

# ARPA

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Fuchs, E. 2010. Rethinking the Role of the State in Technology Development: DARPA and Embedded Network Governance. *Research Policy*. Vol. 39: Issue 9. pp 1133-1147.

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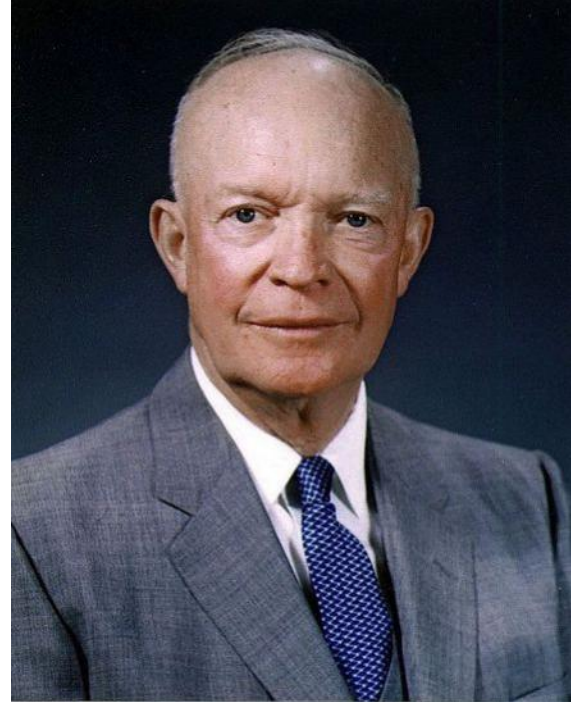
# Howard Hughes / DARPA

“push the boundaries of knowledge”



**Hughes (1905-1976)**  
**HHMI: Founded 1953**

“prevent technological surprise”



**Eisenhower (1890-1969)**  
**DARPA: Founded 1958**

## IDEA GENERATION

Investigator Initiation

Mission-Orientation

PROJECT EXECUTION

Investigator  
Freedom

Empowered  
Program Staff

**HHMI**

**Gates Foundation**

**Venture Capital**

**ARPA**

# So... What is the (D)ARPA model?

Founded 1958

Sputnik, overcome inter-service rivalry

100 people, \$3B: prevent technological surprises

# The Changing Faces of DARPA

	1960s	1970s	1980s
Name	ARPA	'72: DARPA	
Era	Fundament. Research	Military Missions	Industrial Competitiveness
Influential President	Eisenhower, Kennedy	Nixon	Reagan
Legislative / Political Environ.	Sputnik '57, Cold War	Vietnam War, Mansfield Act '69	Japan Competit. National Cooper. Research Act '84
DARPA Director	Betts, Ruina	Heilmeier	Cooper
DARPA Environ.	Scientific merit over military; independence, intell. quality; best people	Mid-term exams, Success measures	Strategic Comp. '83, Sematech '87 Pyramid of tech., Connect academ. industry

# The Changing Faces of DARPA

	1980s	1990s	2000s
Name	DARPA	'93-96 ARPA	DARPA
Era	Industrial Competitiveness	Competitiveness, Internationaliz.	Industry to Military
Influential President	Reagan	Clinton	Bush
Legislative / Political Environ.	Japan Competit. National Cooper. Research Act '84	Sematech weans off public asst., internationaliz.	Sept. 11, 2001 Iraq War '03 RAGS '05
DARPA Director	Cooper	Fernandez	Tether
DARPA Environ.	Strategic Comp. '83, Sematech '87 Pyramid of tech., Connect academ. industry	Priorities: people, competition, outreach, experimentation	Bridging the Gap, milestones, phases, accountability

# The Program Manager

“It really comes down to the program manager. A program manager that has a passion for an idea, that understands the technical elements of an idea, and has some vision for where it might go.”

- Existing research network: Government, industry, academia
- 3-5 year tenure
- Can be a step-ladder in one's career

“...the role of DARPA PM [is] like that of a conductor of an orchestra. The conductor does not play any instrument, but he must understand every instrument and the music. He brings all the harmony together.”

