Comparing Military & Commercial Innovation

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DAU Hot Topic Forum
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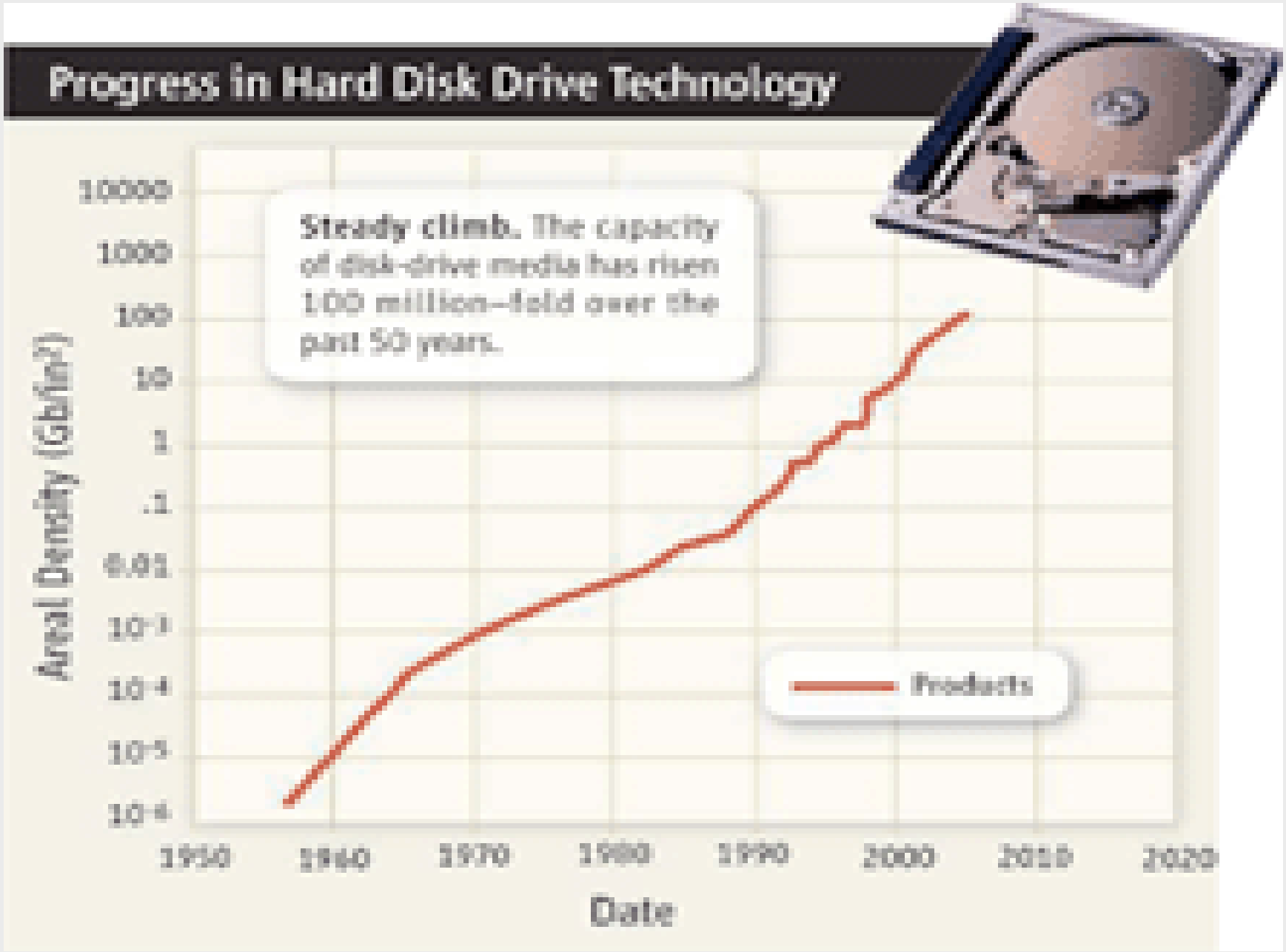
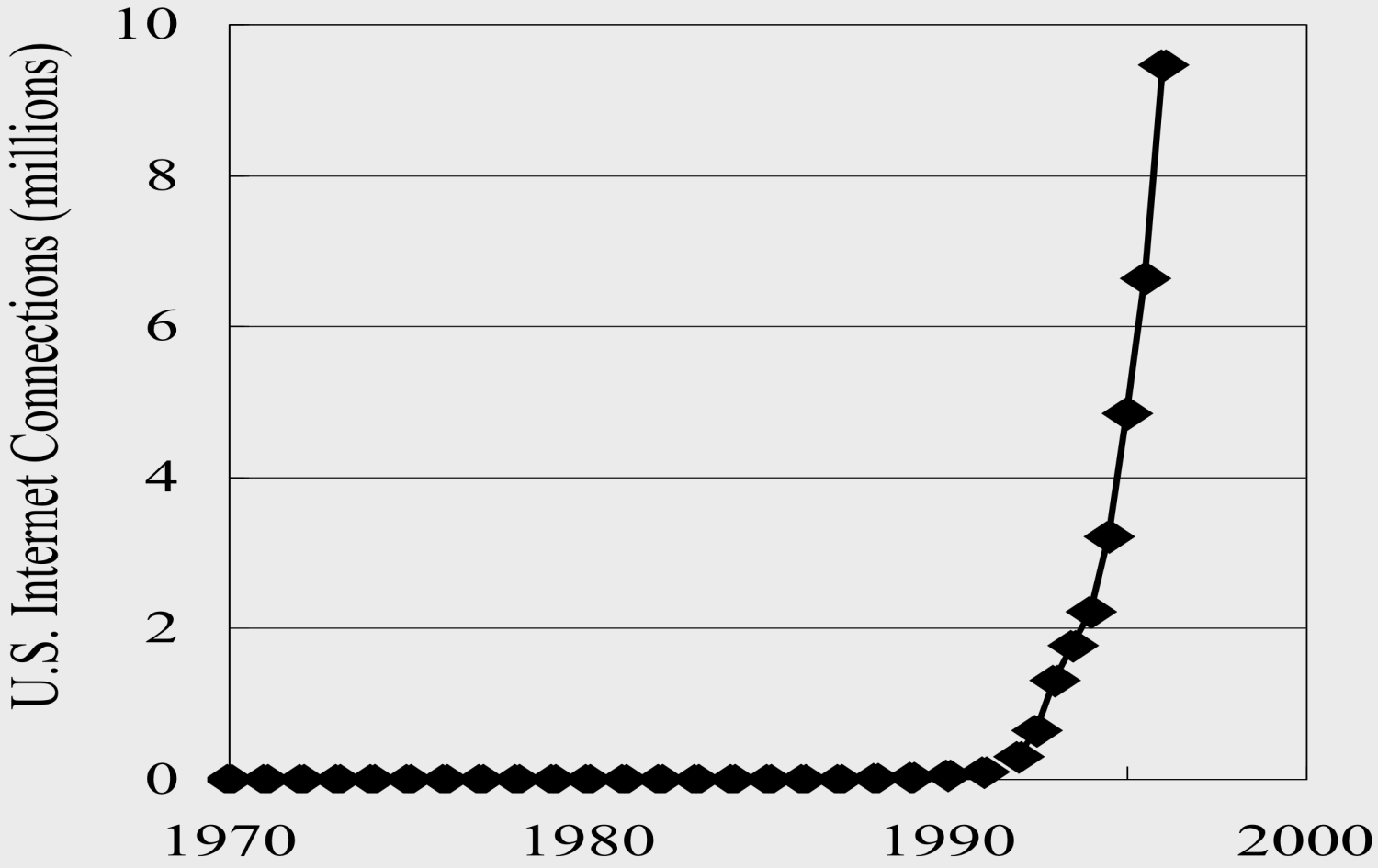
[R]evolutions ... occur in discrete rushes which are separated from each other by spans of comparative quiet. The process as a whole works incessantly however, in the sense that there always is either revolution or absorption of the results of revolution ....

