

Beating Thermonuclear Warheads into Peaceful Plowshares

Project Plowshare

Michael Kohlman
Dept. of Secondary Education
University of Alberta

Project Plowshare and ‘Education for the Peaceful Uses of Nuclear Explosions’

“So you want to beat your old atomic bombs into plowshares?” – I.I. Rabi, on hearing Harold Brown’s idea to use ‘peaceful’ atomic explosives to “give people a more rational viewpoint” on nuclear weapons.¹

Introduction

I will explore the aborted Cold War-era *Project Plowshare* program, for its rather forgotten role in military-industrial based ‘Big Science & Technology’ and for the associated efforts to promote the cause through education. *Plowshare* was the American term for the use of thermonuclear explosives for civilian purposes, part of the international scheme to use ‘Peaceful Nuclear Explosions’ (PNEs), for giant construction and ‘geological-engineering’ projects. It evolved from President Eisenhower’s 1953 *Atoms for Peace* initiative revealed to the world in a speech at the United Nations.² The euphemism was taken from the Old-Testament passage (Isaiah 2:4), “they shall beat their swords into plowshares, and their spears into pruning hooks: nation shall not lift-up sword against nation, neither shall they learn war any more”.³ Excavating canals, blasting harbors or artificial reservoirs, liquefying the Athabasca Tar-sands, generating abundant energy and useful radioisotopes; these were just a few of the novel schemes to use thermonuclear weapons (rather than fission reactors) to ‘benefit all-mankind’.⁴ *Plowshare* was to usher in a new-age of plentiful energy and agricultural, civil-engineering or transportation ‘miracles’ through the peaceful use of what was previously only the scourge of Total War.⁵

In a sense, *Plowshare* was an attempted revival – following in the atomic-halo of America’s victory in World War II and the post-war economic boom (and ‘Baby-boom’) – of the sort of

¹ O’Neil, *The Firecracker Boys* (New York: Basic Books, 2007) 27.

² Eisenhower was not the first to suggest the idea. It was a *Russian* idea in 1949, after the successful test of *Joe I*. Findlay, *Swords into Plowshares: The Invention of Peaceful Nuclear Explosions*, (Canberra, Peace Research Centre, 1986), 1-3. For an evolutionary saltation in the opinion of an *American* atomic physicist to the idea of PNEs pre and post-*Plowshare* see the articles, letters (and exchanges with Lewis Mumford) by Frederick Reines in the *Bulletin of Atomic Scientists*. Over a period of 9 years (1950, 1954, 1958) he undergoes a marked conversion from skeptic to agnostic to believer. Just part of being a ‘Team-player’ at *Los Alamos* and the *AEC*? I defer to the readers judgment.

³ O’Neil, *The Firecracker Boys*, 27.

⁴ For a *popular* glimpse of these *schemes* (before Tar-sands ‘morphed’ into Oil-sands) see the absolutely fascinating article by Edward Teller “father of the hydrogen bomb”, in *Popular Mechanics* “We’re Going to Work Miracles”, 13, 2 (March, 1960) 97-101, 278, 280, 282. It is “written so you can understand it” and includes the schematic diagram of the Chariot harbor excavation (on my title page), though he does not mention that the original plan was for a combined 4.6 MT rather than the 460 kT (10X larger) in the article, nor the stiffening opposition to the project.

⁵ A prominent historical and psycho-social-cultural analysis of the awe, fear and loathing inspired by atomic weapons and technologies is Weart, *Nuclear Fear* (Cambridge, Harvard University Press, 1988).

Progressive-era values that gave us *eugenics*, electrification and other giant engineering projects that inspired Americans who came of age in the last decades of the 19th Century and first decades of the 20th Century.⁶ The Soviet analogue was *Lysenkoism* or *Michurinism*, a few decades later.⁷

When I mention *Plowshare* to today's undergraduates or my young graduate student colleagues – who came of age during the late 20th Century – in the age of environmentalism and social-activism – the reaction is incredulity. For those people of my age or older, who are not versed in its peculiar history, the reaction is muted indignation; or a knowing “what were they thinking” shaking of their post-modern heads. And yet, *Plowshare* is not-unlike the fascination with any powerful technology when it is novel, spectacular, terrifying – particularly if it is associated with Nationalistic pride and accomplishment.⁸ Even more compelling, in a time of imminent or smoldering war – as with the first *Red Scare* following the Bolshevik Revolutions of 1918-1920 – the potential advantage of any new science or technology, however dangerous or unpleasant – is a powerful incentive to its development and acceptance.⁹

Plowshare was in very good company, historically speaking. Previous precedents for using fearsome military weapons for peaceful purposes (gunpowder and high-explosives for blasting, chemical weapons for insecticides and fumigants, radioactive isotopes for atomic reactors) had been successful on many fronts.¹⁰ The scientists and military-industrial leaders who brought these ‘most damnable inventions’ to fruition, sought to recruit public acceptance and support for weapons of mass destruction following the cataclysmic wars in which they were pioneered or premiered. From Dynamit-Nobel to the Nobel Prizes, from ‘poison gas’ to Standard-Oil’s

⁶ For the progressive promise of eugenics see Galton “Eugenics: Its Definition, Scope, and Aims” (*The American Journal of Sociology*, 10, 1, 1904) 1-25. For a uniquely American expression of Galton’s vision at the virtual height of the movement, see Huntington, *The Pulse of Progress*. (New York, Charles Scribner’s Sons, 1926).

⁷ As a primer to Lysenko’s enduring appeal in Soviet science and society see Roll-Hansen, “Wishful Science: The Persistence of T. D. Lysenko’s Agrobiology in the Politics of Science” (*Osiris*, 23, Jan., 2008, 166-188).

⁸ See Josephson “Rockets, Reactors, & Soviet Culture” in Graham *Science and the Soviet State*, 1990; or Nye “The Atomic Bomb and Apollo XI” in *American Technological Sublime* (Cambridge, Mass.: MIT Press, 1994), 225-256.

