Dear Dr. Andrew Darke,

Thank you for your missive of 26 January. It was good to hear from you and I think I remember you from after the RSA Art and Ecology forum.

Small wonder that you and others are a bit bewildered by my talk at RSA last November. It was most unfortunate that I had trouble with my PowerPoint presentation. Three video clips I had embedded in my talk refused to play, although they had played during a rehearsal earlier that morning. #*&!! PowerPoint.

This loss of six minutes of presentation was most unfortunate as I was to make an important point over each of the two minuet video clips. You have my apologies for an unsatisfactory presentation.

Before I address the points you raise let me say something about transmutation as I understand it. In the modern sense transmutation is changing the numbers of protons of an element. The accomplishments of medieval alchemists like Paracelsus or Carl G. Jung's psychological observations of the alchemical unconscious are topics suitable for a spirited evening over a beer but will stand aside from this letter.

Ernest Rutherford transmuted Nitrogen to Oxygen using an alpha source in 1919. Since then we humans have been transmuting up a storm. Although actual transmutation had to await the nuclear age, the dream of transmuting one elemental substance to another is as old as antiquity. In a theoretical sense it is possible to transmute every element to every other element using a number of nuclear processes and particles. I see the ability to transmute elemental substances as an inevitable process of sculpture; similar to carving and casting.

As an artist what should I transmute? I chose element 43, Technetium, for the following reasons: It exists only in man-made form as any Technetium created during the big bang decayed away eons ago. Every isotope of Technetium is radioactive. It would have remained forever a rare laboratory curiosity except for fission. When an atom of Uranium or Plutonium fissions, giving off the energy it is famous for, two fission-fragments are left over: much lighter elements found in the middle of the periodic chart. Technetium is a characteristic fission-fragment and is found in some quantity in spent reactor fuel. With a 230,000 year half-life, and its association with spent fuel, I felt transmuting into its periodic chart neighbor; element 44, Ruthenium, made it a good choice. Ruthenium is a non-radioactive member of the six platinumoids, all very similar as high temp precious metals. Ruthenium will be easy to work with: handling all the fabrication techniques of platinum.

The tool or nuclear process for this transmutation of 43 Technetium to 44 Ruthenium is neutron capture. The isotope Technetium 99 captures a neutron becoming the very unstable isotope of Technetium 100 which promptly transmutes to the stable isotope Ruthenium 100. The key to the success of getting usable quantities of Ruthenium is an abundant supply of neutrons of the right energy, such as found in the high neutron flux in

the core of an operating nuclear reactor. The vast majority of these fission-produced neutrons are *surplus* and not contributing to the transmutation of fissile material but are *free* to engender transmutations in other, non-fissile elements; such as Technetium. The only paper I know on Technetium transmutation is one published a few years ago by a team at the JOYO experimental fast reactor in Japan. I recommend you read this paper, which can be found by googling: technetium transmutation japan.

As to my dream of creating a sculpture using Ruthenium transmuted from Technetium I have been singularly unsuccessful: Both in securing access to a reactor for its neutron flux and the material itself of Technetium 99. The reasons for this are various. The science half of this project is established and there is cautious acceptance by some in the arts and environmental communities. I remain convinced that my idea is a good one and will result in good sculpture.

In the meanwhile, impatiently, I have started a transmutation project on my own working with readily available, inexpensive materials. Like the pioneering Earnest Rutherford I am using a primary alpha source: Americium taken from smoke detectors. The alpha emitting Americium is in direct contact with emeralds, the principal constituent element of which is Beryllium, which converts the alpha particles into neutrons. I use a 6 cm thick slab of beeswax (Hydrogen) to moderate or thermalize the neutrons and increase the probability of transmutation.

This transmutation is the famous one of element 92, Uranium, through 93, Neptunium, to 94, Plutonium. More often called *breeding* then transmuting, the production of Plutonium from Uranium via neutron capture is laden with symbolic value as this nuclear process of transmutation gave humankind its first atomic bomb. I will use the Plutonium-bearing Uranium in the ceramic form of tableware glazed with U3O8 that I am accruing. As far as I know this will be the first artistic use of Plutonium; or any transmuted material.

My equipment produces a very limited neutron flux and I guess my transmutation rate is somewhere between dozens and billions of atoms transmuted per hour. Therefore I am running this campaign around the clock for six months. Unquestionably I will have detectable quantities of Plutonium contained in the Uranium-bearing ceramic glaze of this orange tableware.

I was pleased and flattered that Dr. Paul Dorfman thinks I am worth 500bn pounds. That's more then half a trillion dollars US. Although a typical amount to be thrown around in these recent times, it represents a considerable improvement over my sometimes precarious finances. A sculptor is required to budget works and I see the economics of this sculpture as having the added expense of the transmutation, over and beyond the expenses associated with my usual sculpture.

The chemical extraction of Technetium from the roughly 5,000 isotopes in spent reactor fuel would be a cost of which I have no idea. It is done however as two supply firms in

America offer Technetium 99 for sale. There are a number of suppliers in Europe, especially Russia.

I see the neutrons as being free although one might be charged for space and time in the reactor core. Also the expense of a container/assemblage, made to exacting standards and possibly of exotic materials. Such assemblies would have a short life due to neutron embrittlement.

Then there would be another chem-seps to extract the Ruthenium from the untransmuted Technetium and other isotopes created by radiation flux. This might not be so hard as all six of the platnoids are extraordinarily inert and corrosion resistant. I expect you could just dissolve the whole assembly in acid, decant the liquid off and be left with the Ruthenium. I am sure, kilo to kilo, Ruthenium is worth considerable more then the cost of the Technetium as Platinum is selling for close to $1,000 per troy ounce.

Anyway it probably would not be as cost effective as turning Mercury to Gold with simple kitchen utensils, as the medieval alchemists claimed to have done. The paramount economics of this project for me is expressed in aesthetics. Ideally I would secure an artist-in-residency at a nuclear power station with a budget that would include the costs of the above mentioned expenses, their license to cover the requirements for the purchase and shipping of the Technetium, and their laboratory to conduct the chemical separations in. Possibly in return for ownership of a finished sculpture. That has been the pitch over the years.

Your outline of the surprising lack of interest or support from the engineering and scientific communities is essentially correct. The feasibility of the transmutation was never doubted but rather the reaction was “Why bother”, “Of course it can be done… why do it?”, and most hurtful “Artistic use of transmutation is frivolous”.

The other reaction, from the managers and autocrats who answer to shareholders and government bodies, is simply “No news is good news”. One Director of Reactor Operations even told me he would be happy to do the irradiation if I could guarantee no publicity, which, of course, I can’t. I have tried to point out that the story of making a work of art out of acknowledged high-level nuclear waste using nuclear process is a story with a happy ending, but to no avail. The nuclear industry is so paranoid about looking foolish or inept in the media that it won’t take a chance on anything.

In spite of my disappointment I continue to see art and science as parallel paths we humans travel in search of answers to the big questions such as who we are and why we are here.

This letter certainly became longer then I intended. I much enjoyed my trip to London and having the opportunity of seeing friends and colleagues. Many of the presentations at the RSA Art and Ecology forum were interesting and professional and I am glad I participated. I do think it is unfortunate there was not an articulate spokesperson in favor of an expanded nuclear future.

Best wishes,

James L. Acord