



## ANALOG SUPERPOWERS

How Twentieth-Century Technology Theft Built the National Security State

#### KATHERINE C. EPSTEIN



## **Analog Superpowers**

Kate Epstein

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### **Speaker Bio: Kate Epstein**

- Associate professor of history at Rutgers
- BA in history *summa cum laude* from Yale, MPhil in IR from Cambridge, PhD in history from Ohio State
- First book: *Torpedo: Inventing the Military-Industrial Complex in the United States and Great Britain* (2014)
- Member of the Institute for Advanced Study in Princeton (2018-2019)
- Articles in the Wall Street Journal, Liberties, and American Purpose, as well as various scholarly journals



The speaker with a Mark 8 firecontrol computer, USS *New Jersey* 

#### **Computers and China**

#### THE WALL STREET JOURNAL. U.S. Restricts Semiconductor Exports in Bid to Slow China's Military Advance

#### Reuters

U.S. updates export curbs on AI chips and tools to China

#### The Economist

# America curbs Chinese access to advanced computing



"We welcomed the Chinese Communist Party into this global order. And they took advantage of all its benefits. But they ignored all its obligations and responsibilities. Instead, they have lied, cheated, hacked, and stolen their way to global superpower status, at our expense."

#### **Defense Innovation and Silicon Valley**





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#### Replicator

The Replicator initiative is DoD's effort to accelerate delivery of innovative capabilities to the warfighter at speed and scale through senior leader focus on solving a specific operational challenge.



### **Clashing Perspectives**

### Public sector→ Data rights, vendor lock



Elmer Sperry, exploiter of vendor lock

### Private sector→ Intellectual property

#### Palantir and Tangram Flex executives:

"The result [of the DoD's demand for far-reaching data rights] is that software providers eager to support the Department of Defense risk losing the very assets that sustain their business: company intellectual property. This not only dissuades commercial technology providers from seeking government contractors, it places a particularly onerous burden on younger non-traditional tech firms that are hoping to break into the defense industrial ecosystem both of which limit the public-private partnerships necessary to ensure that the United States stays ahead of technologically advanced competitors."

#### Secrecy

• Secrecy orders and the Invention Secrecy Act (1951)

• State secrets privilege (United States v. Reynolds, 1953)

#### **Genres of the Book**



#### **The Inventors**



#### Harold Isherwood



### **Computers before Silicon Valley**

Antikythera mechanism

> Rockefeller differential analyzer





ANALOG	DIGITAL
Antikythera mechanism (c. 200 BCE)	Pascal's machine (1645)
Oughtred's slide rule (1622)	Babbage's "engines" (1830s)
Kelvin's harmonic analyzer (1878)	Turing's bombe (1940)
Boys' integraph (1881)	Colossus (1943)
MIT differential analyzer (1931)	ENIAC (1945)
Rockefeller differential analyzer (1942)	Von Neumann / IAS machine (1951)



Pascal's machine



Von Neumann / IAS machine

### The Significance of the Invention

• Technological

• Legal (domestic political economy)

 Geopolitical / diplomatic (international political economy)

#### **The Prediction Problem**

Short-range firing



#### Long-range firing



### Why Calculus?



#### **Interconnected Rates**



#### **Gyro-stabilization**

The effect of yaw on bearing



### Networked Warfare and the First "Second Offset"

#### From "Victorian internet"...



British undersea cables, 1901

#### ... to shipboard intra-net



US fire control system, 1953

#### A "Mechanical Brain," or Analog Al

The skull

The brain



Inter-connection of range and bearing rates = mechanical integrated (and integrating) circuit

### **Crossing the "Valley of Death"**

- Analog software
- Problems with patents (even secret ones)
- The Admiralty's fear of vendor lock
- Development contract



From the "Defense Tech and Acquisition" blog

### **The Rival**



Admiral Sir Frederic Dreyer

#### **Mechanical Integrators**





Video by Jack Monaco (3:43-4:43)

#### **The Kelvin Integrator**





Harmonic Analyzer (1878), Science Museum





### **The Slippage Problem**



Vannevar Bush and the Differential Analyzer at MIT



Close-up of one of the integrators in the Differential Analyzer

#### **Isherwood's Integrator**







#### **The US Version**



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#### **IP or National Security Secret?**

#### From Official Secrets...



#### ... to "born secret"



Truman signing the Atomic Energy Act of 1946

#### **Hannibal Ford**



#### A Smoking Gun



Follen's visit here and instructed Mr. Ford, if you will remember to take full advantage of the generated bearing feature and put it into the Ford instruments





Van Auken memorandum, 3 May 1918, RG74/E25A-I/B346, NARA-I

#### **The Ford Indemnification**





Roosevelt to Ford Instrument Co., 30 April 1918, RG80/E19A/B2023, NARA-I

### **Other Topics in the Book**

- US patent secrecy before the Invention Secrecy Act
- The use of eminent domain to "take" patents
- Director technology (electrical systems for gunnery aiming and communications)
- The US Navy's pursuit of British naval technology during World War I
- The Royal Navy's second piracy of the Pollen-Isherwood system in the 1920s
- Pollen's and Isherwood's successful attempt to recover compensation for the theft of their system in Britain
- The role of expert witnesses in patent litigation
- How Elmer Sperry exploited "vendor lock"
- How patents structured the interwar US fire-control industry

#### **Robert Lavender**



#### Pollen and Isherwood v. US (1937)

"The [privilege] applying to the facts of this case is predicated upon the principle of the public good and the right of the Sovereign to maintain an efficient National defense...."

