The Perils of Technological Transformation

A Case Study of the Japanese Attack on Pearl Harbor

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Pearl Harbor and the Perils of Technological Transformation

• What can go wrong:
  – Failure to view a new technology holistically
  – Failure to accept or adapt to successful technology
  – Reliance on faulty technological studies
    • The bizarre world of testing
  – Distrust of new technology
  – Social consequences of new technology
    • Authority, decisionmaking, changing power hierarchies

Shea's Law: “The ability to improve a design occurs primarily at the interfaces. This is also the prime location for screwing it up.”
A “Brilliant” Attack

• “brilliantly conceived and meticulously planned”

  • “The attack was almost textbook perfect.”
  • The plan was “bold and original.”
  • “The Japanese aerial attack was an unqualified success.”
  • “The attack plan was brilliant.”
  • “…like a flashing samurai word [the Japanese at Pearl Harbor] decapitated the U.S. Fleet.”

• Really?
Attack Potential

Priority Targets
- 8 Battleships
- 8 Cruisers

Weapons
- 40 Torpedoes
- 50 800-kg AP Bombs
- 81 250-kg GP Bombs

Expectations
- 27 Torpedo hits
- 5 - 8 AP bomb hits
- 49 GP bomb hits

AP = Armor Piercing
GP = General Purpose
Attack Potential

**Hits to Kill**

- Torpedo hits: 4 to sink BB  
  2 to sink CA/CL

- AP bomb hits: 43% per bomb hit v. BB

- GP bomb hits: 4 to sink cruiser

- 4 BB, 4 Cruisers inaccessible to torpedoes

- With perfect fire distribution, expected value of attack =  
  4 BB torpedoed, 2 BB sunk / crippled by bombs, 8 cruisers sunk

**14 of 16 targets destroyed or crippled**

**PLUS** 11 torpedo hits & 17 GP bomb hits “overkill”

(1/3rd more hits than needed: 3 BB + 4 cruisers, 21 targets total)

BB = Battleship  
CV = Carrier  
CA / CL = heavy or light cruiser  
AP = Armor Piercing  
GP = General Purpose
Meager Results

5 targets sunk

(Killing ordnance on only 3 targets)

1 (Nevada) sunk due to damage control error

1 (California) sunk after ship was abandoned due to burning oil

Attack achieved 20% of its potential
Prior to the Attack on Pearl Harbor:
Japanese Technological Advances

- **Mass employment of carriers**
  - Command and Control and Aircraft Radios

- **Aerial Torpedo Warheads**
  - Defeating BB underwater protection

- **Bombsights**
  - Precision attack dive bombers
  - High altitude level bombers

- **Armor Piercing (AP) bombs**
  - Penetration of armor - Testing
  - Fuzing and manufacturing

- **General Purpose (GP) Bombs**
  - Fuzing and Manufacturing

- **A6M Zero** – high performance fighter

**Much of the Japanese poor performance at Pearl Harbor came from poor assimilation of new technology**
SURPRISE:
Fighter lead to “seize control of the air”
Torpedo bombers descend, head for IP
Dive Bombers orbit, delay
17 November 1941

- Admiral Yamamoto on board Akagi:
  “Although we hope to achieve surprise, everyone should be prepared for terrific American resistance … in this operation we will meet the strongest and most resourceful opponent of all.”

- Japanese preparations and training were all based on surprise.
Meeting while at Sea

CDR Genda
First Air Fleet Air Officer
Lead Planner

CDR Fuchida
Commander of the first wave Planner

LCDR Murata
Leader of the torpedo bombers
Two plans

- **One flare: Surprise**
  - Torpedo bombers lead
  - Fighters offensive counter-air
  - Dive Bombers wait to hit Ford Island

- **Two flares: No Surprise**
  - Dive Bombers “distract” AA by attacking Ford Island
  - Torpedo bombers attack close behind

- **Murata Overruled**

- **Japanese application of bakuryo**
  - “officers behind the curtains”
Fuchida’s Tale

• “[Fuchida] fired a single Black Dragon [flare]. Murata saw it and swung low toward the target. But Lieutenant Masaharu Suginami, a fighter-group leader, kept his aircraft in cruise position. Thinking he had missed the first [flare], Fuchida fired another. Then he groaned – Takahashi, mistaking the second [flare] for the double signal … swooped in with his dive-bombers. Fuchida ground his teeth in range. Soon, however, he realized that the error made no practical difference.”
  
  Prange, Goldstein, Dillon. God’s Samurai: Lead Pilot at Pearl Harbor Page 34.