⁹ See Missner “Why Einstein Became Famous in America” (*Social Studies of Science*, 15, May, 1985), 267-291 for an interesting examination of the influence of the first ‘Red Scare’ upon Einstein’s American fame, and his *relativity* as a potential counter-measure (a theoretical *Technological Sublime*) to this threat in a pre-*Sputnik* ‘Age of Anxiety’. Also see Russell (as noted below) esp. “Joining the Chemist’s War” (Chap 3) and “Minutemen for Peace” (Chap 5).

¹⁰ For the story of the ‘peaceful uses’ of blasting powder, nitroglycerin and dynamite, see Bown, *A Most Damnable Invention: Dynamite, Nitrates, and The Making of the Modern World*. (Toronto, Penguin Group, 2005). For the equally fascinating account of the campaign to promote the peaceful uses of chemical weapons see Chapter 4 “Chemical Weapons in Peace” in Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring*. (New York, Cambridge University Press, 2001).

‘Flit-guns’ and ‘roach-bombs’ for exterminating insect enemies, through nuclear-power’s promise for producing ‘energy too cheap to meter’, there is nothing like the practical peace-time benefits of war-time science and technology to soothe public fears and anxieties over a new wonder-weapon.¹¹ (Is this an alternate example of converting technological terror into Nye’s *Technological Sublime*?)¹² The scientists, engineers, and institutions involved in *Plowshare* and its Soviet analogues (under the umbrella of ‘*Nuclear Explosions for the National Economy*’)¹³, sought to mobilize support in many diverse constituencies, generating many studies, proposed projects, popular and formal education efforts, and a voluminous paper-trail that begs further study and reflection.¹⁴

Project Plowshare’s timing, like that of the late-Cold War era’s aborted ‘Superconducting Supercollider’, was not fortuitous. It followed on the heels of early radiation scares that sparked a spate of Sci-Fi stories and films all-over the world, perhaps best exemplified by the enduring ‘Godzilla’ movie franchise of cult-status. It also preceded the Cuban Missile Crisis, America’s involvement in Vietnam, and the counter-culture and environmental movements of the 1960s and 1970s. By the time Saigon fell, *Plowshare* was moribund, although it was not officially terminated until the post-Vietnam Carter administration finally put a stake in its thermonuclear heart in 1977. *Plowshare* has been largely forgotten in light of new threats and crises; but the program was well-documented, like its analogous historical antecedents since Biblical Times.

This paper will be limited to considering the ‘American Genesis’ of *Plowshare* along with *Project Chariot*, the thermonuclear excavation of a harbor on the frozen coast of Alaska, at Cape Thompson. *Chariot* was the ‘lynchpin’ of *Plowshare*, the first major proof-of-concept. It would have opened the door to even more elaborate projects, the *Holy Grail* of which would have been the excavation of a *fully* sea-level canal across Central America, to replace the narrow and aging Panama Canal, with its cumbersome system of locks and limited traffic.¹⁵ I will argue that *Chariot*, like *Plowshare* in general, was designed to soothe public fears about nuclear weapons,

¹¹ For a dose of the Soviet strain of cold-war ‘Big Tech’ fever see Josephson, “Rockets, Reactors & Soviet Culture,” in Graham (ed.) *Science & the Soviet Social Order*. (Cambridge, Harvard University Press, 1990), 168-191.

¹² Nye, “The Atomic Bomb and Apollo XI” in *American Technological Sublime* (Cambridge: MIT Press, 1994).

¹³ For a detailed and illuminating description of the Soviet PNE program for comparison to *Plowshare* see Nordyke, “The Soviet Program for Peaceful Uses of Nuclear Explosions” (*Science & Global Security* 7, 1, 1998), 1-117.

¹⁴ I wonder if the volume of *Plowshare* documentation and analysis qualifies as a record for a stillborn program?

¹⁵ O’Neill, *The Firecracker Boys*, 26, 27, 42, 43 and Teller, “We will Work Miracles”, 100.

forestall or pre-empt nuclear testing moratoriums, and provide useful data and test-results for the effects of new nuclear weapons in a Bipolar World in which their actual use in war would result in *Mutually Assured Destruction*. I suggest that *Plowshare* was also to have been Dr. Edward Teller's great personal legacy to the future; to overshadow his reputation as "Father of the Hydrogen-Bomb" and the scientist who 'brought-down' J. Robert Oppenheimer.¹⁶ Ironically, the *real* legacy of *Chariot* and *Plowshare* was their profound role as catalysts of the Environmental Movement, the Anti-Nuclear Movement, Aboriginal land-claims and rights movements; and as a template for the sorts of environmental impacts assessments that are now commonplace, if not as universally applied or stringent as many of these groups might wish.¹⁷

American Genesis and Evolution of Plowshare

In the early 1950s (November 1952 in America and August 1953 in the Soviet Union)¹⁸ fusion-based thermonuclear weapons supplanted fission-based atomic bombs. 'H-bombs' had an almost unlimited destructive potential, but they still needed a fission weapon to initiate the fusion reactions. This reliance on a conventional fission core meant the new 'Super' or Hydrogen-bomb would still produce deadly radioactive isotopes and fallout. The trials at Eniwetok atoll proved this to the detriment of various witnesses and innocent victims caught in the wake of the blasts' fallout plume.¹⁹ These trials prompted a second wave of the 'radiation-' or 'fallout-scare'.

Undeterred by bad press, the physicists and publicists on both sides put a 'super-sized' spin on the new invention. Once again, the *Russians* took an early lead, first in a 1954 Soviet science journal (later to be used against them in a 1958 Geneva conference on halting weapons testing):

Progressive science claims that it is possible to utilize the noble force of the explosion for peaceful purposes... With the help of directional explosions one can straighten out the beds of large rivers to construct gigantic dams, to cut canals literally in a few minutes whose construction by ordinary machines would be prolonged for years... Indeed unlimited are the possibilities disclosed due to the new atomic energy.²⁰

¹⁶ For a relative 'judgment' of Edward Teller vs. J.R. Oppenheimer (as well as Francis Galton & Charles Davenport vs. Harry Laughlin) see Chapter 6 and Chapter 2, respectively in E.A. Carlson, "Times of Triumph, Times of Doubt: Science and the Battle for Public Trust" (New York, Cold Spring Harbor Laboratory Press, 2006).

