

# GLOBAL ELIMINATION OF PATHOGENIC DISEASE REGARDED THROUGH THE PRISM OF THE MANHATTAN PROJECT

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# THE MANHATTAN PROJECT...

...what it was...and what it wasn't

- What it **was**

- A large-scale *materials-engineering* technological endeavor, with quite well-defined goals-&-milestones
  - Focused keenly on the production of  $N \times 10$  kg of  $U^{235}$ ,  $N \leq 10$ 
    - The follow-on to the Frisch-Peirels Memo, the Columbia neutronics studies, et al.
  - And after the Fermi pile was operated, on creation of comparable quantities of  $Pu^{239}$
- Which is why a US Army Corps of Engineers general was put in charge of it...
  - ...rather than one of the eminent scientist-members of the Uranium Committee

- What it **wasn't**

- A huge, long-time-scale '*high science*' endeavor, of at least initially diffuse focus
  - Most of the modest quantities of genuinely-scientific knowledge necessary for execution was in-hand when the Manhattan Project was 'stood up' in September '42...
    - ...only 35 months prior to Hiroshima, Nagasaki
  - Only rather modest classic physics-&-chemistry scientific research was done in the Manhattan Project centers
    - Instead, the emphasis on "getting the necessary materials in hand, and then making things work" – *exceedingly* swiftly!
  - And the Manhattan Project 'folded' into the Atomic Energy Commission very soon after WW II ended
    - Emphasizing civilian control of "atomic energy"
    - The cornucopia of scientific research addressing atomic energy matters which eventually appeared in the open literature was mostly pre-&-post-Manhattan Project

# KEY LESSONS FROM THE MANHATTAN PROJECT...

...from the actual/real (if not-so-well-known) history....

- ***Don't be dismayed by apparent impossibilities***

- The history-making Heisenberg Blunder (re the analytic model of the minimum critical mass of  $U^{235}$ )
- The replicated German mis-measurement of the absorption cross-section of graphite  
But instead “intelligently invent your way around the stubborn-&-real problems!”

- ***Have an abundance of ‘parallel paths’ along all crucial tracks***

- The initially-perceived route-to-victory is too-often cluttered with Major Obstacles, e.g.,
  - The materials failure of the  $UF_6$ -centered gaseous diffusion isotopic separation approach
  - The ruinously-large spontaneous fission branching-ratio of  $Pu^{240}$  – and its neutron production
  - The “xenon catastrophe” of the first Hanford Pu production reactors
- ...and alternative routes must have been prepared, and then ‘made to work!’

- ***Never lose sight of “...there is no substitute for victory!”***

- Press ahead, just doing whatever's *truly* necessary – and “Damn the torpedoes!”
- E.g., the smashing-&-pillaging of the Y-12 Calutrons in Spring '45 to get the needed  $U^{235}$

# HISTORIC TASKS OF THE FIRST HALF OF THE 21<sup>ST</sup> CENTURY

Ascent of *all* of humanity into the promised “broad, sunlit uplands”

- Global elimination of extreme poverty
- Global elimination of pediatric malnutrition
- **Global eradication of the pathogens responsible for the major infectious diseases of humans**
  - **Waging of wars-of-annihilation against *Homo*'s killer pathogens: “Extinction is forever!”**

Substantial inter-goal synergisms beckon, especially keenly to “impatient optimists”

# SIGNIFICANT MILESTONES IN PATHOGEN ERADICATION – AND MANHATTAN PROJECT ANALOGS

- ***Intelligently launching*** the Opening Game
  - The Frisch-Peierls Memo; the Fermi/ColumbiaUniv neutron assemblies; the gaseous diffusion system design-&-subscale efforts; securing uranium ore supplies and large land reservations; swiftly amassing the ‘critical mass’ of top S&T talents...
- ***Competently pursuing*** the Middle Game
  - Implement with cost-efficient margins everywhere: early implosion physics studies; initially-unfilled ‘corner’ fuel-channels in the Hanford Pu production reactors; back-up uranium isotopic enrichment efforts at ORNL;...
- ***Conducting an implacably victory-oriented*** End Game
  - Take no unnecessary risks while sprinting for the Finish Line: the JUMBO experimental tank at Alamogordo; the round-the-clock LASL efforts once the first kg-of-Pu came in from Hanford; the patched-together HE implosion system; the smashing-&-pillaging of the Y-12 Calutron plant;...
- ***Securing robustly*** the (never-quite-)Final Victory
  - Don’t ever let up: the Marshall seizure of the final nuclear weapon; the crash-rebuilding of Y-12; the continuing build-out-&-commissioning of the Hanford Pu production reactor fleet; advanced design efforts (centered at LASL, but also elsewhere);...

