“Nothing’s too good for our boys!”

Why Can’t DOD give us Quality and Quantity?

Pierre M. Sprey

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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

<table>
<thead>
<tr>
<th>Cheap Winners</th>
<th>Expensive Losers</th>
<th>Why?</th>
</tr>
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<tbody>
<tr>
<td>AR-15</td>
<td>M-14</td>
<td>AR-15</td>
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</table>
| ![AR-15](image1) | ![M-14](image2) | - Triple the rounds per soldier  
- Double the rate of hits  
- Greater stopping power  
- Demonstrated better accuracy/reliability in Vietnam  |
| $75 | $295 | T-34  |
| ![Soviet T-34 Tank](image3) | ![German Panzer IV](image4) | - Cheap and reliable (57,000 v. 9,000)  
- Unstoppable by mud or ice: wider tracks, softer suspension  
- More survivable: less flammable (diesel fuel), lower profile, better armor slopes |
# Quality vs. Quantity in History (2)

<table>
<thead>
<tr>
<th>Cheap Winners</th>
<th>Expensive Losers</th>
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| ![105mm Towed Cannon](image1.png) **$170k** | ![175mm self-propelled cannon](image2.png) **$560k** | **175mm**
| **WWII Japanese Destroyer** | **WWII U.S. Cruiser** | • Constant breakdowns and tube replacements in Vietnam

<table>
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<tr>
<th><strong>105mm Towed Cannon</strong></th>
<th><strong>175mm self-propelled cannon</strong></th>
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**105mm Towed Cannon**
- **Why?**: Unbreakable, air transportable workhorse

**175mm Self-Propelled Cannon**
- **Why?**:
  - Had highly reliable, lethal, large torpedo

**Destroyer**
- **Why?**:
  - Had highly reliable, lethal, large torpedo
  - **Cruiser**
  - No torpedo
  - Slower, bigger target
### Quality vs. Quantity in History

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<tr>
<td><img src="image" alt="AIM-9D Sidewinder IR" /> $14k</td>
<td><img src="image" alt="AIM-7D/E Sparrow Radar" /> $44k</td>
<td><strong>AIM-7D/E (Radar)</strong>&lt;br&gt;• Unreliable, unmaneuverable, 20 seconds to lock on&lt;br&gt;• Combat $P_K = 8$ percent&lt;br&gt;<strong>AIM-9D (Heat-seeking)</strong>&lt;br&gt;• Combat $P_K = 24$ percent&lt;br&gt;• 5 times faster to lock on</td>
</tr>
<tr>
<td><img src="image" alt="P-51 Mustang" /> $51k</td>
<td><img src="image" alt="P-38 Lightning" /> $125k</td>
<td><strong>P-38</strong>&lt;br&gt;• Big, visible, and unmaneuverable&lt;br&gt;• Twin-engine vulnerability&lt;br&gt;• Failed in WWII European combat—withdrawn&lt;br&gt;<strong>P-51</strong>&lt;br&gt;• Best fighter in World War II</td>
</tr>
</tbody>
</table>
Tank Effectiveness

M1A2

M48A5
## Tank Effectiveness

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<th>Critical measures</th>
<th>Winner</th>
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| Operational mobility       | M48    | **M1 much slower**  
|                            |        | • Needs 1 hour's refueling every 3 hours (uses 3+ times as much fuel) and another hour of filter cleaning every 2 hours |
| Numbers engaged            | M48    | **M1 more expensive, less reliable**  
|                            |        | • Can field 6 times as many M48s; they cost 1/3 as much and are twice as available, i.e., 85% v 45% |
# Tank Effectiveness (2)

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| Machine gun effectiveness | M48 | **M1**  
  • Machine guns can’t depress to sweep roadside ditches  
  **M48**  
  • Carries 200% more MG rounds  
  • Can sweep ditches with machine guns |
| Firefight mobility | ? | **M1**  
  • Throws tracks in maneuvering  
  • Has small edge in short dash acceleration |
# Tank Effectiveness (3)

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<tr>
<td>Rate of kill v. (multiple targets at real combat ranges)</td>
<td>M48</td>
<td>• Loading slightly faster in M48&lt;br&gt;• Battlesight accuracy same&lt;br&gt;• 54 rounds for M48 versus 40 for M1 (120mm)&lt;br&gt;• High rate of failure with 120mm caseless ammo</td>
</tr>
<tr>
<td>Crew Survival</td>
<td>M48</td>
<td>• Not one live firing test against a combat-loaded M1&lt;br&gt;• M1 better against infantry hand-held anti-tank round from front but worse from rear&lt;br&gt;• Both penetrable by modern tank cannon rounds&lt;br&gt;• Exhaust visible to IR at 3 miles&lt;br&gt;• M1 much more flammable</td>
</tr>
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Close support effectiveness

F-15E

A-10
# Close support effectiveness (1)

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| Finding hidden weapons or armor emplacements (visible at 1/4 mile or less) | **A-10** | • A-10 can search at 225 MPH with 1,500 ft. turn radius.  
• F-15 searches at 400 MPH with 1 to 1.5 mile turn radius due to lack of low speed maneuverability |
| Weapons lethality against camouflaged emplacements     | **A-10** | • A-10 has highly lethal 30mm cannon;  
• F-15 has only 4 laser-guided, GPS, or IR missiles with almost zero ability to lock-on to camouflaged targets |
### Close support effectiveness (2)

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| **Total force on-station per $**  | A-10   | • F-15 costs 5 times the A-10  
• F-15 has 1/5 the loiter time  
• F-15 has 1/2 the sorties per day  
• A-10 delivers 50 times the hours on-station per $! |
| **Surviving front-line air defenses** | A-10   | • A-10 essentially invulnerable to 0.50 cal and even 20mm  
• F-15 easily shot down by 0.22 cal |
Close support effectiveness (3)

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| Basing mobility    | A-10   | • A-10 can fly from 4,000 foot dirt or steel mats  
                  |        | • F-15 needs 12,000 feet of concrete             |
| Ease of shifting assets in under-developed areas | | |
Future Design

More cost = more effectiveness?

Quantity versus quality founders on negative marginal returns

- The elusive “knee” of the curve
- The curve
- The curve
- The curve

Unit Cost ($) Unit Cost ($)

Theory

Combat Effectiveness (multi-dimensional)

Reality

Current “first-line” weapons
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