (GIS) (Fig. 5). Geographic information systems, a term coined in the 1960s, had evolved by the late 1980s into a widely-adopted software application. They can generate a relief, and they allow the geographical exploration of any surface on Earth. The scientific community has been involved in solving the technical problems of building using GIS, including the design of data structures [17]. GIS software helped generate a relief map of Dino’s bullet wound, which shows where the injury is concentrated (Color Plate B). The map was then crafted with a CNC machine (a drilling device) into an actual wooden object, which I call a “sculpture.” The big “mountains” show where the physical injury is most significant in this sculpture. This object represented somewhat of a conclusion of this process of looking into the physical trauma to understand it better.

Peshko

Other stories the project explores included different approaches. In the case of Peshko, an eight-year-old dog with a head tumor, we created a topographic map to show the

physical features of the damaged tissue. After a histological examination in a laboratory, the cancer was diagnosed as fibrosarcoma (Fig. 7a). Fibrosarcoma represents a rare group of soft tissue malignancies derived from fibrous connective tissue and immature proliferating fibroblasts or undifferentiated anaplastic spindle cells [18]. After the surgical removal of the tumor, it was converted into a paraffin block, prepared in a laboratory, and slices from it were examined under a microscope. In the structure of the tumor, cells were grouped very clearly. These groups were subsequently converted into a topographic map based on their formed areas. The isohypses on the topographic map match places with the same “altitude” and, in this case, it distinguishes the location of the healthy tissue and the position of the tumor. Peshko’s topographic map (Fig. 7b) yields more information—pink areas mark where tumor cell concentration is observed.

Loli and Meggy

The Voronoi diagram [19] was applied in the case of Loli, a kitten suffering from feline immunodeficiency virus (FIV), also known as feline AIDS. As a result of her illness, Loli developed severe anemia, a red blood cell deficiency that makes it difficult for cells to carry oxygen throughout the



Fig. 6. An installation view of *Trauma Mapping* at Ars Electronica Festival, *Out of the Box*, 2019. (© Florian Voggeneder)

body. A drop of her blood was stained and examined under a microscope, and the red blood cell positions were converted into a dot graph. The Voronoi diagram was then applied, resulting in translating the plane into regions close to each of the given set of dots (the positions of the red blood cells). This illustrates how big of a terrain the red blood cells need to cover but cannot. Thus, based on the distances between the cells, a polygon graph is created—the bigger the area of the polygons, the longer path the red blood cells must traverse to supply the body with oxygen (supplemental material Fig. 1).

Another example was Meggy, a cat with so many system failures that it simply couldn't function. Meggy, a 3-year-old cat weighing 1 kg, had kidney failure, FIV, hemobartonella

infection, rhinotracheitis, and heart failure (supplemental material Fig. 2). Her blood was like a device recording the diseases her body was fighting. Even when her blood was stained, the cells were so damaged that they did not detach themselves from one another but formed clumped groups. These groups were subsequently differentiated by the Convex Hull diagram linking the most protruding points of the group and turning them into a terrain in which these cells can be considered separate plots. The goal is to find the smallest set—in cardinality—of vertices describing the convex hull, i.e. the output is a convex polygon P covering all the points of S [20]. The darker the stain on the graph, the more “helpless” her cells appear.

