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‘Translating’ and ‘Retranslating’ Data: Tracing the Steps in Projects that Address Climate Change and Antarctic Science

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ABSTRACT
In this paper I discuss the notion of translation as it relates to the practice and communication of science. While science is a creative translation of the natural world, it pretends to be a carbon copy of reality and therefore it eschews expressive and metaphorical use of language. I argue that the denial of subjectivity in the pursuit of science and in the scientific approach to language impedes communication with the general public. The use of digital data has exacerbated this ‘objective’ trend. Art can bridge the gap by retranslating this data into metaphors thereby making the information more sensually and emotionally accessible as well as intellectually comprehensible. I present two case studies of my collaborations with scientists centered on ocean acidification and ultraviolet radiation respectively, showing how digital data is retranslated into physical phenomena and inserted into a larger historical and cultural narrative that includes the history of Antarctic science.

Keywords
Art/science collaboration, Antarctic science, climate change, ocean acidification, UV radiation, data translation, narrative

1. INTRODUCTION
For over five years I have worked on visualizing science through art in order to inform a broader public about issues of climate change. I initiated the art and science project at CSUSM when scientist colleagues showed interest in my work with physical phenomena that incorporated the transformation of matter. I had used fire, steam, optical effects and projections to speak about time and memory (both personal and collective). My early work transformed family photographs into shadows as well as objects altered by fire. Later I investigated the development of the western psyche from the Middle Ages to modernity. In all of this work the translation of images into phenomenological effects spoke about the continually shifting nature of reality and identity.

Scientist colleagues felt that these artistic processes were also well suited to communicating science and they were hopeful that through art they could reach an audience beyond the scientific community. Since then my work has focused on “translating” the data collected and interpreted by my scientist collaborators into physical phenomena that visualize that data while placing it in a larger historical and cultural narrative.

2. SCIENCE AS TRANSLATION
In this paper I would like to trace the ‘translation’ that occurs in my collaboration with scientists beginning with their data collection to my interpretation through the art process. Before I demonstrate this cycle through specific examples I will discuss the notion of ‘translation’ as it relates to the communication of science, thereby placing my activity as well as the activity of other ‘art and science’ practitioners in a larger philosophical and conceptual context. In my discussion I will primarily reference Sundar Sarrukai’s essay on “Translation and Science.” [8] In this paper Sarrukai makes very interesting observations about the activity and communication of science as a mode of translation that can also be extended to artistic representations of science.

Sarrukai describes science as a form of translation where the original text is the world or nature itself, often described by scientists as an ‘open book.’ “If translators are readers of the source text that they translate, scientists are the readers of the ‘book of nature’ which they then translate.” [9] Since the pursuit of science is to ‘translate’ this a priori original (or reality) the issues of translation as they are discussed in literature or philosophy provide an interesting lens for the analysis of the way science relates to language, in other words the way science communicates. Interestingly science is suspicious of language as literature is suspicious of translation. In both cases there is a concern about identity and correspondence between the original and the representation (the translation). In order to stay faithful to the original there is a tendency in translation to reduce meaning, which is also very much true in the communication of science. Science views natural language as an inadequate tool to represent the world and makes an attempt to construct an existence outside of natural language resorting as often as possible to mathematics, which it views as the real language of the world. In this sense science continues Plato’s suspicion of poetry and the western tradition of privileging literal over figural language. The contention is that figural language (or metaphorical language) is a frill, an addition that diverts rather than adds to literal language. Therefore science tries to reduce its mode of communication to

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definitions and entities avoiding the complexity and multiplicity of language in order to pretend that any given science text is simply a one-to-one translation of the 'book of nature.' Yet philosophers question the ability of language to describe reality without the aid of figural language. They do not believe it is possible to remove metaphoricity in order to exhibit the literal 'behind' it (Derrida, 1982) or to grasp the original in its 'purity,' apart from the constitution of language. "The original itself is a site of plurality and ambiguity, and it is as much the figural that allows us a hold on the original." [10] Practitioners of science studies such as Bruno Latour demonstrate the complex embeddedness of science in a web of social and cultural processes. [2] Scientists are very much the authors of what they say and they are themselves very much the products of a particular place and time that forms the narrative they generate. In this sense scientists are 'translators' of the 'book of nature' whose activity is better described through Walter Benjamin's concept of the echo. For Benjamin a translation is never a one-to-one correspondence but it is an echo of the essence of the original. A good translator needs to add and transform in order to transcribe that essence into another language. The otherness of language should be acknowledged and embraced. In an echo our voice comes back to us but it does so distorted by the space and topography of the route it has traveled.