Joseph A. Schumpeter, 1942

Hewlett Packard garage, Palo Alto, 1939



Science, 12/22/06



Early Growth of the Internet

Commercial Innovation

- Still a place for heroic inventors, entrepreneurs (Edison, Jobs, H-P)
- And still a place for organized laboratory research (AT&T - transistor, IBM - disk drives)
- But Intel has never had a research laboratory & innovations also emerge from networks of firms, university groups, gov't (Arpanet → Internet)
- Systemic innovations, finally, increasingly complement & sometimes overshadow discrete product (& process) innovations (chips + software + optical fiber → Internet)

Trends: Commercial Innovation

- Small firms, networks, collaboration (biotech)
- Manufacturing (organized R&D) → services (informal, fluid)
- Shorter product cycles (autos, financial instruments)
- Continuous incremental innovation driven by market feedback

Underlying Causes

- Technological change itself (disk drives, declining real costs of computing)
- Organizational change (internal & external to the firm)
- Competition (deregulation, globalization) → stringent "selection environment"

Lockheed Skunk Works, ca. 1943

Messerschmitt Me-262

- First flight mid-1942
- Some 300 operational before end of WW II

Lockheed F-80s

- First flight early 1944
- First combat, Korea (1950)

Military Innovation before 1950

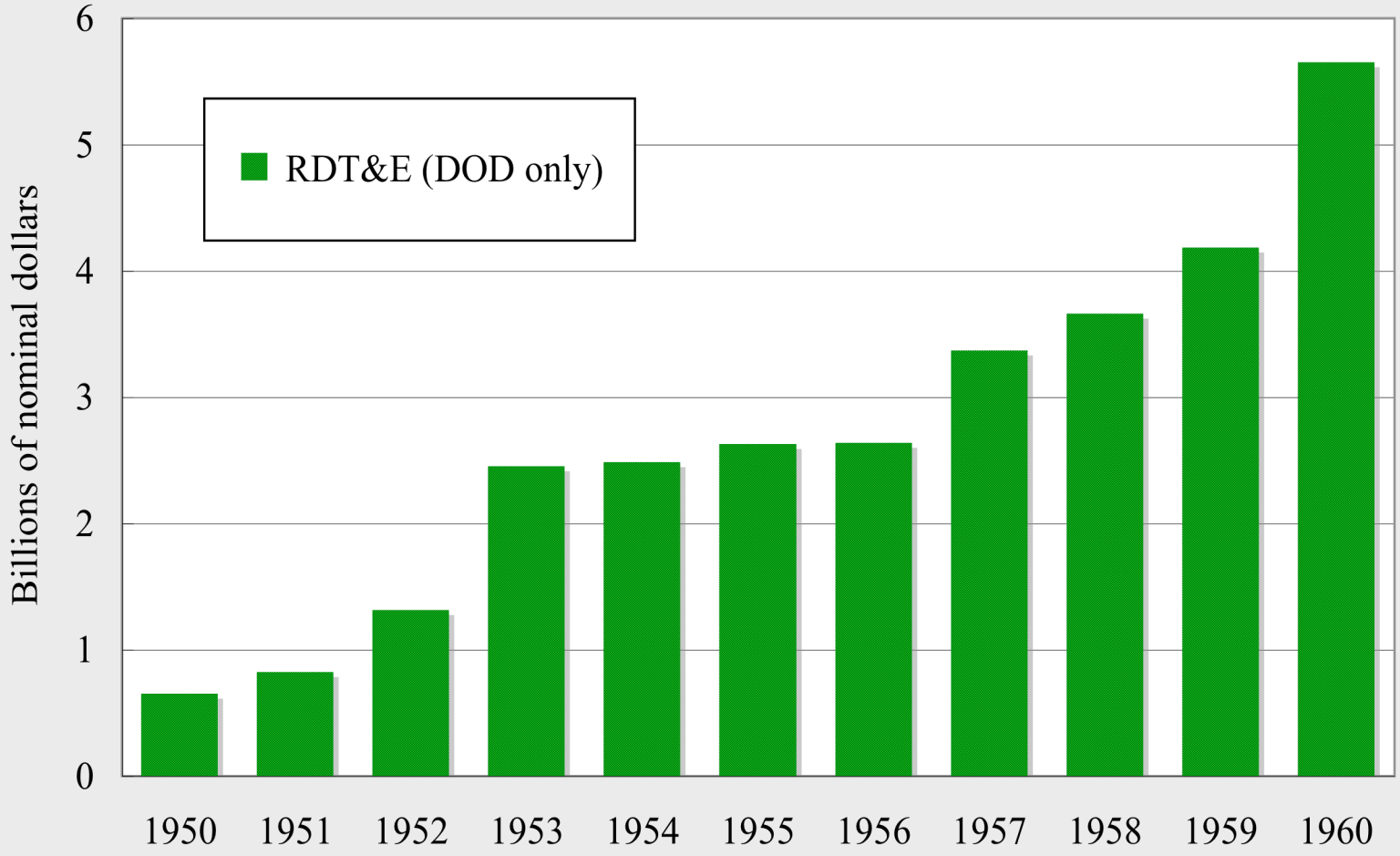
- Not a priority until WW II
- During the war, radar (& proximity fuze), atomic bomb, electronic computer
- But U.S. lagged in jet propulsion, aerodynamics