¹⁷ O'Neil, *The Firecracker Boys*, 292-310.

¹⁸ Findlay, *Swords into Plowshares*, 2,6.

¹⁹ Carlson, *Times of Triumph, Times of Doubt*, 75-77.

²⁰ Findlay, *Swords into Plowshares*, 6.

In America, after prolonged campaigning by Teller, a new ‘National Laboratory’ to compete with *Los Alamos* – the University of California Radiation Laboratory at Livermore – was formed in July 1952, to be operated under Atomic Energy Commission (AEC) and university oversight.

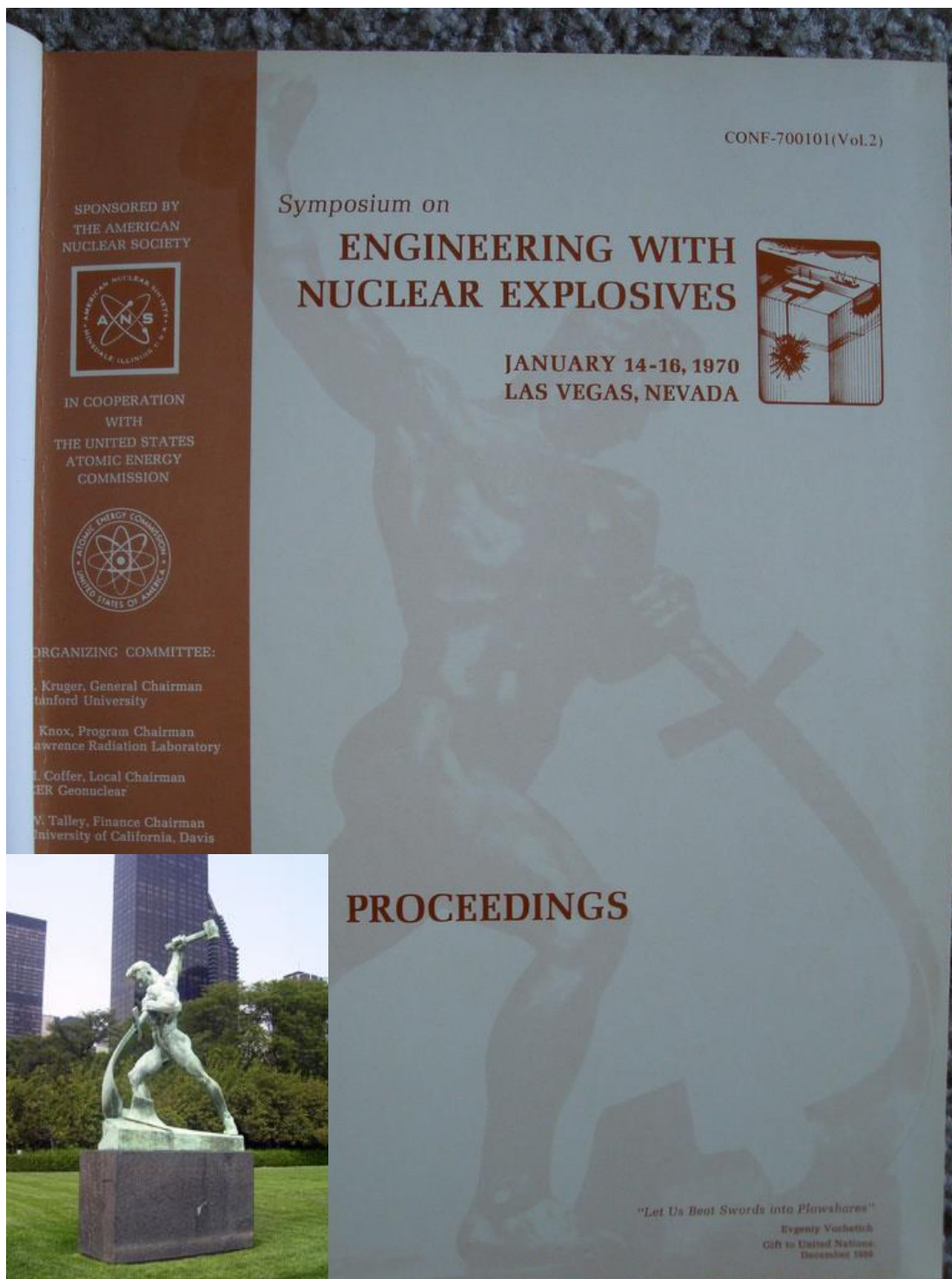


Fig 1: Title-page from a 1970 *Plowshare* Symposium. Note the Soviet statue and caption from sculptor Evgeniy Vuchetich (A 1959 gift to the United Nations - original in inset photo – An optimistic ‘*new Soviet Man*’ for the nuclear age?). Is this ‘*homage*’ the U.S. atomic engineers’ attempt at *Détente*?

The first director, Ernest O. Lawrence, was replaced by Edward Teller in 1958, after Lawrence's death and renamed in his honor. A subsequent director (from 1961, now the *Lawrence Livermore Radiation Laboratory - LLRL*) was Dr. Glenn T. Seaborg, Nobel *laureate*, future AEC Chair and Presidential Science Advisor, enthusiastically described the new "idea factory" at Livermore:²¹

The late Ernest Lawrence and Edward Teller assembled a corporal's guard of amazingly young men, most of whom had only recently received their Ph.D.'s... Their job was to help improve and diversify the nuclear weapons that are so important to American security and to explore some proposals for applying nuclear energy for peaceful purposes. They were infected with the 'gung-ho' spirit of Ernest Lawrence, a spirit that has prevailed at Livermore ever since.

