Detonography™: The Creation of Bas–Relief Sculpture by Explosives

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Abstract — Using the force of explosives as a giant stamping press, the author has created a way to make large-scale bas–relief panels in brass, copper and stainless steel. The highly complex surfaces of these panels, which cannot be achieved in any other way, have led to a new art form the author has named 'detonography'.

I. INTRODUCTION

Since January 1985 I have been developing a technique to create bas–relief metal sculpture using explosives. I have named this technique 'Detonography™'. Working with the Center for Explosive Technology Research (CETR) and the Terminal Effects Research Analysis Group (TERA), both located at the New Mexico Institute of Mining and Technology (New Mexico Tech), in Socorro, New Mexico, I have evolved an alternative method to die stamping, bronze casting and repoussage, creating what I believe to be a unique artform in its own right.

My method combines three known phenomena of explosives: forming (Fig. 1), in which explosives create a kind of stamping press to drive metal into a mold; cladding (Fig. 2), in which explosives fuse dissimilar metals onto a base sheet; and engraving (Fig. 3), in which an image from an object, such as a leaf or coin, is transferred to the metal by placing the object between the metal and the explosives.

Detonography acts as a perfect medium for translating my images from painting and printmaking into a new form, which expands and enriches the direction my work has taken over the past 15 years.

II. HISTORY OF THE PROJECT

In the fall of 1985, I met Gideon Sivan, an Israeli explosives expert who was on a 3–month sabbatical at the newly formed CETR, one of the five 'Centers for Excellence' created by the New Mexico state government. Each center has a unique goal, the mandate of the CETR being to explore non-military uses for explosives. As I am an etcher, Sivan suggested I help him develop a technique to use explosives to create etching plates. I immediately thought that if such a method could be developed, it could be used to create bas–relief metal sculpture on a large scale.

We were not the first to consider the creative possibilities of explosives. Per–Anders Perrson, director of the center, had worked with the Swedish artist Verner Molin [1] to use explosives to make etching plates. Salvador Dali had once made an etching plate by blowing a bomb filled with nails into a copper plate and then printing it. However, most art done with explosives is made by blowing metal into random shapes and using these shapes to spur the imagination to create more complex work by conventional means. One person working this way is Ted Egri in Taos, New Mexico.

Sivan's invitation appealed to me because it coincided with interests I had wanted to pursue in my own work. I was experienced in working with images on metal, having made prints from zinc and copper plates since 1972. It had occurred

Fig. 1. *The Earth Gives Up Her Riches*, stainless steel, 6 × 9 ft, 1987 (shown: detail). Deep relief is stamped into the plate by the force of the explosives.

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to me that my highly embossed etching plates would make interesting bas-relief wall pieces if done on a large enough scale. Some years ago, while working as artist-in-residence for the Albuquerque Public Schools [2], I created seven large murals, two of which were in metal and cement relief. Working on murals piqued my desire to work on an even larger scale. Around this same time, I began to make cast paper using my own paper pulp formed over plaster or silicone molds to make three-dimensional sculptural reliefs. Since this experience could be transferred directly to the explosive process, detonography in many ways became a natural extension of my earlier work.

Shortly after Perrson agreed to fund the project for one year, Sivan returned to Israel. I continued to work, helped by ordnance technicians, a scientific advisor from CETR and an artist friend from Albuquerque [3]. Results were discouraging at first; 80 experiments were necessary before we achieved our first 'work of art'.

As the CETR was building its facilities at the time, I conducted all of my original experiments (and have conducted all of my work to date) at TERA. This second explosives testing center conducts military testing, particularly for the U.S. Navy. Since I am not licensed to handle high explosives, the direct work with the charges, detonators, etc. was done by ordnance technicians. These technicians, who have extensive training in this dangerous business, were able to solve many of the problems we faced. Working with them has been interesting because their approach to problem solving is quite different from mine, and the collaboration has been extremely productive. I also taught two classes in Explosive Art to engineering students through the art department program at New Mexico Tech. These students also greatly helped me refine the technique [4].

The first experiments extended Sivan's work in surface manipulations of the plates and involved subtle changes in color and texture. I soon realized that while fine surface changes might work for small-scale pieces, it was inappropriate for large works, which would have to be viewed at a distance.

