A Review of the Future “Bomb Shop”

A review of how the Future Weapons Stowage Compartment (WSC) could fundamentally affect the Capability and Affordability of tomorrow’s submarines.

Steve Richards – BAE Systems Submarines
Alan Watson – BAE Systems Maritime Services
The Future “Bomb Shop”

Introduction

Our paper outlines:

• A definition & key design factors of a WSC
• Provide a brief history of WSC
• Review key technology drivers
• Conclude with an overview of WSC options for a future submarine.
Definition – Design Challenge

• The WSC on a submarine is the area where weapons are stored and prepared for discharge.
• The WSC is a fundamental part of the submarine design.

• **Key design factors include:**
  • Submarine size & operational function including stealth, stability, sensors and compensation tanks.
  • Payload type, size and weight
  • Crew safety
  • Munition’s safety
  • Overall submarine complexity and affordability.
1900s – The first “Bomb Shop”

- HMS Holland 1 – First Submarine with a WSC
  - A single forward facing 18 inch (450mm) torpedo tube on the centreline
  - 3 torpedoes
  - Firing reload time?
  - No munitions safety features (shock, fire suppression)
  - Limited crew space and manual torpedo handling

Picture Credit: Maritime Museum Portsmouth
1910s – WW1 innovation

Royal Navy K-Class – Dedicated WSC

- 4 x 18inch Torpedo Tubes in the Bow
- 4 x 18inch Torpedo Tubes Broadside
- 2 x 18inch trainable Torpedo Tubes in the Superstructure
- Firing Reload – ~30 minutes
- No munitions safety features (shock, fire suppression)
- Limited crew space and manual torpedo handling

Picture Credit: Covertshores
1940s – WWII Innovation

Elektroboot U Boat Type –XXI – Mother of modern submarine

- Standardised 6 x 21-inch forward facing fixed torpedo tubes
- Accommodate 17 torpedoes in WSC
- Semi – mechanised loading
- Firing Reload – ~10 minutes
- No munitions safety features (shock, fire suppression)

Picture Credit: Defensionem
1950s – Mechanical Innovation

A10 Class – Novel designs

- Standardised 6 x 21-inch forward facing fixed torpedo tubes no reloads
- External 20 x 18inch revolving torpedo magazine
- Firing Reload – ~5 minutes for LWT

Picture Credit: Covertshores
1960s – Sonar Innovation

Thresher SSN Class – Acoustic compromise

- Standardised 6 x 21-inch forward facing fixed torpedo tubes
- WSC further aft to allow large sonar array
- Torpedo Tubes fire outwards around the sonar
- Firing Reload – ~10 minutes
1970s – Automation Innovation

Alfa Class – Automation
- Standardised 6 x 21-inch forward facing fixed torpedo tubes
- Reduced crew so relied heavily on automation
- WSC above sonar array with Torpedo Tubes firing above sonar
- Firing Reload – unknown
- Munitions safety features?
1980s – Flexible Innovation

Typhoon / Akula SSBN Class – Size matters
- Complex build provides capability at substantive cost.
- Standardised 6 x 21-inch forward facing fixed “Arch” torpedo tubes positioned above the large sonar array
- Carries Squall Rocket Torpedo & STARFISH Anti submarine missiles
- Firing Reload – unknown (Fast automated / two loads per tube)
Belgorod SSBN Class – Size matters
- Standardised 6 x 21-inch forward facing torpedo tubes positioned above the large sonar array
- Complex build provides capability at substantive cost
- Carries Squall Rocket Torpedo & STARFISH Anti submarine missiles
- Firing Reload – unknown (Fast automated / two loads per tube)
2020s – Flexible Innovation

A-26 AIP Attack Submarine – Flexibility

- Capable of a multiple loads incl. LWT / HWT & UUVs
- Firing Reload – unknown (Fast automated)
- Recovery of large expensive UUVs presents a challenge
2030s – Full Autonomy

SMX-31 The Electric future Submarine
- Capable of a multiple loads incl LWT / HWT & UUVs
- Positioned Front facing ahead of sensors for additional flexibility
- Complex build provides capability at substantive cost
- Firing Reload – unknown (Fast automated)
# Evolving Design

<table>
<thead>
<tr>
<th>Year</th>
<th>Platform Example</th>
<th>WSC Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900s</td>
<td>Holland Class</td>
<td>The First WSCs</td>
</tr>
<tr>
<td>1910s</td>
<td>K-Class</td>
<td>Dedicated WSCs</td>
</tr>
<tr>
<td>1940s</td>
<td>U-boat</td>
<td>Semi-automated WSCs</td>
</tr>
<tr>
<td>1950s</td>
<td>A10 Class</td>
<td>Novel designs</td>
</tr>
<tr>
<td>1960s</td>
<td>USS Thresher Class</td>
<td>Acoustic Compromise</td>
</tr>
<tr>
<td>1970s</td>
<td>USSR Typhoon</td>
<td>More flexible WSCs</td>
</tr>
<tr>
<td>1990s</td>
<td>USS Chicago</td>
<td>Alternative Requirements</td>
</tr>
<tr>
<td>2010s</td>
<td>USSR Belogrod</td>
<td>Maximizing Flexibility</td>
</tr>
<tr>
<td>2020s</td>
<td>A-26 Class</td>
<td>Multiple Uses</td>
</tr>
<tr>
<td>2030s</td>
<td>SMX-31</td>
<td>Full automation</td>
</tr>
</tbody>
</table>
Technology Drivers