• “That blockhead Takahashi”
  – Killed at the Coral Sea
Decision to use FLARES to communicate
Dive Bombers depart first

Torpedo Bombers depart

Torpedo bombers loose formation, extended intervals, no fighters, some get lost
C2 Issues: Deconfliction

CV Group (16 Kate) briefed profiles
BB Group (24 Kate) briefed profiles

Radio to the Rescue?
Japanese Radio Innovation

- 1940 – Capability to install radios in aircraft
- Full fleet installation by late 1941
  - Installation problems

Captured A6M Zero.
Note position of pilot’s head
Comparison Cockpits

USN F4-F “Wildcat”

German FW-190 “Shrike”
Japanese Radio Innovation

- 1940 – Capability to install radios in aircraft
- Full fleet installation by late 1941
  - Installation problems

Captured A6M Zero.
Note position of pilot’s head
Time – Event Plot

Japanese Torpedo Attack

- **Soryu 8**
  - Nagai
  - Mori
  - Tadashi
  - Kimura
  - Nakajima
  - Fujiwara
  - Sato
  - Kawashima
  - Attack CV anchorage

- **Hiryu 8**
  - Matsumura
  - Oku
  - Yanigimoto
  - Urata
  - Takahashi
  - Kasajima
  - Kadono
  - Sugimoto
  - Attack CV anchorage

- **Akagi 12**
  - Murata
  - Murakami
  - Katsuki
  - Goto
  - Ikumoto
  - Yasue
  - Negish
  - Kaido
  - Hanai
  - Suzuki
  - Tateyama
  - Goto
  - Attack Battleship Row

- **Kaga 12**
  - Kitajima
  - Yoshikawa
  - known
  - Sato
  - Nakagawa
  - Kitahara
  - Suzuki
  - Tanaka
  - Kumamoto
  - lwata
  - Ohashi
  - Nagai
  - Attack Battleship Row

- **Formation Change**

- **Attack**
**Soryu 8**
- Nagai
- Mori
- Tadashi
- Kimura
- Nakajima
- Fujiwara
- Sato
- Kawashima

**Hiryu 8**
- Matsumura
- Oku
- Yanigimoto
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- Negishi
- Kaido
- Hanai
- Suzuki
- Tateyama
- Goto

**Kaga 12**
- Kitajima
- Yoshikawa
- unknown
- Sato
- Nakagawa
- Kitahara x
- Suzuki x
- Tanaka
- Kumamoto x
- Iwata
- Ohashi x
- Nagai x

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**As Executed**

*Underway claims reports from Rengo Kantai*
Japanese Torpedo Attacks
Technology to Sink a Battleship

Technology: Offense v. Defense

• Torpedo defense:
  • Outer hull
  • Four torpedo bulkheads
  • Alternate air- and liquid-filled voids
  • Inner holding bulkhead

• Are Japanese aerial torpedoes powerful enough?

Plate thicknesses in millimeters, 25.4mm = 1 inch

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<th>Thickness (mm)</th>
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Tosa Full-Scale Destructive Tests
Actual Torpedo Damage

What Went Wrong?
- No inner holding bulkheads were breached
- Subscale experimental errors
- Calculated “fudge factors” off
- Assumption regarding voids

Lessons for Historians: Tech Reports cannot always be trusted
Assumptions Drive Results
Technology Advance: Bomb Sights

Course Setting Bomb Sight
(CSBS1 - Japan)

Norden
(“Hit a pickle barrel from 30,000 feet”)

12/19/2016
Japanese v. US Bomb Sights

CSBS
Pearl Harbor
49 Bombs: 10-14 hits (4 on collateral targets)

Norden
Midway
291 Bombs 0 hits
Technology Advance: Armor Piercing Bomb

- 1940 - No AP bombs available
- Converted 41cm AP shells Nagato-class BB
- Exceeded max payload • Shaved off ~ 181 KG (400#)
- Tested by dropping against armor plates from 4,000 and 3,000 meters altitude
Technology Advance: Armor Piercing Bomb

- 10 confirmed hits
- 6 duds, malfunctions, or low-order detonations – Dreadful!
  - 2 Penetrated turret tops at seams
  - Several broke up on entry
Technology Advance: General Purpose Bombs + D3A “Val” Dive Bomber

- 250-kg General Purpose bomb, 0.2 second delay fuze (“carrier killer”)

- Facts:
  - Bomb & Hit counts
  - Witness reports

- Evaluation:
  - high dud / Malfunction rate

- Causality:
  - poor manufacturing and testing

- Suggests poor manufacturing and testing
Gap: Weapons-to-Target Matching
250-kg GP bomb crater, 0.2-sec fuze, Ford Island Dispensary
Poor Weapons-to-Target Match
550-pound GP bomb crater, 0.2-sec fuze, Wheeler Field