> Swept-back wings, delta wings, wings with variable sweep-back, leading-edge flaps — all came from Germany during the war.
>
> Miller & Sawers,
>
> *The Technical Development of Modern Aviation*, 1968

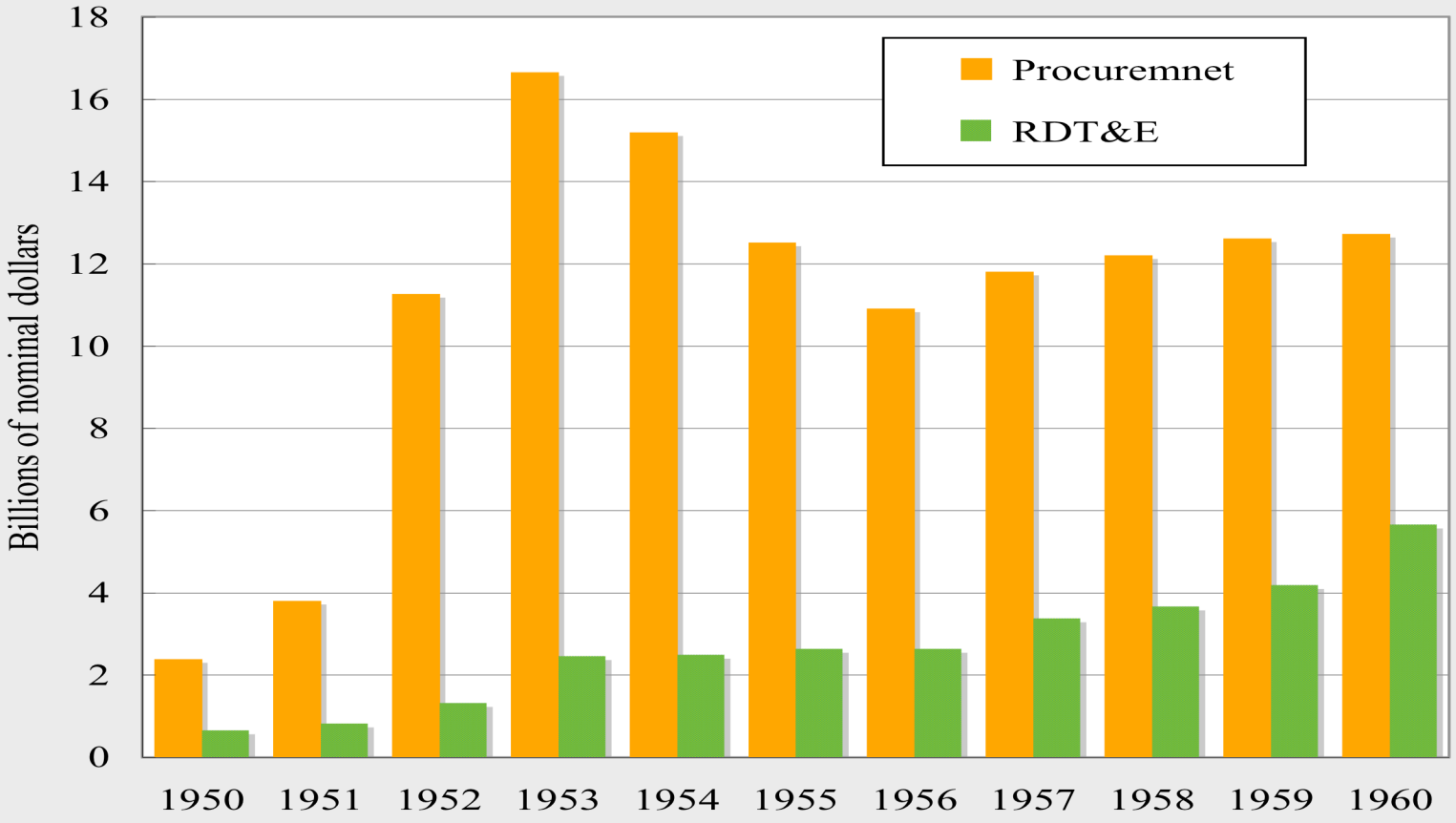
Korea

- U.S. unprepared
- Near-disaster in late 1950
- NSC 68 approved
- Nuclear deterrence insufficient to "contain" the Soviet Union