The first breakthrough in working on a large scale occurred when I decided to explode one of the molds I had been using to make my paper casts. Initially, I was not sure the mold would hold up long enough after the impact of the blast to make the image. In fact, the first piece was full of holes, because the mold was too deep in some areas and had undercuts. Nevertheless, I felt excited because the image had transferred and I knew I was at last headed in the right direction. Dozens of variables still needed to be worked out: the thickness of the plate, the best metal to use, the right amount of explosive, which materials to use for molds, and

Fig. 2. *Deer Dancer*, **copper and aluminum on brass, 3 × 4 ft, 1986 (shown: detail). Copper and aluminum cut-outs were fused on a brass plate.**

Fig. 3. *Chameleon,* brass and copper on stainless steel, 2 × 3 ft, 1987. The images from real leaves and branches were transferred to the plate in the blast.

Fig. 4. Preparations for a blast: the C1 Datasheet glued to a rubber mat is placed on the plaster mold by a technician. Twenty pounds of plastic explosives will make four plates measuring 3 × 4 ft.

how thick and deep the image should be. Many more tries were required before I could make a plate that took a perfect reproduction from a plaster mold with only a few breaks in the metal.

III. METHOD

After I create the design in a plaster mold in my studio in Albuquerque, I take the mold 70 miles south to the TERA blast site in Socorro. I cover the mold with a thin metal plate of brass, copper or stainless steel, depending on the effect I want. On top of the metal plate, I lay any thin foils I wish to fuse with the plate plus any leaves, cloth or string whose image I wish to transfer. The technician then covers the plate with C1 Datasheet, a plastic explosive made by Du Pont. This explosive is composed of 63% PETN (perta erythetol tetranitrate) and 8% NC (nito-cellulose) mixed with plastic binder and rolled into 10-inch-wide sheets. These sheets give an even detonation across the whole plate and a fast enough explosion (6800 meters a second) to form the metal before shattering the mold (Fig. 4). A blasting cap is attached to a flap of Datasheet and then connected to the detonation cord, which is run about 200 feet to a cement bunker. All personnel enter the bunker, and the shot is initiated electrically. First-time viewers are always surprised by the force of the blast; the explosive sheet looks so innocuous that the 20-foot fireball is quite startling. After the blast, the hard work of completing the plate begins. This involves cleaning the plate down to the bare metal and then patinating (chemically coloring) and polishing the plate to bring out the design.

IV. ADVANTAGES OF DETONOGRAPHY

The invention of explosive forming — shaping metal against a mold or die —is attributed to an engineer from Kent, England, Walter Claude Johnson, in 1897. The first commercial application of high explosives to work metal was the use of explosive rivets to assemble aircraft in 1940; but it was not until the 1950s that the aircraft industries provided the incentive and support for major experiments in explosive metal forming. At that time everything from steel, concrete and wood to ice was used for dies. This method of forming was found useful when one had limited production requirements, unusual and non-symmetrical shapes, large-size workpieces or unusual metal properties that made them hard to form by conventional means [5]. All of these specifications apply to the artmaking process as well.

Three alternative methods could probably be used to make a metal piece resembling a detonograph. One would be die stamping. Because of the expense involved in making the dies and setting up the equipment, this method is practical only when large quantities of the final product are required. Thus this method is used for constructing such things as car bodies.

The second alternative would be to make a casting at a foundry. This is also extremely expensive and labor intensive. It requires about 10 times more work and much more equipment than explosive forming.

The third alternative would be repoussage. This classic technique of hammering and chasing metal to form a design works only on very soft metals, such as copper, silver and gold, and is also extremely time consuming.

Most modern explosive forming takes place in specially constructed water vats, which transmit mechanical energy more efficiently than air. Unfortunately, this method was way beyond my budget as no such vats were available to me; thus I have been forced to develop a less efficient, more primitive, but much cheaper method of forming (see Fig. 1). However, the greatest and most interesting advantage of detonography is that it creates results that cannot be achieved in any other way.

In the method known commercially as cladding, one metal can be explosively welded to another metal. Metals that ordinarily cannot be joined will bond using this method. Metal cladding has been used for a long time by the U.S. Mint for coating coins. Explosive welding has also been used to repair heat tubes in nuclear power plants. Metallurgical bonds formed this way are less likely to leak or separate than a mechanical joint. I have been able to clad thin foils of copper, brass and aluminum to a thicker base plate using the C1 Datasheet (see Fig. 2). This fusion is permanent and can be separated only by physically grinding off the foil. Cladding adds variety and color to the surface of the plate.