The 1956 *Suez Crisis* provided the stimulus for the idea of using hydrogen bombs as 'nuclear dynamite' to excavate a 300-mile bypass of the Suez Canal through Israel, from Gaza through to the Gulf of Aquaba. A group headed by Harold Brown met in November, to discuss the idea to end the blockade as an academic exercise.²² Brown, Teller and Gerald Johnson wrote to the AEC with a number of imaginative proposals, which were "to feed the high hopes held for PNEs and which largely relied on the experiences of those who had spent their lives designing nuclear weapons rather than solving the problems which would arise in carrying-out nuclear explosions in inhabited locales."²³ They held a closed conference in February 1957 (the *First Plowshare Symposium*) to "sift fact from fancy in the new field", and proposed several projects.

One of the critical tasks for the 'idea factory' was to create and promote 'clean bombs' (a foreshadowing of the 'Neutron Bomb' of the 1980s) that would enable 'planetary engineering' on a grand scale. One early exposition of this effort was Teller's own "How to Be an Optimist in the Nuclear Age" a chapter from his 1958 book *The Legacy of Hiroshima*, written with Allen Brown.²⁴ Teller enthuses on the unlimited potential of fusion explosions for geographical engineering, outlining the plans for giant construction, mining, and oil & gas stimulation projects, including an early outline of *Project Chariot*. He dismisses as unwarranted pessimism the 'overblown fears' of radiation effects and fallout damage (he states this pessimism is the reason he longer reads science-fiction). Teller also insinuates a 'Plowshare Gap' vis-à-vis the

²¹ Findlay, *Swords into Plowshares*, 4.

²² Edward Teller (ed.) *The Constructive Uses of Nuclear Explosives* (New York, McGraw Hill, 1968), vi.

²³ Findlay, *Swords into Plowshares*, 7-9.

²⁴ Perhaps the original inspiration for Stanley Kubrick's tongue-in-cheek subtitle for *Dr. Strangelove*?

Soviets, and vehemently argues against the proposed nuclear testing moratorium.²⁵ Teller predicted these ‘clean bombs’ could soon be realized, and communicated his enthusiasm to Eisenhower in a June 1957 meeting, along with E.O. Lawrence, Lewis Strauss, and Mark Mills. Eisenhower was ‘greatly interested’ in the idea. Teller’s later recollection includes this excerpt:

One point raised in the discussion which was and is of great importance. We can perfect ‘clean’ nuclear explosives. These can be used in war to destroy an intended target without releasing radioactivity to be carried by the winds to do damage indiscriminately. . . . These ‘clean’ explosives can also be used in peace as powerful workhorses in mammoth construction jobs.²⁶

Eisenhower announced at a press conference the next day that a moratorium on nuclear tests “might impede progress on the production of a fall-out-free nuclear bomb and the development of nuclear energy for peaceful purposes.”²⁷ A month before *Sputnik* ‘changed everything’, *Operation Rainier*, the first fully-underground bomb test in Nevada, provided a graphic example of possibilities for *Plowshare*, confirming Teller’s optimistic speculations.²⁸ What was needed now was a large-scale test of one of those practical possibilities to get everyone on board.

Teller and *LLRL* had just the project in mind. In the turbulent wake of *Sputnik* (which is beyond the scope of this paper), no idea was too optimistic or bold, so long as it promised to ‘restore’ America’s technological supremacy. The *Plowshare* program was promoted as one avenue to recapturing America’s crown, even so far as declassifying part of the *First Plowshare Symposium*, proposing an international conference for the next year in Geneva, and publishing a fanfare expose of the “Non-Military Uses of Nuclear Explosives” in *Scientific American*.²⁹ There was to be only a short window of opportunity before other events intervened. Teller and his ‘corporal’s guard’ made plans for a full-scale test that would not only make future projects and applications possible, but would convince America and the world that ‘nuclear dynamite’ could be cost effective, efficacious, and safe. They needed a remote location in need of a major project that only PNEs could provide. They chose Cape Thompson, Alaska, and called it *Chariot*. Like Apollo’s golden chariot, they would bring the power of the sun to the Land of the Midnight Sun.

²⁵ Teller, *The Legacy of Hiroshima*, 83-93.

²⁶ Findlay, *Swords into Plowshares*, 11.

²⁷ Pringle & Spigelman, *The Nuclear Barons* (New York, Avon Books, 1981) 252.

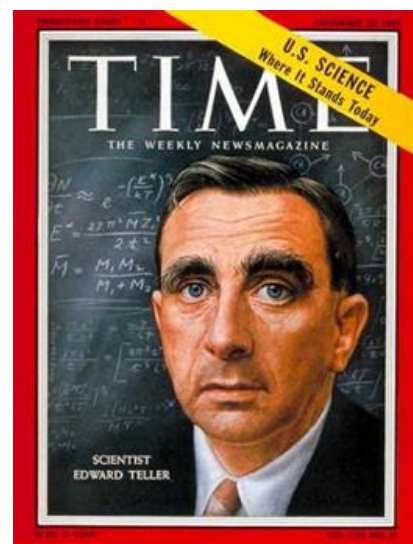
²⁸ Findlay, *Swords into Plowshares*, 12.

²⁹ Findlay, 14-17. (One problem voiced by the Soviets in Geneva was the fact that *Plowshare* was assigned to the AEC’s Division of Military Applications. This was ‘corrected’ in August 1961 with a ‘new’ *Division of PNEs*.)

A Collage of Edward Teller Images



Teller making headlines at the Fairbanks Airport, 1958



Teller at his LRL desk (same photo as 1960 *Popular Mechanics* article)



Reagan congratulating Teller for his work and support of the SDI initiative, 1983.

Teller passionately testifying in opposition to the *Limited Test Ban Treaty*, circa 1962.



Fig. 2 – A quintet of Teller images from the Web. Sir Francis Galton once used the number of lines in obituaries to judge the eminence of men. On that score Teller would surely be a man of distinct genius, Galton's highest category. Is 'rarity of genius' the problem Galton would have us believe?