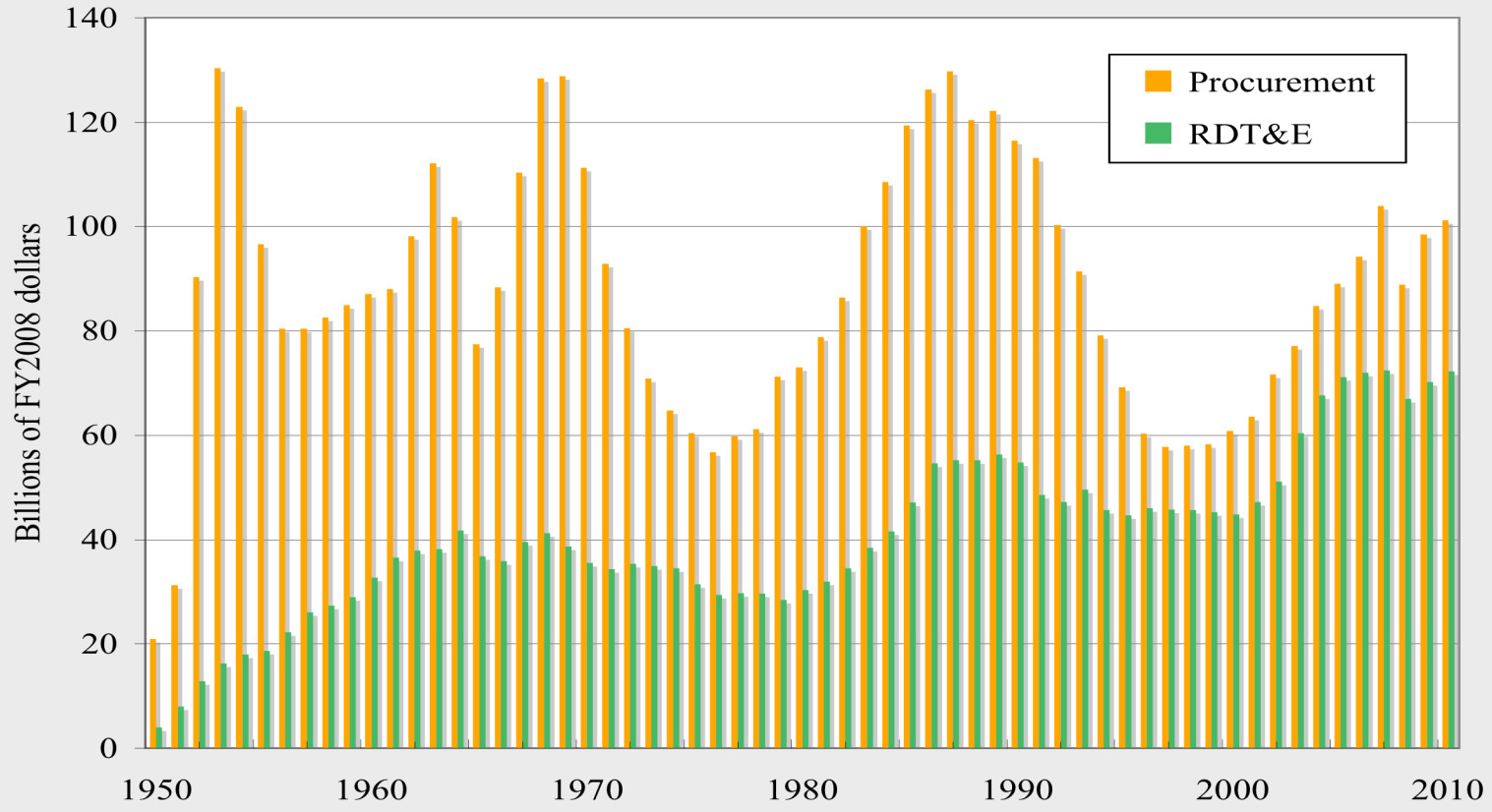
> World War II tanks retained as monuments on pedestals at Fort Knox had to be refurbished and issued for combat.
>
> Philip L. Bolté, in *Camp Colt to Desert Storm, 1999*