Bomb achieved 6-25% of superquick fuzed weapon
Technology Advance:
Dive Bomber Bombsights, Command and Control

- D3A “Val” dive bomber

Type 96 Sight

Sight Picture
Dive Bombing Tactics, Techniques, and Procedures

Following bombers adjust aimpoint based on leader’s fall of bomb

60-degree dive

Sight on top of mainmast

3,000 meters altitude initiate dive

30-45 second intervals

Japanese achieved 60-80% hits during training
Later, up to 90% under combat conditions
Poor Performance

- Japanese expected 49 hits
- Hit what was aimed at: 9 hits
  - 12%
  - Only one hit on cruiser
  - 6 “collateral damage” hits
    - DD Cassin and DD Downes: 3
    - DD Shaw: 3
- Not one hit of strategic importance

**QUESTIONS**
- Why so few hits?
- Why did the attack take so long?
Time Magazine Pearl Harbor Photograph
90% Cloud Cover at 3,500 to 5,000 feet
Cloud Cover

Photo # 80-G-19949  USS Maryland and capsized USS Oklahoma, 7 December 1941
Following bombers adjust aimpoint based on leader’s fall of bomb

60-degree dive

Sight on top of mainmast

Splash

Adjust

Sight Picture

10,000 meters altitude

30-45 second intervals
Dive Bombing Tactics, Techniques, and Procedures

Following bombers adjust aimpoint based on leader’s fall of bomb

- 60-degree dive
- Sight on top of mainmast

- 30-45 second intervals
- 10,000 meters altitude

Splash
Adjust
Sight Picture

This technique doesn’t work with a 1,000 meter cloud deck!
Pearl Harbor Anchorage 0840 – 0920, 7 Dec 1941

Dive Bomber Attacks

# Target
1 Aylwin
2 Neosho
3 California
4 Nevada
5 Tangier
6 Curtiss
3 Dobbin
1 Solace

Cruiser targets

Outside entrance buoy
Results: far less than Potential

5 targets sunk
Killing ordnance on only 3 targets
2 by Torpedoes, 1 by AP bomb
1 (Nevada) sunk due to damage control error
1 (California) sunk after ship was abandoned due to burning oil

78 Dive bombers made no substantive contribution

Attack directly achieved
20% of expectations
15% compared to capacity
Lessons

✓ Introducing a new technology does not guarantee proper employment
  ✓ Doesn’t guarantee people will even *think* about how to best use it

✓ New technology may require (or lead to) new approaches

✓ Human Proclivities trump technology!
  ✓ You have to convince them on the deck plate/cockpit level
Stump the Chump Time

Questions?

Just quit actin’ like a know-it-all and answer the dam’ questions, OK?

Someone in the audience has the question that will prove that the speaker is a Bloody Idiot.
Good Reads

- Prange, Goldstein, Dillon. At Dawn We Slept
  - Standard, Comprehensive Account
- Prange, Goldstein, Dillon. Pearl Harbor: the Verdict of History
  - Excellent analysis
- Prange, Goldstein, Dillon. God’s Samurai
  - Biography of Fuchida. Does not include recent research
- Prange, Goldstein, Dillon. The Pearl Harbor Papers
  - Some dry documents but also first person accounts
- Walter Lord. Day of Infamy
  - Readable account
- Michael Slackman. Target: Pearl Harbor
- Daniel Madsen. Resurrection: Salvaging the Battle Fleet at Pearl Harbor
- Mitsuo Fuchida. For that one Day
  - Memoire – but with exaggerations and limited truthfulness
- Kinoaki Matsuo. How Japan Plans to Win
  - Japanese intel officer, translation of 1940 book
- Lambert and Polmar: Defenseless
  - Excellent assessment of US air defenses before the attack
- Ron Werneth. Beyond Pearl Harbor
  - Accounts from surviving Japanese aviators, many post PH
- Paul Stillwell. Air raid: Pearl Harbor!
  - Recollections of a day of infamy
- Burl Burlingame. Advance Force Pearl Harbor
  - Japanese submarine deployment
- Roberta Wohlstetter. Pearl Harbor warning and Decision
  - Good information, a bit of a slog to read
- Some Supplemental Reading:
  - Akira Yoshimura. Build the Musashi
    - Full of insights on the Japanese approach to naval warfare, technology, culture, carriers v. battleships
  - Akira Yoshimura. Zero Fighter
    - New Zeros being towed by water buffalo
  - Evans and Peattie: Kaigun: strategy, Tactics, and Technology in the Imperial Japanese Navy, 1887 – 1941