Teller Greases *Chariot's* Wheels

The story of *Project Chariot* contains all the promise of *Plowshare*, as well as the seeds of its long, languishing demise. Any detailed description is beyond the scope of this paper, but it has been well documented and analyzed from a myriad of perspectives.³⁰ The long-story might be analogized as a sort-of ‘Best Laid Plans of Mice & Men’, where the lab-mice are taken out of their element and thrust into a world they did not know or understand. Teller and his colleagues took their plans on a whirlwind tour of Alaska in the summer of 1958, to a newly opened frontier territory on the cusp of great-State status, but which had suffered something of a down-turn in fortunes since the great burst of Federal spending during World War II and its aftermath. They found an enthusiastic and eager response from the business community, media, local politicians and community leaders. Teller was magnanimous in his praise for the people of Alaska and their pioneer can-do spirit. The visitors were welcomed with a curious mix of awe and puzzlement:

Selling the plan to Alaskans, Teller mixed flattery with frontier bravado. He said that Alaska had “the most reasonable people,” and that the atomic scientists had “looked at the whole world” for the right place to host the visionary technology. Teller said a number of proposals were under consideration, but that the harbor at Cape Thompson seemed most likely. Planning for the shot had progressed to a stage where it could be fired the following summer, provided the harbor was economically justifiable and that Alaskans were ready to step-in and develop it.³¹

The groups they addressed were warm to the general idea of grand projects, and raised nary an eyebrow to ‘nuclear dynamite’s’ potential for altering grand geographic features even more ambitious than Teller’s modest plan. In fact, they could not understand why he wanted to dig a harbor where he did, and peppered the distinguished visitors with suggestions for a bewildering variety of other schemes that they thought made better economic and geographic sense:

As alternatives to the Cape Thompson project, they suggested shortening the shipping lane to Bristol Bay, the world’s richest fishing grounds, by blasting a canal across the Alaska Peninsula; or a harbor in Norton Sound near Nome; or on the Arctic coast to serve Umiat, where oil was known to exist. “I’m delighted,” said Teller. “This is just the type of suggestion and objection we are looking for. . . . We came here to be partners with you, and because we

³⁰ The authoritative full-story is provided by Dan O’Neill in his popular book *The Firecracker Boys* (1994 & expanded and updated in 2007), as well as his shorter article “Project Chariot: How Alaska escaped Nuclear Excavation” (*Bulletin of Atomic Scientists*, 45, Dec., 1989), 28-37. Also O’Neil, “H-Bombs and Eskimos: The Story of Project Chariot” (*The Pacific Northwest Quarterly*, 85, Jan., 1994), 25-34. Another excellent source is Kirsch and Mitchell “Earth-Moving as a ‘Measure of Man’: Edward Teller, Geographical Engineering, and the Matter of Progress” (*Social Text*, 54, Spring, 1998), 100-134.

³¹ O’Neill “Project Chariot”, 29.

want suggestions.” By the time Teller’s group reached Fairbanks, Project Chariot appeared wide open: the Yukon, Susitna, or Copper Rivers might be dammed with nuclear explosives, harbors or canals might be excavated at a half dozen locations.³²

In fact, Teller and the AEC had already made up their minds. They had already submitted a classified application to the Department of the Interior, and their compatriots were already on the ground at the arctic outlet of Ogotoruk Creek, planning where to set their thermonuclear charges. Teller relayed the results in a classified letter to General Starbird, director of military applications at the AEC, citing the lack of general acceptance for a ‘commercial harbor’ at Cape Thompson.³³

Shortly after the Livermore group returned from Alaska, the ‘underground’ *Neptune* test in Nevada produced unexpected results and an accidental escape of considerable radioactive steam and dust.³⁴ When test officials returned to the site (after a prompt evacuation of the blast-site), they were shocked to see a crater, considering the depth of burial and low yield of the device. *Neptune* revealed that crater size increased with depth of burial (to a limit), while the release of radiation decreased. Thus, optimum depth of burial could theoretically be calculated for a particular yield; excavation could be accomplished with lower yields and radiation release could be minimized. Great news for *Plowshare* promoters, but before the atomic scientists new theoretical models could be applied in large-scale explosions near populated areas; it would need to be tested in a suitably remote location.³⁵

Thus *Chariot* planners now switched to the idea of an experiment “using two to three 20 kT explosions plus two at about 200 kT” in a scaled-down test or ‘proof-of-concept’ that could be applied elsewhere, where more obvious economic or military advantages might dictate general acceptance of the validity of *Plowshare*.³⁶ For the next decade, even after other global events intervened, Teller continued to tout the theoretical economic benefits of the Cape Thompson scheme, despite the mitigating geographical, logistic and environmental realities of the scheme. Like the true optimist he claimed to be, Edward Teller rarely allowed economic or geopolitical realities to dampen his faith or enthusiasm in the march of progress and science.³⁷

³² O’Neill “Project Chariot”, 30.

³³ O’Neill “Project Chariot”, 31.

³⁴ Teller’s prior and later denials of any significant radiation hazard at Cape Thompson are belied by the ‘facts and dangers’ detailed in his book written with Albert Latter, *Our Nuclear Future*. (New York, Criterion Books, 1958).

³⁵ O’Neill “Project Chariot”, 31,33.

³⁶ O’Neill “Project Chariot”, 33.

³⁷ See, for instance, *Science, Ideology and Spectacle* in Kirsch & Mitchell (*Social Text*, 54, Spring, 1998), 105-108.

“The Crystal Reveals” the Prophet/Scientist at the Altar



Fig 3 - One of the photo-plates from A. Cressy Morrison's 1937 iconographic book, sponsored by the *American Chemical Society*.

After Ede, A., “Creating an Image of Science: Persuasion & Iconography in A.C. Morrison's *Man in a Chemical World*”, *Canadian Journal of History*, Vol. 39, No. 3. (Dec. 2004).

“When you come to the end of all the light you know, and it's time to step into the darkness of the unknown, faith is knowing that one of two things shall happen: Either you will be given something solid to stand on, or you will be taught to fly.” – Edward Teller
[Quoted in O'Neill “Project Chariot” (*Bulletin of the Atomic Scientists*, 45, Dec.1989), 33.]