Transferring, or engraving, the image of a real object to the plate in exact detail introduces many design possibilities. I have used such things as cloth, plants, broken glass and string to produce different effects (see Fig. 3).

V. CHOOSING THE IMAGES

I have always been interested in organic images, especially animals. I have used animals mainly because their diversity of shape and range of color and size fulfill my design needs. Also their simplicity of character makes them suitable symbols for philosophical statements about human nature. I have always liked the more conventionally unattractive animals—such as snakes, lizards, hippopotami, armadillos and prehistoric animals of all kinds—because they seem to exist entirely for themselves and not just because humans find them 'cute'. The metal is a perfect translator for the kinds of images that appeal to me (Color Plate B No. 2).

I am also interested in the idea of the earth goddess, or earth mother, and the riches that lie beneath the ground (Fig. 5). Sometimes in my pieces I use controlled and random breaks in the metal as settings for stones or beads to give the look of huge jewelry. The parallel between explosive power, which I use to create works of art, and the terrible force of 'Mother Nature', which both destroys and creates, intrigues me. For whatever reason, 'explosive art' has a magic, primitive quality that speaks to me and reinforces what I am trying to say as an artist.

The introduction of a new technology, of an innovative method, is helping me to create things I have never seen before. However, I am wary of becoming too captivated by the technique alone. Detonography is only another medium through which the artist can express his or her individual vision. In 20 years—or even 100—will it matter how the images were made if they are not worthy of being seen? In the last analysis, it is the art, not the technique of its creation, that matters.

Fig. 5. ***Earth Goddess,*** **copper with brass and aluminum, 3 × 4 ft, 1987.**

VI. RECENT WORK

My first large-scale project was a work commissioned in 1986 for the Macy Center, the performing arts and convention building at New Mexico Tech [6]. Since New Mexico Tech originally was a mining school, the piece, called *Evolutionary Geoscape,* traces the history of the earth under the ground. This work measures 25 × 4 feet and was done in cold rolled steel and polished to a bright silver color. I made a slightly smaller edition of this piece after I had learned how to fuse the various metals together. *Evolutionary Geoscape II* now hangs over the front entrance of the Museum of Natural History in Albuquerque, New Mexico (Fig. 6) [7].

My recent work also includes a 12-foot mural on the history of technology for the Albuquerque office of the BDM Corporation (McLean, Virginia). I am

Fig. 6. ***Evolutionary Geoscape II,*** **copper, brass and aluminum, 21 × 4 ft, 1986. Each panel (3 × 4 ft) contains a prehistoric beast and a modern-day animal from the same family. It follows an evolutionary time line. Museum of Natural History, Albuquerque, New Mexico.**

currently working on three other large commissions, one for a medical building in Chicago and the two others for the Montgomery County, Maryland, public schools.

Editor's Note: See Cai Guo-Qiang's article "Painting with Gunpowder" in this issue of *Leonardo* for further reading about art and explosives.

REFERENCES AND NOTES

1. Verner Molin, "A New Engraving Technique by Means of Explosives", *Leonardo* **12,** No. 3, 222–223 (1979).

2. My artist-in-residency was funded by a 2-year grant from the U.S. National Endowment for the Arts.

3. Alexander Szecket was the scientific adviser who helped me during the first year of the project, along with Alice Warder Seely, an Albuquerque artist known for her repoussage. Dennis Hunter and the technicians from TERA continue to be my greatest source of help in making my pieces and in expanding my technical knowledge.

4. Michael Iatauro, the head of the fine arts department at New Mexico Institute of Mining and Technology, has been extremely helpful in arranging my classes and promoting the idea of explosive art as a new art discipline within the school.

5. The technical information for this section was taken from the following references: C. H. Johansson and P.-A. Perrson, *Detonics of High Explosives* (London: Academic Press, 1970); "Behavior and Utilization of Explosives in Engineering Design", 12th Annual Symposium, March 1972, University of New Mexico (Albuquerque: American Society of Mechanical Engineers, 1972); and Bahrani Aladdin, "Engineering with a Bang", *New Science* (10 July 1986) pp. 44–47.

6. The Arts Board of New Mexico Institute of Mining and Technology bravely commissioned the piece even though I had not yet proven that the process worked on a large scale.

7. *Evolutionary Geoscape II* was purchased by the Southwest Arts and Crafts Festival and donated to the Museum of Natural History in Albuquerque, New Mexico.