3. ART AND SCIENCE

Scientists practice creative thinking when they formulate the questions they investigate and choose the methods they use. In addition they also use creativity in translating these results. Throughout this process they narrate a story. However, because their field claims to be one with reality rather than an echo of it, they try to use language that masks this narrative. Today computers contribute to the masking process since their power of calculation as well as the tables, graphs, models and other impressive representations they produce bolster the notion of 'objective' truth. The scientific communication that emerges from this process is difficult to follow and almost impossible to comprehend for the general public. Yet many scientists are eager to reach people with their results. In particular, scientists working on issues of climate change know that public pressure for action in regard to climate change will only occur when enough people understand the science and believe the gravity of the situation. It is at this particular juncture that I would like to situate my work as well as the work of other artists. If scientists translate 'the book of nature' into scientific language eschewing the figural the activity of the artist involves the transformation of this 'scientific text' into an echo that embraces metaphor. We can freely unmask the language of science and tease out the metaphors inherent in it, thereby making the information more sensually and emotionally accessible as well as intellectually comprehensible. We can also layer the scientific information with personal, historical or any other elements in order to reflect the 'complexity and ambiguity' of reality within which we experience nature and pursue science. Here I would like to present two case studies of my own practice both of which are related to climate change issues and Antarctic science.

3.1 Case study 1: ocean acidification

This project builds on collaboration with Dr. Victoria Fabry, biological oceanographer, who studies the effects of ocean acidification on calcifying organisms such as pteropods (shelled planktonic snails). I began working with Dr. Fabry in 2004 when I sent out a call to scientist colleagues expressing my interest in visualizing science through art. Dr. Fabry was enthusiastic as she felt that through art we could reach wider audiences with the message of ocean acidification than she could with scientific articles. She personally briefed me about the principles involved and she also sent me a multitude of materials in digital format. Thus the data that she and her colleagues had collected about the chemistry of the oceans as well as about the state of pteropod shells had been 'translated' into the multi-semiotic language of science including prose (articles) as well as tables, graphs, and other visual aids including images of healthy and damaged pteropod shells. These were transmitted to me as PDF files, PowerPoint files or digital photographs. I viewed the various translations of nature on my computer and labored to extract the essence that I in turn would translate into the language of visual art. The central source text was an article coauthored by Dr. Fabry with several other ocean scientists. It was published in *Nature*

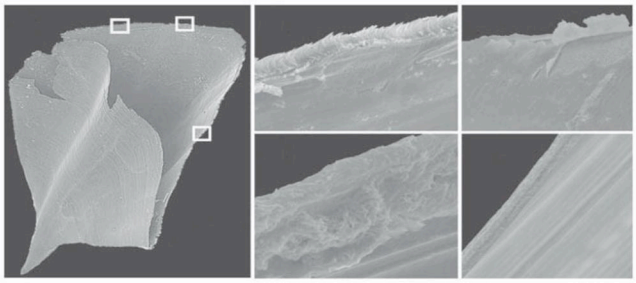

Figure 1: Shell dissolution in a live pteropod, Shell from a live pteropod, *Clio pyramidata*, collected from the subarctic Pacific and kept in water undersaturated with respect to aragonite for 48 h. The whole shell (left) has superimposed white rectangles that indicate three magnified areas: the shell surface (top middle), which reveals etch pits from dissolution and resulting exposure of aragonitic rods; the prismatic layer (top right), which has begun to peel back, increasing the surface area over which dissolution occurs; and the aperture region (bottom middle), which reveals advanced shell dissolution. Pyramidata shell not exposed to undersaturated conditions (bottom right). [5]

(September 2005) with the title "Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms." This article describes how the increased level of CO_2, produced by human activity, is causing changes in ocean chemistry. The absorption of excess atmospheric carbon dioxide (CO_2) creates ocean acidification, which results in undersaturation with respect to aragonite and other necessary elements for calcification. In response pteropods (planktonic snails), corals, and other organisms with shells, show reduced calcification. Even the shells of live plankton snails dissolve under predicted acidity levels.