# ESSENTIALS FOR WINNING THE END GAME

- Reliably determine the minimum sizes – in number-immunization coverage space – of the population ‘pockets’ that can sustain pathogen propagation chains for durations-of-interest
  - And then public-health/medically assure that such ‘pockets’ cannot persist for intervals-of-interest
  - The crucial utility of performance-validated modeling tools – of assuredly applicability to the pathogen/disease-of-interest...
    - ....together with reliable data-from-the-field re real populations and actual/current immunization status
  - Manhattan Project analogs: the scoping/forecasting Frisch-Peierls Memo; continuing world-wide ‘talent surveys;’ extensive anticipatory ‘failure modalities’ studies-&-analyses;...
- Invariably “turn within the tactical radius” – in spacetime! – of the pathogen, in the particular/unknown-in-advance Close-Out circumstances
  - I.e., reacting more swiftly to its presence than it can ‘present’ such presence
  - Manhattan Project analogs: blockade Nazi acquisition of key data, uranium-&-ore, heavy-water,...
- Leveraging the ‘molecular clocks’ intrinsic/innate to pathogenic genomics
  - Rationally/probabilistically and semi-quantitatively determining where-&-when this pathogen’s most-immediate ancestors were ‘located,’ and thus how – inferentially – did they get to here-&-now...
    - ...and thus what do we do about seeing to it that they “propagate-&-transit no more!”
    - Genetics are destiny – and genomics are history!
  - Manhattan Project analogs: Operation Paperclip; the Farm Hall Project;...

# SECURING THE VICTORY

- Ensure that neither ‘natural’ nor anthropomorphic disease eco-system ‘niche-fillers’ ever appear-&-propagate
  - Far-too-many pathogen genomes are ‘simple’ and are published – and thus linger-in-‘memory’ forever -- while “general pathogenic structural/compositional principles” are well-known
    - Thus, proscribe the sourcing/trafficking of any-&-all ‘lively fragments – and take-notice of ‘nearby’ ones!
    - Resolutely/intelligently ban RDT&E on all aspects of human immune system defeat – while remaining ‘current’ on what these may be
  - Cf. ongoing nuclear weaponry non-proliferation efforts – quite imperfect, yet remarkably effective
- ***“Eternal vigilance is the price of liberty”*** – also from micro-pathogens
  - E.g., keep an eye on all of the major sewers and public-area HVAC systems, indefinitely
    - Leveraging high-quality human-mimetics for apt, reliable recognition of both ‘ordinary’ and ‘odd’ pathogens
  - Be forever-posed to “Strike hard; strike fast” against emerging suspect strains – wherever!
  - *“Fortune favors the prepared mind!” – and “Incentives matter!”*
  - And never forget about zoonoses – and the dismal prospect of anthropogenic (hyper-)pathogens
  - Cf. the evolution of the Manhattan Project into the Atomic Energy Commission
    - Following the rejection of the Baruch Plan for UN control of nuclear energy by the USSR

# THE BOTTOM LINE

- Highly-ambitious S&T undertakings require extensive planning-&-preparation, if they're to have any chance of succeeding
  - And they have to be designed-&-operated to gracefully cope with major contingencies and surprises – which will surely arise!
    - Human imagination is stunningly limited – and ‘foresight’ is greatly over-rated!
    - Fundamental scientific discovery – and technological surprise – always-&-forever lurks!
  - The Manhattan Project was “dead in the water” in Summer-Fall ‘44 – but was programmatically triumphant less than 12 months later
- Effort leadership *must* be of “no foolin’” world-class quality – and *must* staff the effort likewise
  - ‘Second best’ is *always* far from sufficiently-capable: “money incinerators” result!
- It always costs much more and takes far longer than initially estimated
  - The Frisch-Peierls Memo – one of history’s most brilliant S&T forecasts – was underscoped in critical mass by nearly 10X ( $U^{235}$ ) and in time-to-succeed by 2 years
  - Even Groves’ formal estimate/promise to Marshall was 6 months late-in-fulfillment
    - And history was (arguably, profoundly) altered as a consequence....