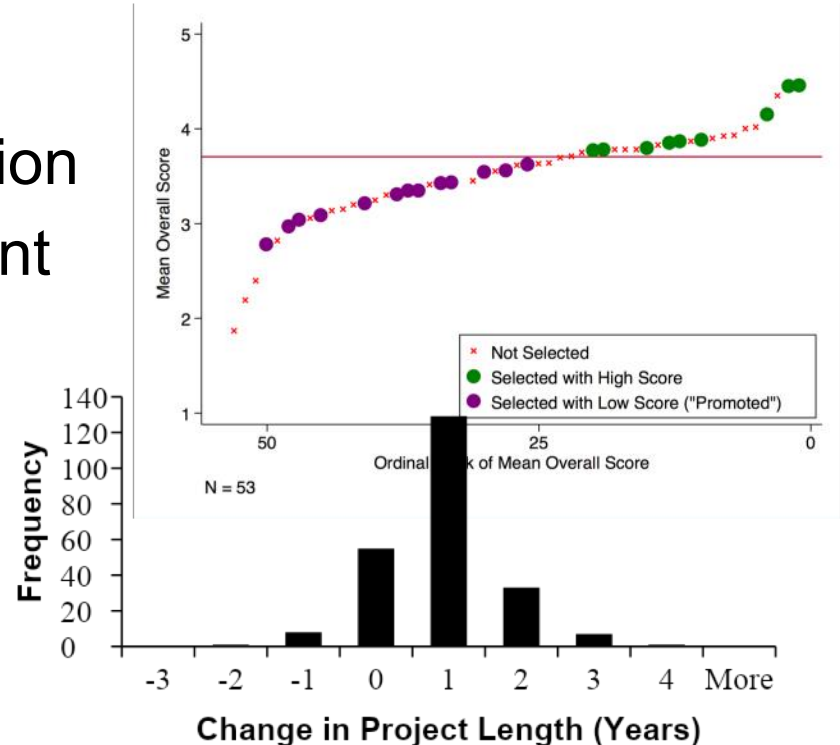
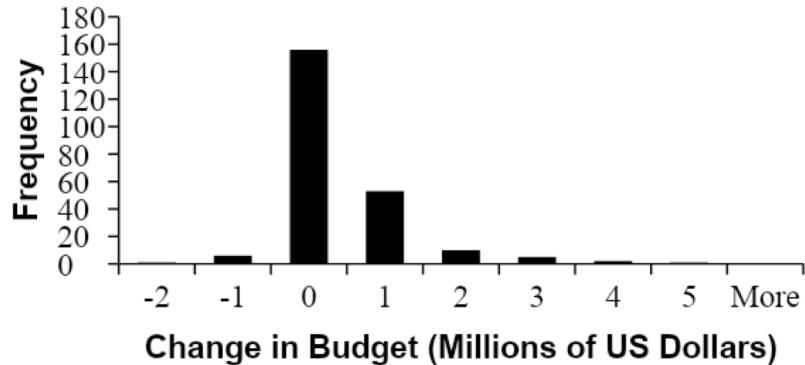
# Bottom-Up Program Design

- Identifying Directions
  - Formal: DARPA-DSRC, DSB task forces, ISAT
  - Informal brainstorming sessions
  - In the field...
- Seeding Common Themes
  - Across star scientists, industry-academic teams
- Building Community
  - Workshops, forced to present to each other
- Providing Early Validation
  - other funding agencies, industry, established vendors
- Not Sustaining the Technology



# ARPA Model: Four Components

- Bottom-up Program Design
- Organizational Flexibility
- Discretion in Project Selection
- Active program management



# Challenges

- Autonomy vs. accountability
- Trust
- Culture w/ high turnover
- Transition to market when not a public customer
- Scale of funding (technology interdependencies)

# Measuring long-term transformation

- Large-scale causal evaluation elusive
- Traditional innovation metrics ill-suited to lofty ARPA goals
  - “prevent technological surprise”
  - “transform... seeming impossibilities into practical capabilities”
- For long-term high-risk investments, many failures can justify a single success
- Impossible to measure one-in-a-thousand ideas, much less one-in-a-million ideas, on timescale relevant to political decision-making around program authorization

# Questions?

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# Back-up Slides

# DARPA: The Myth, The Legend

- Founded 1958 (ARPA)
  - Sputnik, overcome inter-service rivalry
  - 100 people, \$3B: prevent technological surprises
- Since its inception
  - Hailed: Laser, PC, Microsoft windows, Internet
  - Copied:
    - 1998: ARDA/DTO (Intelligence Community)
    - 2002: HSARPA (Homeland Security)
    - 2006: IARPA (Intelligence)
    - 2007: ARPA-E (Department of Energy)
  - Books in popular press (Belfiore 2010, Jacobsen 2015, Weinberger 2017)

# Identifying directions, seeding common themes

“So I’ll tell you the SiGe story.... So, the first guy *to show me* this, actually two guys, ...was the guy who founded Amberwave. He showed me this is possible. And then Jason Woo and UCLA, ... he *showed me* a plot of bandgap as a function of percent Ge. And he had two plots. He came to DARPA. And he said, look, there is a dependency, here it is, it follows band gap theory. ... And I said, ‘Jason, two dots don’t make a program.... I need a third dot.’ And he faxed me a chart the next day. ...So I sent him a small seedling.

At the same time, *I called* Bernie (a fellow at IBM), and I said, ‘Bernie, have you even seen this bandgap dependency in SiGe? You know, do you think it’s something we can exploit?’ He said, ‘Funny you should ask.’ We’ve been looking at the same thing, and we’ve got some ideas as well.’ So I funded him \$2M or whatever it was.”

# Platform coordination: A critical role?

“So, [we were talking to the] DARPA program manager, and they got interested in the field, and they got a program out of this. They got a bunch of people involved in the program.”

(Start-up Company)

“I don’t want people to go out and do something in the basement and say, ‘Ah, I developed the best results in the world in a process that is totally incompatible with what the rest of the industry does... There was one... condition imposed on [the teams], and that was that these things had to be developed in a Si-CMOS... compatible process.”

(DARPA Program Manager)

“DARPA funding is enabling system players to determine the direction of this technology. If you don’t get the system guys involved, you end up getting widgets that don’t work in the bigger picture.”

(Established Vendor)



# Rethinking the Role of the State in Technology Development

- The Program Manager: Embedded Network Agent
  - Not “picking winners”
  - Not the one’s with the ideas, but rather the central node to which ideas flow
  - And yet, need “vision”
  - In constant contact with the research community
    - Understanding emerging themes
    - Matching themes to military needs
    - Betting on the right people
    - Connecting disconnected communities
    - Standing up competing technologies against each other
    - Maintaining critical birds-eye, systems perspective

# ARPA Model: Bottom-up Program Design