"The presumption obtains that in the exercise of the authority good faith will characterize the conduct of the Government officials in discharging their duties."

#### Pollen and Isherwood v. Ford Instr. Co. (1939)

... the privilege against revealing military secrets... is well established in the law of evidence.<sup>11</sup>

11 Totten v. United States, 1875, 92 U.S. 105, 107, 23 L.Ed. 605; Firth Sterling Steel Co. v. Bethlehem Steel Co., D.C.E.D.Pa.1912, 199 F. 353; Pollen v. Ford Instrument Co., D.C.E.D.N.Y.1939, 26 F.Supp. 583; Cresmer v. United States, D.C.E.D.N.Y.1949, 9 F.R.D. 203; see Bank Line v. United States, D.C.S.D.N.Y.1946, 68 F.Supp. 587, Id., 2 Cir., 1947, 163 F.2d 133. 8 Wigmore on Evidence (3d ed.) s 2212(a), p. 161, and s 2378(g)(5), at pp. 785 et seq.; 1 Greenleaf on Evidence (16th ed.) ss 250—251; Sanford, Evidentiary Privileges Against the Production of Data Within the Control of Executive Departments, 3 Vanderbilt L.Rev. 73, 74—75 (1950).

US v. Reynolds (1953)

### **Sir Henry Tizard**



#### **Admiral William Furlong**



### **The Furtive Furlong**

"[They] had quite a long conversation, at the end of which Admiral Anderson explained to me that the real difficulty was connected with the design of the predictor known as the Ford Predictor... It appears that an English firm (?Paul and Isherwood) had sued the U.S. Government for infringements of patents. They have been refused access to the latest U.S. predictors for ship work and had been unable to prove their case. They had shifted their attack on Ford and were suing him. It was felt by Admiral Furlong that if we had full information about the predictor, it might afterwards be said that we handed some of this information to Paul & Isherwood to enable them to fight their case" (emphasis added).

Tizard diary, 10 September 1940, HTT 16/116, IWM

### **Erasing Pollen & Isherwood from US Computer History**

nnevar

I can name an inventor who made a differential analyzer long before I did, or rather who readily could have done so without question if he had put his mind on it. This was Hannibal Ford. He was about as ingenious an individual as I ever heard of. He made the devices, the computers, if you will, to aim the great guns of battleships, to take into account the flight of the shell, including the effect of the rotation of the earth upon its path, the air density at the time, the speed and direction of the enemy target, and so on. This he did principally by interconnecting integrators. And he made a new form

of integrator which could do the job

Did he invent the differential analyzer? One can say merely that he not only could have, but that he could have been the leader in the whole movement toward the modern computer, if he had wanted to. And the only reason he did not is probably that he did not move about in academic circles to see the need and the opportunity. I hail his memory.

### **Takeaway Points**

- Pollen and Isherwood in computing history
- The secret sauce of "Yankee ingenuity"
- The not-so-special relationship
- Government secrecy, IP, and defense contracting

#### How to Buy the Book

From Amazon (Hardcover—\$35) (Kindle—\$33.25)





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## Thank you!

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### Some Recommended (Not Required!) Further Reading

- Stathis Arapostathis and Graeme Gooday, Patently Contestable: Electrical Technologies and Inventor Identities on Trial in Britain (MIT, 2013)
- Christopher Beauchamp, *Invented by Law: Alexander Graham Bell and the Patent that Changed America* (Harvard, 2015)
- Oren Bracha, Owning Ideas: The Intellectual Origins of American Intellectual Property, 1790-1909 (Cambridge, 2016)
- Paul Ceruzzi, Computing: A Concise History (MIT, 2012)
- Gerardo Con Diaz, Software Rights: How Patent Law Transformed Software Development in America (Yale, 2019)
- Matthew L. Jones, *Reckoning with Matter: Calculating Machines, Innovation, and Thinking about Thinking from Pascal to Babbage* (Chicago, 2016)
- John Krige and Mario Daniels, *Knowledge Regulation and National Security in Postwar America* (Chicago, 2022)
- Donald Mackenzie, Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance (MIT, 1990)
- David Mindell, Between Human and Machine: Feedback, Control, and Computing before Cybernetics (Johns Hopkins, 2002)
- Jon Sumida, In Defence of Naval Supremacy: Finance, Technology, and British Naval Policy, 1889-1914 (Unwin Hyman, 1989)
- Alex Wellerstein, *Restricted Data: The History of Nuclear Secrecy in the United States* (Chicago 2021)