The article presents several scenarios based on computer simulated climate models. These models differ in respect to expected CO_2 levels and other environmental factors but even the most stringent and conservative models show a progress of ocean acidification that will be corrosive to calcifying organisms within a hundred years. According to these findings only significant reduction in the output of CO_2 could reverse this trend. [4]

3.1.1 Retranslating the data

After I absorbed all the materials presented to me verbally and in digital format I arrived at the dissolution process as the physical manifestation of this information. Thus my first step in translating the essence of the data back into physical form was to employ the very process that was measured in the first place (the dissolution of calcium carbonate -the material of shells- in acidic water). In the summer of 2005 I was invited for an artist residency at the Lucas Artists Residency Program in Saratoga (California) where I spent two months experimenting with submerging materials containing calcium carbonate in acidic solutions. Parallel to this my research into the history of science led me to the work of Dr. Ruysch, a 17th century anatomist, who was the first to invent methods to preserve organs through injections and other methods (the precursor of the current method of plastination). I grew interested in the antonymic metaphors of dissolution (destruction) and preservation, or the contradictions of a worldview that builds on the exploitation of that which it claims to preserve. While Ruysch's contemporaries who were active at the dawn of science were just beginning to understand and admire the diversity of nature, they also began to perfect the mechanisms by which we distance ourselves from it. By collecting, containing, organizing, classifying and displaying natural specimens, and in Ruysch's case the body, they turned these specimens into objects to behold and study. This separation, predicated on a desire to improve life on earth, built on a view of nature as resource and the body as instrument for progress. Yet this progress begs the question: how do you improve something that you are consuming in the process?

Figure 2: etchings of dioramas created by Dr. Ruysch from preserved body parts (including veins) and skeletons

It is this question that my first larger scale 'translation' of this research explores in the exhibition "Shifting Baselines" that took place at the California Center for the Arts in Escondido (March-July 2006). The show borrows its title from a web page that was launched in 2003 by marine biologists at Scripps Institution of Oceanography working together with ocean conservationists, underwater cinematographers, and Hollywood filmmakers in an attempt to inform the public about the gradual degradation of the ocean environment. [7] The first piece of the installation, "Seven Days of Dissolution," shows the effects of ocean acidification due to the ocean's absorption of atmospheric carbon dioxide (CO_2). The piece consists of a carbon dioxide tank that is connected with transparent pipes to seven acrylic containers that hold water. In addition each container has a black sea fan from which a human heart and lung appears to be growing. The heart and lung sculptures are created from crushed Capiz shells. As viewers walk from left to right they notice that in each successive container the heart and lung gradually disappear until the last container exhibits an empty black sea fan. The dissolving objects hark back to my early work where I focused on processes that exist in time, reflecting on the ephemeral moment and on a sense of loss. Here we are presented with a loss as well - the loss of habitat on earth - which will ultimately lead to our own destruction.

Figure 3: Shifting Baselines – Seven Days of Dissolution (tanks 3 and 5 from a sequence of 7)

In "Shifting Baselines" I expand this metaphor through two additional pieces that form part of the installation, "Winners and Losers?" and "Huzmer." "Huzmer" sits on the wall facing "Seven Days of Dissolution" and consists of eight different segments of a toy Hummer created from Capiz shells that appear to be 'growing' out of the wall surface. These segments are placed on the wall in such a way that they describe one revolution from front to back. Climate change is caused by our constantly shifting baseline of consumption and life style choices. It appears that the technological advances that have prolonged our lives and improved our living conditions, are also distancing us from the values that respect our connection to the earth and concern for its degradation. In "Winners and losers?" Einstein's vision of the Hiroshima explosion, as portrayed in Nicolas Roeg's movie "Insignificance," is projected onto floating jellyfish. While jellyfish are the seeming winners of the changing ocean environment, as they thrive under the current circumstances, this work reflects on the tenuous nature of 'victory' in a cycle of destruction.