- Energy: Batteries & Propulsion
- Advanced Materials & Manufacturing
- Warhead Development
- Automation
- Modular “Mix & Match”
- EM Rail Launchers
- Common Control Technologies
- Condition Based Monitoring

Evolution not Revolution
Having reviewed WSC development and some of the proposed design options, we have produced a high level concept which addresses:

- Affordability
- Submarine design constraints
- Crew and Munitions Safety
- The following payload options:
  - Tactical Heavy Weight Torpedo
  - Light Weight Torpedo
  - UUVs (medium and small size)
  - Additional Embarked Personnel and Equipment
## Flexible Payload Characteristics

<table>
<thead>
<tr>
<th>ID</th>
<th>Payload</th>
<th>Length</th>
<th>Dia</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tactical HW Torpedo</td>
<td>7m</td>
<td>0.5m</td>
<td>Munitions Safety, Shock protection, embarkation &amp; stowage</td>
</tr>
<tr>
<td>2</td>
<td>Lightweight Torpedoes</td>
<td>3m</td>
<td>0.3m</td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>Medium Size UUVs</td>
<td>7m</td>
<td>0.5m</td>
<td>Charging &amp; Data Connections</td>
</tr>
<tr>
<td>3b</td>
<td>Small UUVs</td>
<td>3m</td>
<td>0.3m</td>
<td>Lower cost and therefore expendable</td>
</tr>
<tr>
<td>4</td>
<td>Bunks and lockers for</td>
<td>3m</td>
<td>0.5m</td>
<td>Easily embarked, removed, compatible with other payloads, provides additional crew with safety and comfort</td>
</tr>
</tbody>
</table>
Payload Solutions

<table>
<thead>
<tr>
<th>ID</th>
<th>Payload</th>
<th>Embarkation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tactical HW Torpedo</td>
<td>Traditional embarkation trolley</td>
</tr>
<tr>
<td>2</td>
<td>Lightweight Torpedoes</td>
<td>Half length pallet</td>
</tr>
<tr>
<td>3a</td>
<td>Medium Size UUVs</td>
<td>Traditional embarkation trolley</td>
</tr>
<tr>
<td>3b</td>
<td>Small UUVs</td>
<td>Half length pallet</td>
</tr>
<tr>
<td>4</td>
<td>Bunks and lockers</td>
<td>Half length pallet</td>
</tr>
</tbody>
</table>

Payload options would ideally be split into 2 categories:
1. Traditional weapon length and diameter
2. Approximately half weapon length and smaller diameter

The upper tier of circa 10 stowage positions could be for full length pay loads
The lower tier could accommodate either 20 half length payloads or 10 x full length payloads. Other payload variations could be accommodated
Payload Embarkation Options

UK Submarines use 2 Embarkation Methods, Inclined and Vertical Embarkation. The Future WSC payload trolleys and pallets would be designed to be compatible with either Embarkation Method.
Potential Payload Solution – View Looking Fwd.
### Potential Lower Tier Payload - 1

<table>
<thead>
<tr>
<th>Half length stowage position</th>
<th>Half length stowage position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half length stowage position</td>
<td>Half length stowage position</td>
</tr>
<tr>
<td>Half length stowage position</td>
<td>Half length stowage position</td>
</tr>
<tr>
<td>Half length stowage position</td>
<td>Half length stowage position</td>
</tr>
<tr>
<td>Full length stowage position</td>
<td>Full length stowage position</td>
</tr>
<tr>
<td>Centre Line Lift</td>
<td></td>
</tr>
</tbody>
</table>

- **Short small diameter WLT**

10 x full length stowage positions on the upper tier.
Up to 20 stowage positions (LWT, UUV or Bunks) on the lower tier.
Potential Lower Tier Payload - 2

<table>
<thead>
<tr>
<th>Half length stowage position</th>
<th>Half length stowage position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half length stowage position</td>
<td>Half length stowage position</td>
</tr>
<tr>
<td>Half length stowage position</td>
<td>Half length stowage position</td>
</tr>
<tr>
<td>Full length stowage</td>
<td>Full length stowage</td>
</tr>
<tr>
<td>Full length stowage</td>
<td>Full length stowage</td>
</tr>
<tr>
<td>Centre Line Lift</td>
<td>Centre Line Lift</td>
</tr>
<tr>
<td>Half length stowage position</td>
<td>Half length stowage position</td>
</tr>
<tr>
<td>Half length stowage position</td>
<td>Half length stowage position</td>
</tr>
<tr>
<td>Full length stowage position</td>
<td>Full length stowage position</td>
</tr>
<tr>
<td>Full length stowage position</td>
<td>Full length stowage position</td>
</tr>
</tbody>
</table>

Each stowage position can either be split into two half stowage’s or joined to make 1 full length stowage.
Potential Payload Solution – View Looking Aft.
Half length payload pallet

1. Pallet
2. Securing band
3. 3m x 0.3m Payload
4. Embarkation and stowage system interface
Bunk Solution

The bunk and personal locker is embarked and stowed as a pallet which includes connections that link to the weapon embarkation and handling system, enabling ease of handling. The pallet could be adapted to provide only locker space which could be used for trials equipment etc.
The Future “Bomb Shop”

Conclusion:
- The design of the WSC has evolved and it will be needed in the future
- Tomorrow’s WSC will retain:
  - Munition Safety
  - Crew safety
  - Fight capability

It could also improve:
- Affordability
- Flexibility
- Modularity
- Automation
Thank you