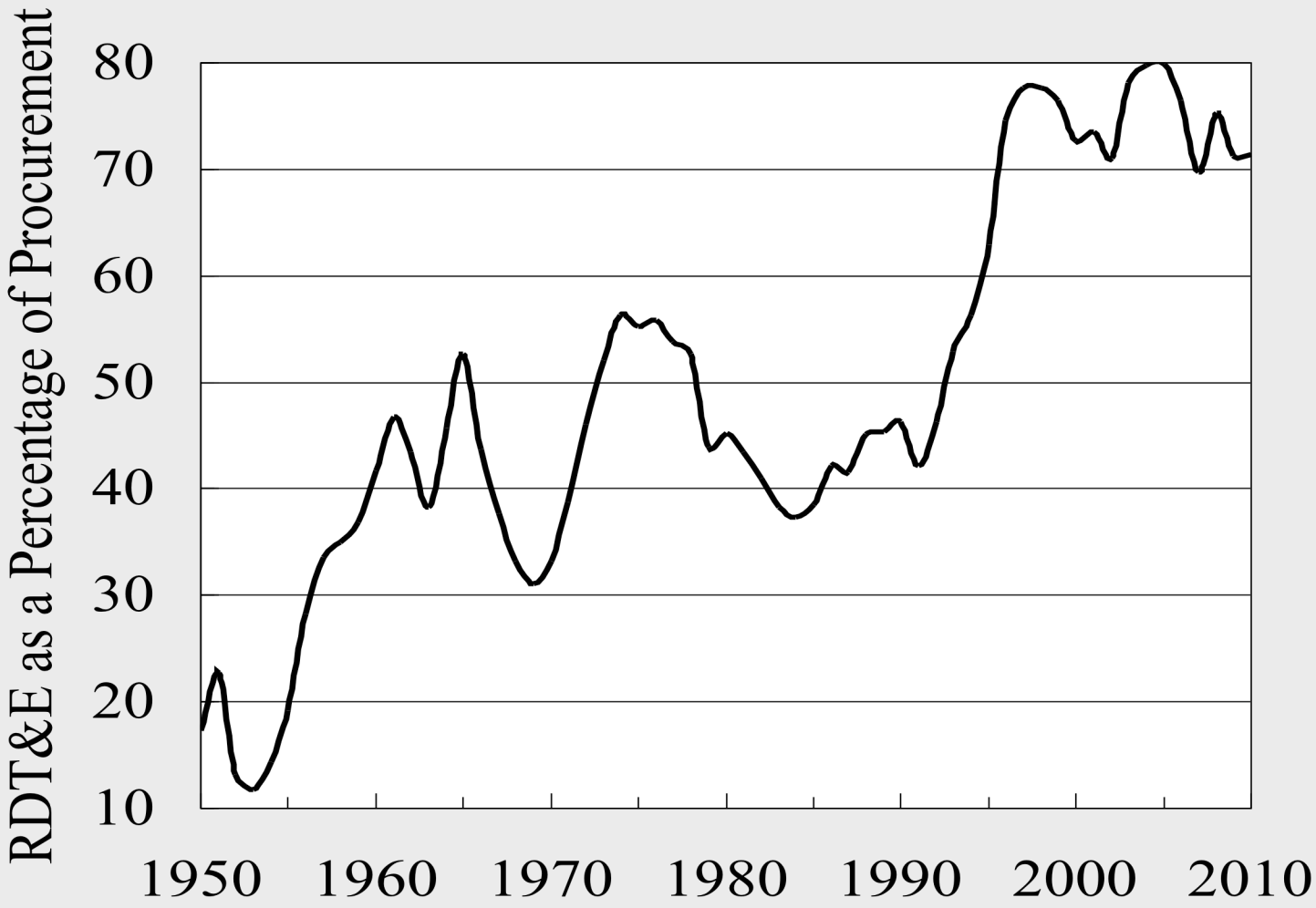
1950s - RDT&E outlays up more than 7 times
in nominal terms, 5 1/2 times adjusted for inflation