3.1.1.1 Antarctic science

When it comes to the effects of ocean acidification on calcifying organisms, the most rapid changes are occurring in the cold oceans of the Polar Regions. If we return to the *Nature* article "Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms" we find out that ocean acidification in these regions (including the Ross Sea) develops more readily due to low surface temperatures and large amounts of 'deep water upwellings' that affect ocean chemistry. "In the Ross Sea the prominent subpolar–polar pteropod *Limacina helicina* sometimes replaces krill as the dominant zooplankton, hence it becomes central at the bottom of the food chain and is considered an overall indicator of ecosystem health." However this pteropod "may be unable to maintain shells in waters that are undersaturated with respect to aragonite. Data from sediment traps indicate that empty pteropod shells exhibit pitting and partial dissolution as soon as they fall below the aragonite saturation horizon." [6] Researchers worry that pteropods endemic to Polar Regions could disappear altogether affecting their predators and the whole food chain. To study this phenomenon Dr. Fabry spent two seasons in Antarctica focusing on the pteropod *Limacina*

helicina as well as on the gymnosome *Clione antarctica*, a shell-less, pelagic mollusc which blooms each austral summer in McMurdo Sound and feeds exclusively on the *Limacina helicina*. I followed with a NSF Antarctic Artists and Writer's grant during the 2008/2009 season.

3.1.1.2 History of Antarctic exploration and science

My research preceding the journey to Antarctica deepened my understanding of the history of Polar exploration and science. The social and cultural implications of this history as described by Lisa Bloom in "Gender on Ice" [1] inspired me to insert an unknown (female) explorer into the narrative structure of the work I began to develop. The first iteration of "Pages from the Book of the Unknown Explorer" centers on a fictitious "unknown explorer" from the 1930s called Anna Schwartz. While the information presented in the work is based on true facts and actual people, the insertion of the fictitious Anna Schwartz into the story speaks about the absence of women in Antarctic exploration and science until the late 1960s. Anna Schwartz' scientific interest in Antarctica are the two plankton snails that Dr. Fabry studies - the *Limacina helicina* (sea butterfly) and the *Clione antarctica* (sea angel). The first three pieces I completed in the series are sculptural book pages made of transparent silicone rubber that cast shadows on the wall. The first page is a portrait of the unknown explorer Anna Schwartz based on a photograph of my mother from the 1930s. The portrait is 'embedded' with tiny plankton snail shells that were cast into transparent rubber and then removed leaving fossil like remnants. The second piece is a letter cast into the silicone rubber surface that is legible in shadow form on the wall. In this letter, Anna Schwartz tells the story of how she managed to join the Byrd Antarctic expedition of 1939. This letter sets the stage (based on actual historical facts) for the future of this series. The third panel is a scientific page from the notebooks of Anna Schwartz that contains the scientific descriptions of the *Limacina helicina* and the *Clione antarctica* flanked by two minimalist squares on which I have placed playfully sculptural representations of these planktonic snails reminiscent of butterflies pinned to a surface. This page also contains a brief paragraph that speaks about the unique interdependence of these two planktonic snails. The *Clione antarctica* feeds exclusively on the *Limacina helicina*. If this tiny snail is affected by ocean acidification (which is the subject of Dr. Fabry's research) than the *Clione antarctica* will lose its sole food source, thus illustrating the effect of climate change on the food chain and the ecology of the oceans.

3.2 Case study 2: ultra violet radiation

The narrative, which I initiated in "Pages from the Book of the Unknown Explorer," works its way into my next translation of scientific data. One of my project proposals for the Antarctic Artists and Writers grant was to create UV-graphs or images created with UV rays in order to reflect on the ozone hole in Antarctica. (I consulted with a physicist colleague -Dr. Charles De Leone- who advised me that just as sunrays alter photosensitive materials UV rays create change on UV sensitive surfaces.) The NSF Polar Program's UV Monitoring Network, overseen by Biospherical Instruments, collects the data used in this project. [3] This network compares the UV levels at four locations in the

