



**“Nothing’s too good  
for our boys!”**

**Why Can’t DOD give us Quality and Quantity?**

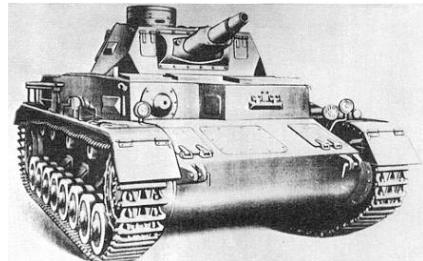
**Pierre M. Sprey**

Sponsored by the Straus Military Reform Project of the Center for Defense Information

# Outline

- History's choices: cheap winners versus expensive losers
- Today's choices (two examples):
  - A-10 vs. F-15E
  - M48A5 vs. M1A2
- Future design: more cost = more effectiveness??
- Insights

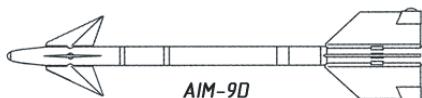
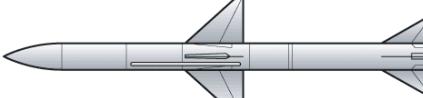
# Quality vs. Quantity in History (I)

Cheap Winners	Expensive Losers	Why?
 AR-15  \$75	 M-14  \$295	<b>AR-15</b> <ul style="list-style-type: none"><li>• Triple the rounds per soldier</li><li>• Double the rate of hits</li><li>• Greater stopping power</li><li>• Demonstrated better accuracy/reliability in Vietnam</li></ul>
 Soviet T-34 Tank	 German Panzer IV	<b>T-34</b> <ul style="list-style-type: none"><li>• Cheap and reliable (57,000 v. 9,000)</li><li>• Unstoppable by mud or ice: wider tracks, softer suspension</li><li>• More survivable: less flammable (diesel fuel), lower profile, better armor slopes</li></ul>

# Quality vs. Quantity in History (2)

Cheap Winners	Expensive Losers	Why?
 105mm Towed Cannon \$170k	 175mm self-propelled cannon \$560k	<b>175mm</b> <ul style="list-style-type: none"><li>Constant breakdowns and tube replacements in Vietnam</li></ul> <b>105mm</b> <ul style="list-style-type: none"><li>Unbreakable, air transportable workhorse</li></ul>
 WWII Japanese Destroyer	 WWII U.S. Cruiser	<b>Destroyer</b> <ul style="list-style-type: none"><li>Had highly reliable, lethal, large torpedo</li></ul> <b>Cruiser</b> <ul style="list-style-type: none"><li>No torpedo</li><li>Slower, bigger target</li></ul>

# Quality vs. Quantity in History (3)

Cheap Winners	Expensive Losers	Why?
 AIM-9D Sidewinder IR <b>\$14k</b>	 AIM-7D/E Sparrow Radar <b>\$44k</b>	<b>AIM-7D/E (Radar)</b> <ul style="list-style-type: none"><li>• Unreliable, unmaneuverable, 20 seconds to lock on</li><li>• Combat <math>P_K = 8</math> percent</li></ul> <b>AIM-9D (Heat-seeking)</b> <ul style="list-style-type: none"><li>• Combat <math>P_K = 24</math> percent</li><li>• 5 times faster to lock on</li></ul>
 P-51 Mustang <b>\$51k</b>	 P-38 Lightning <b>\$125k</b>	<b>P-38</b> <ul style="list-style-type: none"><li>• Big, visible, and unmaneuverable</li><li>• Twin-engine vulnerability</li><li>• Failed in WWII European combat—withdrawn</li></ul> <b>P-51</b> <ul style="list-style-type: none"><li>• Best fighter in World War II</li></ul>