Procurement fell after 1953 armistice
while RDT&E continued to rise



Long term tendency: Increasing real RDT&E outlays, fluctuating procurement

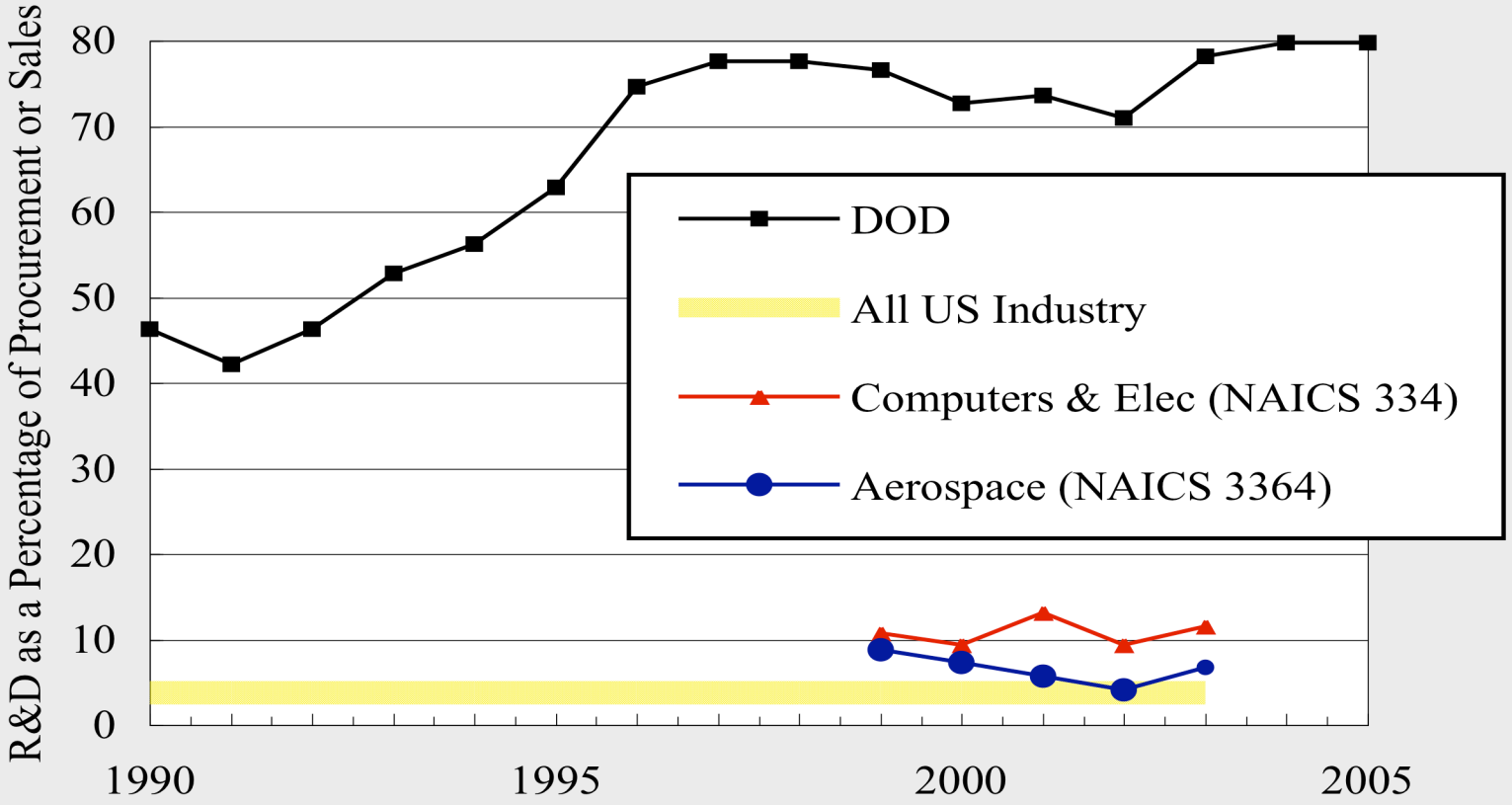


Increase in ratio of RDT&E to procurement one indicator of rising technological complexity

Lockheed Martin F-22s

	F-80	*F-22*
Production	1700	183
Unit cost (1947$)	$ 110,000	-
(2007$)	$ 1 million	$350+ million

R&D as a Percentage of Procurement (DOD) or Sales (Commercial)



Although *not* strictly comparable,
military innovation differs fundamentally

Military Innovation

- Military requirements establish directions for RDT&E and engineering
- Technical contributions (from firms, laboratories, university groups) bureaucratically managed
- Complex systems hierarchically designed (rather than emergent)
- Sparse, sporadic feedback from warfighting experience
- Intra- & inter-service competition, but little meaningful economic competition

Trends: Military Innovation

- Growing concentration among primes & subcontractors
- Increasing R&D intensity (software)
- Longer acquisition cycles
- High costs, limited feedback act as constraints on incremental innovation

Underlying Causes

- Economic growth favors other sectors
- Military policy dictates "heroic" technological ventures
- Absence of economic competition + perverse political/bureaucratic incentives → weak "selection pressures"

Commercial		*Defense*
Abundant	*Feedback from field*	Sparse, sporadic, possibly distorted
Incremental	*R&D*	Technology push
Fluid, flexible (market judgment)	*Design decisions*	Constrained (military judgment, bureaucratic politics)
Stringent (firm reputation)	*Developmental testing*	Political hurdle

To transform military operations, DOD has embarked on developing multiple megasystems ....

In the past 5 years, DOD has doubled its planned investments in new weapon systems from $700 billion to $1.4 trillion.

GAO, *Assessments of Selected Major Weapons Programs,* 2006