Chariot Encounters Obstacles and Grinds to a Halt (but quietly)

Even before the inception of *Plowshare*, opposition to nuclear weapons development and testing had a luminous and storied history. Early ‘mavericks’ like geneticists H.J. Muller, Linus Pauling and philosopher Bertrand Russell had begun to chip away at the pervasive enthusiasm and authority of the atomic physicists and their chorus of mimics and sycophants. The images of *Hiroshima* and *Nagasaki*, despite the best efforts to generate a positive-spin and downplay the dangers had shaken many scientists and lay people. One response was the establishment of the *Bulletin of the Atomic Scientists*, perhaps best known for their ‘Doomsday Clock.’³⁸

Even before Eisenhower’s *Atoms for Peace Initiative* was announced at the United Nations, Lewis Mumford had delivered a speech to the American Philosophical Society in November, 1953, which was published in the *Bulletin* in February 1954.³⁹ Mumford criticized the social detachment of atomic scientists, and the inherent irrationality of their research program:

[T]he advance in scientific knowledge, in which we are now committed to processes whose tempo we do not dare to retard, whose direction we do not govern, and whose ultimate results we do not stop to evaluate. Under such conditions every permission becomes a compulsion. As long as our present knowledge continues to expand the sphere of the irrational and the pathologically automatic, the survival of man, to say nothing of his development, is plainly threatened. The dangers of our present situation would not be so great had our responses to it been alert and timely. Even now, we should probably be able to mobilize enough political wisdom to provide a minimal basis for the necessary cooperation and safeguards, if only we could throw off the sleepwalker’s insulation from reality that characterizes our collective conduct.⁴⁰

Mumford proposed a ‘World Assize’ of scientific knowledge on the effects of atomic bombs, and pleads for a ‘reorientation’ of scientific paradigms away from a “passive acceptance of the catastrophes their old tradition of social irresponsibility helped to create.”⁴¹

That *Plowshare* (and the larger *Atoms for Peace* program) was designed and conducted (in part) as a strategy to combat Mumford’s perception of atomic science and its practitioners is one consideration. The continuance to practice what he decried is an indictment that Big Science and Technology continues to combat with similar tactics and strategies, but enhanced sophistication.

³⁸ See Barry Commoner “Project Chariot” (*Science*, 134, Aug.18, 1961), 495-503 for a sample of the back-and-forth between the AEC/Los Alamos/LRL “hawks” and the many prominent scientists who took them on.

³⁹ Mumford, “Anticipations and Social Adjustments in Science” (*Bulletin of the Atomic Scientists*, 10 (Feb., 1954), 34-36. This article was followed by a spate of letters and replies, including from Frederick Reines (of *Los Alamos*) in May, the same month as the notorious Bravo Test at Bikini Atoll. The fiasco that resulted glaringly called into question expert appraisals and reassurances of the minimal danger of radiation and fallout in weapons tests.

⁴⁰ Mumford, 34.

⁴¹ Mumford, 36.

In 1958 – the year that Teller and his crew planned *Chariot* and visited Alaska for the first time, Linus Pauling and Edward Teller engaged in a furious exchange – in the media, in debate and in a series of publications – over the dangers posed by radiation and nuclear fallout. In January, Pauling presented a petition to the United Nations, coauthored by Barry Commoner of the *Centre for Nuclear Information* with veteran physicist Leo Szilard; signed by some 9000 scientists, including H.J. Muller, a *Nobel laureate* for the effects of ionizing radiation on DNA.⁴²

In Alaska, Teller’s young associates also ran into trouble in the form of the biology faculty at the University of Alaska, Fairbanks (though not the administration). They were to form a vital local-front of the opposition to *Chariot*. In a fission-style cascade reaction, the biologists actions and efforts expanded into a huge network of activists, academics, Aboriginal groups, and mass media; finally reaching high-level bureaucrats and politicians in both the State and Federal Governments. Whereas now we hear about ‘grass-roots’ activism or environmentalism; this was a ‘lichen-roots’ prototype; and still one of the great eco-activism successes that has rarely been replicated. But it was a creeping, quiet victory, one that was not obvious for some time.

The opponents of *Project Chariot* - the Eskimos, biologists, and conservationists - were denied a clear-cut acknowledgment of their success. But their victory is as stunning as it is historic. They took on Edward Teller's dream to use nuclear explosions in the “great art of geographic engineering,” and they turned it into a stimulus to the incipient environmental movement. And something larger than *Chariot* was knocked off-course. Bugged-down also was Teller's headlong rush to establish *Plowshare* as a highly visible affirmation of nuclear power. Indeed, the civilian application of nuclear energy, other than for electric generation, never regained its momentum. On the surface, *Chariot* is a tale of conflict and even scandal, involving passionate, radical, pioneering people. But it is more than that... The lesson *Chariot* offers is that a free society must be a skeptical one, and that rigorous questions and dissent protect, rather than subvert, our freedoms.⁴³

Of course, the efforts of these and many others were allied and aided by the announcement in October, 1958, of a voluntary bilateral moratorium on nuclear testing that lasted for almost three years. By then *Chariot* was in real jeopardy, both from the studies conducted by the Alaska scientists and others the AEC had contracted to study the botany, ecology, geology, hydrology, human geography, and zoology of the Cape Thompson region, and unfavorable public opinion.⁴⁴ By the end of the moratorium, the AEC had put the brakes on, but they and the physicists at LRL

⁴² Kirsch, *Proving Grounds: Project Plowshare the Unrealized Dream of Nuclear Earthmoving*. (New Brunswick, N.J., Rutgers University Press, 2005) 32-36.

⁴³ O’Neill, “H-Bombs and Eskimos: The Story of Project Chariot”. (*Pacific Northwest Quarterly*, 85 Jan., 1994), 34.

⁴⁴ O’Neill, 29-33.

did not want the opposition to declare a victory. Rather than calling-off *Chariot*, it was announced that it was to be ‘postponed indefinitely’.