# Tank Effectiveness



M1A2



M48A5

# Tank Effectiveness (I)

Critical measures	Winner	Why?
<b>Operational mobility</b>	<b>M48</b>	<b>MI much slower</b> <ul style="list-style-type: none"><li>• Needs 1 hour's refueling every 3 hours (uses 3+ times as much fuel) and another hour of filter cleaning every 2 hours</li></ul>
<b>Numbers engaged</b>	<b>M48</b>	<b>MI more expensive, less reliable</b> <ul style="list-style-type: none"><li>• Can field <b>6</b> times as many M48s; they cost 1/3 as much and are twice as available, i.e., 85% v 45%</li></ul>

# Tank Effectiveness (2)

Critical measures	Winner	Why?
<b>Machine gun effectiveness</b>	<b>M48</b>	<b>M1</b> <ul style="list-style-type: none"><li>• Machine guns can't depress to sweep roadside ditches</li></ul> <b>M48</b> <ul style="list-style-type: none"><li>• Carries 200% more MG rounds</li><li>• Can sweep ditches with machine guns</li></ul>
<b>Firefight mobility</b>	?	<b>M1</b> <ul style="list-style-type: none"><li>• Throws tracks in maneuvering</li><li>• Has small edge in short dash acceleration</li></ul>

# Tank Effectiveness (3)

Critical measures	Winner	Why?
<b>Rate of kill</b> v. <b>(multiple targets at real combat ranges)</b>	<b>M48</b>	<ul style="list-style-type: none"><li>• Loading slightly faster in M48</li><li>• Battlesight accuracy same</li><li>• 54 rounds for M48 versus 40 for M1 (120mm)</li><li>• High rate of failure with 120mm caseless ammo</li></ul>
<b>Crew Survival</b>	<b>M48</b>	<ul style="list-style-type: none"><li>• Not one live firing test against a combat-loaded M1</li><li>• M1 better against infantry hand-held anti-tank round from front but worse from rear</li><li>• Both penetrable by modern tank cannon rounds</li><li>• Exhaust visible to IR at 3 miles</li><li>• M1 much more flammable</li></ul>

# Close support effectiveness



F-15E



A-10

# Close support effectiveness (I)

Critical measures	Winner	Why?
<b>Finding hidden weapons or armor emplacements (visible at 1/4 mile or less)</b>	<b>A-10</b>	<ul style="list-style-type: none"><li><b>A-10 can search at 225 MPH with 1,500 ft. turn radius.</b></li><li><b>F-15 searches at 400 MPH with 1 to 1.5 mile turn radius due to lack of low speed maneuverability</b></li></ul>
<b>Weapons lethality against camouflaged emplacements</b>	<b>A-10</b>	<ul style="list-style-type: none"><li><b>A-10 has highly lethal 30mm cannon;</b></li><li><b>F-15 has only 4 laser-guided, GPS, or IR missiles with almost zero ability to lock-on to camouflaged targets</b></li></ul>

# Close support effectiveness (2)

Critical measures	Winner	Why?
<b>Total force on-station per \$</b>	<b>A-10</b>	<ul style="list-style-type: none"><li>• F-15 costs 5 times the A-10</li><li>• F-15 has 1/5 the loiter time</li><li>• F-15 has 1/2 the sorties per day</li><li>• A-10 delivers <b>50 times the hours on-station per \$!</b></li></ul>
<b>Surviving front-line air defenses</b>	<b>A-10</b>	<ul style="list-style-type: none"><li>• A-10 essentially invulnerable to 0.50 cal and even 20mm</li><li>• F-15 easily shot down by 0.22 cal</li></ul>