Figure 4: Installing UV-graphs at McMurdo Station Antarctica, January 2009

Figure 5: Persian carpet installed at Willey Field NASA balloon Launch Pad, Antarctica, January 2009

southern hemisphere and three locations in the northern hemisphere. These are all high latitude locations with the exception of San Diego where the company overseeing the project (Biospherical Instruments) is located. At Biospherical Instruments I am collaborating with lead scientist Germar Bernhard who has provided me with a series of articles in PDF format about historical and current results based on the measurements collected by the UV monitoring network. One interesting piece of information that emerged from my reading of these materials is the effect of increased UV radiation on plankton in the Southern Ocean. (This brings my UV work in relation to my collaboration with oceanographers who study plankton in this region.) In preparing the UV sensitive surfaces I collaborated with Jim Druzik, Senior Scientist and Christel Pesme, conservator at the Getty Conservation Institute who coated watercolor papers with UV sensitive materials Acridine (DNA and RNA indicator), Coomassie Brilliant Blue (protein indicator) and Bromocresol Green (PH indicator). Two papers were treated with Coomassie Brilliant Blue combined with the spice turmeric. The choice of UV sensitive dies is purposeful and metaphorical. We selected materials that have biological

references or are used in measuring acidity, hence they relate to my work with the acidity and biology of the oceans. In addition to the treated watercolor papers this project includes a Persian rug since died wool is especially sensitive to UV radiation. The contrast between the colorful rug and the white of the ice shelf on which it was exposed matches the difference between the cultural histories attached to both [figure 5].

3.2.1 Retranslating the data

Once again I chose to visualize the data by employing the natural phenomenon that was measured in the first place (UV radiation). After I applied transparencies and stencils to the watercolor papers and the rug, I exposed them to UV radiation that faded the materials creating images on the surface corresponding to the transparencies and stencils. The nature of this process is similar to the dissolution of shells in acidic water in that the artwork created is temporal and with time it will be entirely erased (faded by the UV rays or dissolved by acidity). Hence these pieces will only exist as part of the digital archive, thereby closing the loop of physical phenomena translated into digital data (through scientific measurements), retranslated into physical phenomena (through art) and retranslated into digital data for preservation.

Figure 6: UV-graphs in Antarctica before and after exposure January 2009

Figure 7: UV-graph Portraits of Anna Schwartz on paper treated with Bromocresol green

3.2.1.1 Antarctic science brought home

The first portion of the UV-graph project took place during the austral summer (December 31, 2008 to January 23, 2009) at McMurdo Station, Antarctica. The second took place in San Diego during the corresponding summer days in July 2009. The transparencies and stencils applied to the papers and the rug in these two projects expand the 'unknown explorer' narrative. They include the portrait of Anna Schwartz, her letter about the Byrd expedition as well as the page from her scientific notebook describing the *Limacina helicina* and the *Clione Antarctica.*

Figure 8: UV-graphs and carpet segment exposed in San Diego July 2009

The images exposed in San Diego also include a letter by the daughter of Anna Schwartz from 2009. It reflects on Anna's death while it also raises questions about the uneasy relationship between nature and culture. Underscoring the conflict of nature and culture are two graphs that also form part of the San Diego project. One of them depicts the UV levels at McMurdo station from July 2008 to May 2009, which includes the period when the McMurdo UV-graphs were exposed. The other shows the S&P 500 index (Standard and Poor's) July 2008 to June 2009.

The computer-generated graphs of numbers describing a natural and a cultural phenomenon are related through their representation (a "scientific" graph) but possibly they inform each other in other ways as well. The graph that bears witness to the trajectory of the S&P 500 index during 2009 speaks about a culture of greed that spares nothing in its pursuit of profit (real or virtual). The complex web of financial interests crisscrossing the globe is deeply implicated in the issues of the environment.

3.2.1.2 Call to action

The ozone hole was created by the use of human-made chemicals (CFCs) that were used in refrigeration as well as in aerosol cans. Ocean acidification is created by excess atmospheric CO_2 also caused by human activity (primarily the burning of fossil fuels in the manufacturing of products and the driving of vehicles of all kinds). While the science may speak clearly, as in the UV data graph, the solutions are harder to come by, as evidenced by the S&P index graph [figure 9]. Nevertheless, when scientists simulated the prospects of a globe with an expanding ozone hole and enough people realized the horrors of such prospects, CFCs were phased out under the 1987 Montreal Protocol. Since then the ozone hole has been shrinking and is eventually expected to mend. Similarly scientists are warning of impending disaster if we do not change our ways when it comes to CO_2 emissions. The scientific evidence is gathering. It is here that we as artists should labor to intensify the echo of translation using the language of metaphor afforded to us to tip the balance in favor of action.

Figure 9: UV-graph before exposure San Diego California, July 2009

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