Livermore officials concluded that *Project Chariot* should be canceled, but were concerned that the decision might create "serious political problems." LRL planners had always been sensitive to any change in the design that “looks like another retreat to mollify local demands.” So when Livermore director John S. Foster finally wrote to the AEC to recommend cancellation, he pointed out: “Such an action could have repercussions which would adversely affect the whole *Plowshare* program... since *Chariot* has been vigorously criticized from the standpoint of safety...its cancellation will contribute to the skepticism on the safety of nuclear excavation.”⁴⁵

Attempted *Plowshare* Revivals & Last Rites

The ‘end’ of *Chariot* was by no means the end of *Plowshare*. Indeed, like so many creations of American Technocracy and the military-industrial-academic complex (so poignantly captured by Ike’s swan-song speech) *Plowshare* had a momentum and inertia of its own that was to propel it for another decade before grinding to a halt.⁴⁶ Further tests – such as the scaled-down *Gnome* and *Sedan* ‘shots’ in Nevada – followed the end of the ‘voluntary moratorium’, in a flurry of nuclear activity reminiscent of that which preceded it.⁴⁷ The AEC and LLRL (both under new management) undertook further studies, hosted additional conferences and symposia, published numerous books, articles, even films to advocate for PNEs; and they campaigned to exempt their programs from any future moratoria.⁴⁸ Even after the *Limited Test Ban Treaty* (implemented in October 1963), funding for *Plowshare* work and studies continued, including 18-million dollars for a five-year study of the Central American canal project, beginning in the Fall of 1964.⁴⁹ A set of promising latter-day schemes involved *underground* detonations for mining or fossil-fuel extraction, including a novel plan to liquefy the Athabasca Tar-sands.⁵⁰

⁴⁵ O’Neill, “H-Bombs and Eskimos”, 34.

⁴⁶ The official DOE (in which *Plowshare* was subsumed) document *Plowshare Program Executive Summary*. (U.S. Department of Energy, Nevada Operations Office, Office of Public Affairs and Information, 1977) contains a compendium of projects, publications, tests, conferences, *et al*, until the very end.

⁴⁷ For an enthusiastic account of the *Sedan* ‘shot’ see Kelly “Moving Earth and Rock with a Nuclear Device”. *Science, New Series*, Vol. 138, No. 3536 (Oct. 5, 1962), 50-51.

⁴⁸ See, for example, Ralph Saunders *Project Plowshare: Development of the Peaceful Uses of Nuclear Explosions*. (Wash. D.C., Public Affairs Press, 1962), and Saunders “Defense of Project Plowshare” (*Technology and Culture*, 4, Spring, 1963), 252-255, in response to a lukewarm review and impertinent letters to the editor. For an appeal to ‘pure science’ and ‘basic research’ see Cowan “Scientific Applications of Nuclear Explosions” (*Science, New Series*, 133, 3466, Jun. 2, 1961), 1739-1744. This was a *Los Alamos* initiative under the unfortunate acronym *Project SANE*, providing an easy target for jibes from critics.

⁴⁹ Kirsch, *Proving Grounds*, 1-5. See also Elinor Langer “Project Plowshare: AEC Program for Peaceful Nuclear Explosives Slowed Down by Test Ban Treaty” (*Science, New Series*, 143, (Mar., 1964), 1153-1155.

⁵⁰ As profiled by Teller in his popular articles (*Popular Mechanics*, Mar, 1960), his books (Teller, 1958, 1962, 1968, 1970) and *Plowshare* symposia (1959, 1964, 1970). See the *Plowshare Executive Summary* for a complete listing of tests and projects and a comprehensive chronology of important events.

In the end, no *Plowshare* project was ever carried to fruition outside the Nevada test-area, *except* for underground tests in Colorado and New Mexico. These were of low-modest yields to assess the possibility of gas or oil-well stimulation and shale-oil fracturing, ending with *Rio Blanco* in May, 1973.⁵¹ *Plowshare* was terminated in 1977, in the wake of America's deflating defeat in Vietnam and South-east Asia, the Watergate fiasco, and the crunch of the first 'Energy Crisis'. After the creation, in 1969, and gradual strengthening of the Environmental Protection Agency, and the cumulative effects of eco-activism on many fronts; even the great urge to achieve 'energy independence' in a 'Fortress North-America' could not resurrect *Plowshare* to active-duty for even limited 'underground' energy-related projects.⁵² To close this chapter, let me quote from the DOE executive summary of '*Plowshare Termination*'.⁵³

Plowshare was a program that started with great expectations and high hopes. Many projects did not progress beyond their planning phase and construction was not started. In general, planners were confident that the projects could be completed safely, at least within the guidelines at the times. There was less confidence that they could be completed cheaper than by conventional means and most importantly, there was insufficient public or Congressional support for the projects. Projects Chariot and Coach were two examples where environmental concerns and technical problems prompted further feasibility studies and, after several years of continuous field work and numerous delays, each project was eventually canceled. In addition, throughout the course of the Plowshare Program citizen groups voiced concerns and opposition to some of the tests.

By 1974, approximately 82 million dollars had been invested in the nuclear gas stimulation technology program (i.e., nuclear tests *GASBUGGY*, *RULISON*, and *RIO BLANCO*). It was estimated that even after 25-years of gas production of all the natural gas deemed recoverable, that only 15 to 40 percent of the investment could be recovered. At the same time, alternative, non-nuclear technologies were being developed, such as hydrofracturing. Consequently, under the pressure of economic and environmental concerns, the Plowshare Program was discontinued at the end of FY 1975.

After an investment of some 770-million dollars, *Plowshare* was terminated,⁵⁴ but certainly not forgotten. Hopefully, not to be mourned, or resurrected in some future *Project Lazarus* guise.⁵⁵

⁵¹ DOE *Plowshare Program Executive Summary*, 7-10. The list of non-nuclear and cancelled 'test-shots' is longer.

⁵² *Project Independence* was launched in the waning years of the Nixon Administration. It included huge schemes to rapidly exploit the Alberta Tar-sands and Colorado Oil-shales, the focus of much Plowshare study in the final years. For a brief introduction see the profile of Nixon science advisor Alvin Weinberg in "Project Independence and Future R&D" (*Science News*, 106, Dec. 14, 1974), 374). It is all the more ironic for the same-page story "EPA criticizes atomic assessment" in which the upstart EPA criticizes the venerable AEC for shoddy monitoring and management of its reactors and waste disposal facilities. I wonder if Mumford would be amused and/or vindicated?