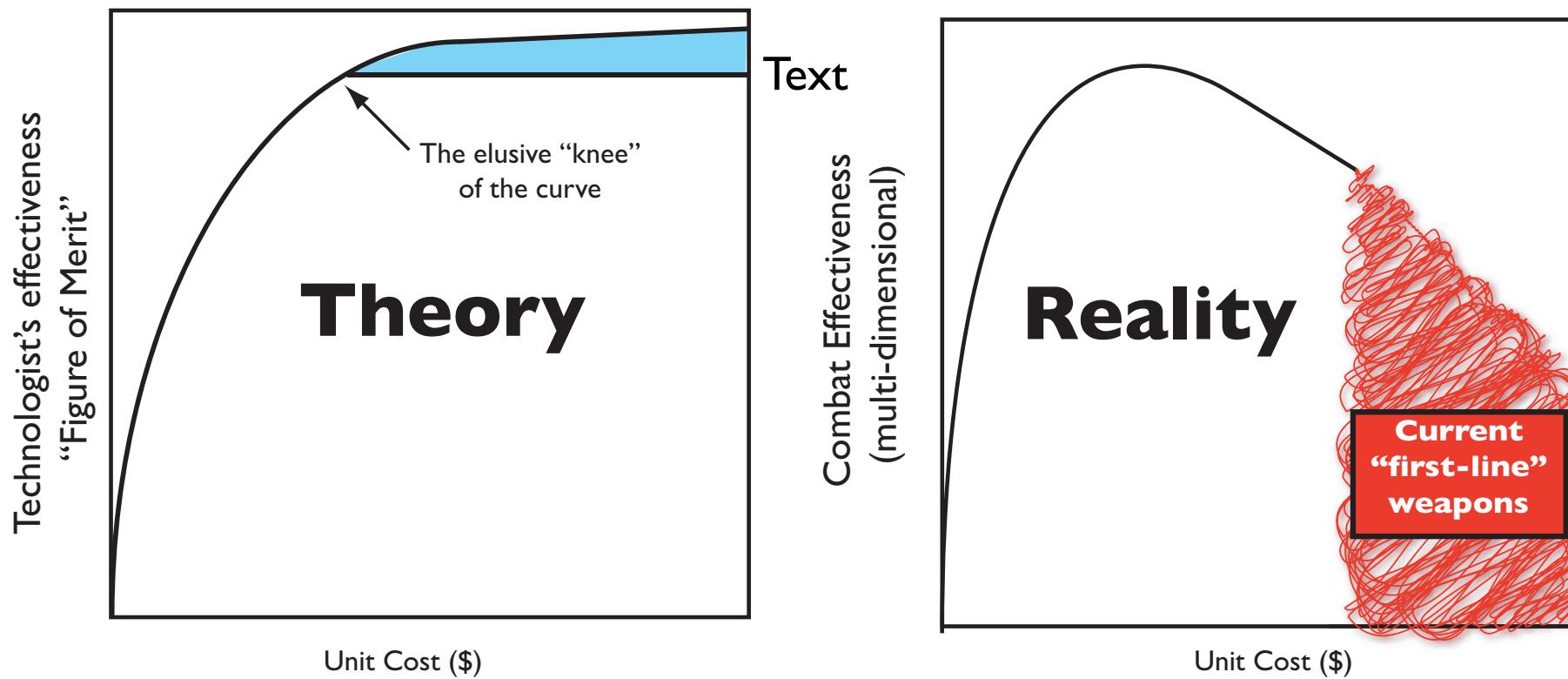
# Close support effectiveness (3)

Critical measures	Winner	Why?
<b>Basing mobility</b> Ease of shifting assets in under-developed areas	<b>A-10</b>	<ul style="list-style-type: none"><li>• A-10 can fly from 4,000 foot dirt or steel mats</li><li>• F-15 needs 12,000 feet of concrete</li></ul>

# Future Design

## More cost = more effectiveness?

### Quantity versus quality founders on negative marginal returns



# Some budget insights

- There is no quantity-quality issue
- The real issue is what works in combat and what does not
- High cost and complexity usually doesn't work

# Some budget insights (2)

- Not all simple, low cost weapons work
- However, war-winning weapons are almost always simple
- **The current procurement system inexorably drives us to expensive high complexity weapons that certainly enhance industry gross sales but often endanger our boys in combat**

# Some technical insights

- **You cannot design for superior effectiveness if you cannot define it**
- To understand effectiveness, study combat data, not technological promises
- Combat effectiveness is always irreducibly multidimensional, never a single number

# Some technical insights (2)

- **Two essential dimensions are always “rate” of kill (not  $P_k$ ) and numbers in combat**
- **combat models, particularly computer simulations, are useless for design tradeoffs—or any other practical purpose**