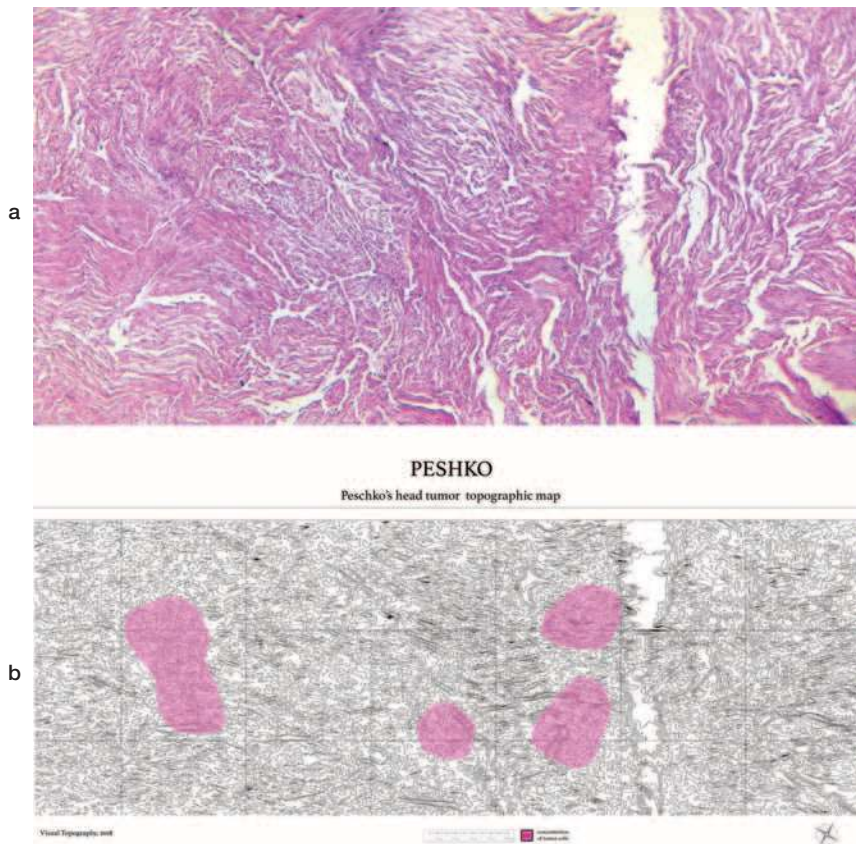


Fig. 7. (a) An image from the histological sample, prepared by RAMUS Laboratory. (© Aksiniya Peycheva) (b) A topographic map showing the tissue damage from the tumor. (© Aksiniya Peycheva)

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References and Notes

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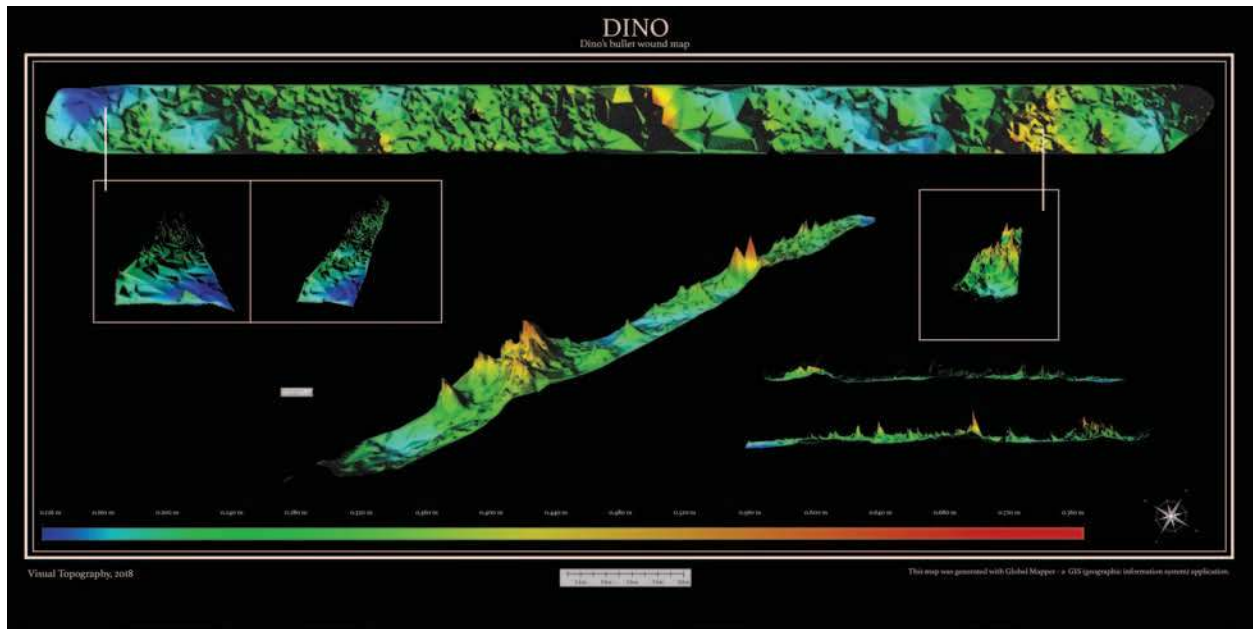
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AKSINIA PEYCHEVA (b. 1990, Bulgaria) lives and works in Sofia. She holds a PhD from the National Academy of Arts in Sofia, where she also teaches. The focus of her work is the process of visual translation, wherein she explores the possibilities of shifting information between different fields of knowledge—how one or several scientific fields can be combined in order to answer a question only relevant to art. She often collaborates with scientists, and her projects are usually accompanied by a theoretical component, which include the visual translation of music or pain.

COLOR PLATE B: **A TRANSDISCIPLINARY APPROACH IN ART:
TRANSLATING PHYSICAL TRAUMA INTO A
GEOGRAPHIC MAP**



The relief map of a bullet wound. (© Aksiniya Peycheva and Alexander Penkov)
(See the article in this issue by Aksiniya Peycheva.)