⁵³ DOE *Plowshare Program Executive Summary*, 5-6.

⁵⁴ Kirsch, *Proving Grounds*, 6-7. (Stated as 1996 dollars – not big by Cold War standards, but an expensive study.)

⁵⁵ *Project Lazarus* is a *Doctor Who* audio-book, in which the villain tried to trick the Doctor into regenerating him. I wonder if that would be optimistic enough for Dr. Teller's approval? Might Teller have been a passable *Doctor*?

Education for Peaceful Uses of Nuclear Explosives

Before closing the book on *Plowshare*, one additional development is worth exploring briefly. As was the case of the Eugenics Movement, *Plowshare* was seen as a multi-generational endeavor, one that required extensive public and formal education efforts, in order to recruit new supporters and cadres of bright young graduates in the associated science, technology and related administrative disciplines. In addition to previous symposia and conferences, both classified and open to the public, a late-charge for the hearts and minds of nuclear engineers, physicists, and related educators was mounted in April, 1969, in the form of a symposium entitled *Education for the Peaceful Uses of Nuclear Explosives*, at the University of Arizona, Tucson. It resulted in an edited book, under the direction of Lynn E. Weaver, Associate Dean - College of Engineering, University of Oklahoma. It is dedicated to the late Dwight (Ike) Eisenhower “– a gallant warrior who also dreamed of converting the sword of nuclear energy into a plowshare for peace.”⁵⁶

It includes featured presentations by Plowshare veterans at the Livermore Rad Lab and the AEC, including Gerald Johnson, Wilson Talley, William Libby and the ever-optimistic Edward Teller, on all aspects of *Plowshare*, old and new. Even *Chariot* was resuscitated as an exemplar. The latter sections of the book deal with ‘Legal Problems and Educational Programs’, ‘University Research and Manpower Needs’, and ‘Educational Development’. Teller himself contributes a keynote address on the “University Role in Nuclear Explosives Engineering Research”, in which he again optimistically argues for continued R&D on ‘clean’ thermonuclear devices.⁵⁷ Representatives of many Nuclear Engineering or Physics departments showcased their institutions inclusion of *Plowshare*-related courses or programs, optimistically forecasting future expansion with increased demand, contingent upon the development of new technologies. Willard F. Libby, a *Plowshare* veteran now UCLA Chair, gives the closing keynote, recapping the history of the project and its initiatives, and optimistically concludes:

It seems to me that the future is particularly bright. Of course, we Plowshare enthusiasts have always had this attitude, and it is natural that we find ourselves continuing to be hopeful.”⁵⁸

⁵⁶ Weaver (ed.) *Education for the Peaceful Uses of Nuclear Explosives* (Tucson: University of Arizona Press, 2005).

⁵⁷ Weaver, 293-298. Teller even invokes Hamlet’s dilemma paraphrased as “To Shoot or not to Shoot”, arguing it is time for the Prince of Denmark to stop the off-stage soliloquys and make a triumphant entrance on the world stage.

⁵⁸ Weaver, 338. Libby even hopes to try making diamonds by “placing a large block of graphite near a device”.

Conclusion:

That *Chariot* (and ultimately *Plowshare*'s other proposed 'mammoth projects') did not see the 'light of a thousand suns' is cause for retrospective celebration. But it was only by the tireless efforts and courageous actions of dedicated activists and academics, as well as the eventually enlightened decisions of those leaders and politicians that curbed Edward Teller and his coterie of atomic physicists and engineers, squelching their dreams of nuclear geographical engineering. However, as history has proved and current societies continue to witness, it was by no means the end of global nuclear fear or man-made environmental catastrophes. Nor was it the fall or even decline of large-scale industrial-engineering projects that – in their cumulative impacts and sheer ubiquity – have done much more collateral damage to the biosphere and humanity than *Chariot*, or even its planned follow-on projects would have caused.⁵⁹

'Progressive' American eugenics required the exposition of Nazi racial-hygiene programs and genocide to curb it (though some critics argue eugenics still lives under new aliases).⁶⁰ Had *Plowshare* projects been allowed to proceed, it *may* have shocked the world into a more drastic rejection of the kind of *technological hubris* that is embodied in this sort of radical military-industrial Big Technology.⁶¹ It may also have slowed the pervasive onset of *Technopoly*, as enunciated by Neil Postman.⁶² I am skeptical on both counts. In addition to examples like the debacles in Vietnam or Afghanistan (Soviet and U.S.), Bhopal, Chernobyl, or Fukushima; there are numerous other cautionary tales that have and continue to be played-out that argue against the prospects of real success of a 'World Assize' on irrational *Big Science and Technology* that Lewis Mumford advocated.⁶³ The 'will-to- power' is too strong. We are destined to progress ever onward and upward, on supreme faith, even stepping into the face of total darkness; just like Edward Teller. Will we always have something solid to stand on, or be taught how to fly? Or, is this all "just another line in the [well-plowed and fertilized] field of time."⁶⁴

⁵⁹ This cautionary tale is made especially poignant by the current political debate and public relations campaigns that are being played-out at this writing by the Keystone XL and Northern Gateway Pipelines being contemplated to carry Alberta's Oilsands bitumen to refineries and markets in America and China, respectively.

⁶⁰ Kohlman "The Anthropology of Eugenics in Progressive America", a forthcoming journal article, I *hope*.

⁶¹ O'Neill, *The Firecracker Boys*, 29.

⁶² Neil Postman, *Technopoly: The Surrender of Culture to Technology* (New York, Vintage Books, 1993).

⁶³ Mumford "Anticipations & Social Adjustments in Science" (*Bulletin of Atomic Scientists*, 10, Feb. 1954), 34-36.

⁶⁴ Neil Young, "Thrasher" (*Rust Never Sleeps*, Track 2, Warner Records, 1979).

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