AMUET

ADVANCED MOBILE UNIVERSAL ELECTRICAL TOOLING

TO ASSIST IN THE MANAGEMENT, ASSEMBLY AND QUALITY CONTROL OF ELECTRICAL HARNESS PRODUCTION
The installation of electrical harness in ship represents MANY THOUSANDS of man-hours and subsequent testing with manual ring-out techniques often lead to further troubleshooting delays when arrives the time to fire up the different ship sub-systems.

1. AMUET addresses the needs of the NSRP FY14 copper test equipment integration into shipyard processes. The goals of that project were to identify and deploy technologies to shipyards and combat system developers that will reduce the time to terminate and test cables. Proper termination, connector installations, and testing of cables comprise a complex industrial evolution that is the foundation for system test programs, operations and successful new construction and modernization of Navy ships.- WARFARE (1 IN 5)

2. AMUET provides a cost effective COTS solution that reduce the footprint and cost to develop interface cables, effectively complementing the NSRP Flexible interface project under - ELECTRICAL panel (1 IN 10)

3. Above all, AMUET appears to be a cost effective solution in light of its agility of to be set-up with nominal configuration effort, accelerate all electrical installations with real-time tracking of production progress and finally its unique ability to convert final installation test results into an effective sustainment maintenance program. The NAVY and all shipyard should benefit from this project.– PRODUCTION PANEL (1 OF 18)
Electrical failures are costly!

- Represent 20-25% of unscheduled maintenance
  - Unpredictable ------------------------ no tool for preventive
  - Difficult to fix right 1st time------- needle in a haystack

- Each occurrence has an impact on:
  - Navy operations------------------------ decision time to realign
  - Maintenance control:------------------ pressure to deliver on time
    - Operations priorities
    - Available electricians
    - Level of difficulty
Automated Test Equipment provides Quality control assurance

1. Capabilities to validate circuit, degradation, intermittent on complete sub-system
2. Interface cables are major obstacle to deployment (delay to procure, cost, weight, maintenance)
3. Test Program Sets (TPS) need to be developed for specific applications
4. Operation requires completed harness

- Requires proper planning and high investment/operating costs at shop level
Production/Line - Agility to be at any place/time/ship/sub-system

1. Multiple test equipments; often cumbersome
2. Scope limited with 2 short probes
3. Extensive documentation of maintenance processes required
4. Limited by availability of skilled electrical technicians
5. Limited tracking of details of historical data

- Potential for human error is high (turnaround time, expertise, measurement reliability, repeatability)
Conventional ATE in depot maintenance

D-LEVEL- provides ability to improve QC but limited agility to react to unexpected failure

1. Capabilities to validate circuit, degradation, on complete sub-system
2. Interface cables are major obstacle to O-level deployment (delay to procure, cost, weight, maintenance)
3. Test Program Sets (TPS) need to be developed for specific applications (ATE, ship sub-system)
4. Requires loopback- TPS, critical may be in loopback (shorts, resistive value, reverse polarity)
5. Global data mining is possible

- Limited scope of work, high operating costs
AMUET - Agility of Handheld, Power of ATE

Production/Line - Agility to be at any place/time/ship/sub-system

1. Standardized tooling
2. Test from point to point, 300 to 5000 testpoints
3. Extensive documentation of maintenance processes included
4. Automation
5. Tracking historical data per ship/sub-system

➢ Potential for human error is removed
Overview - Hardware and concepts

AMUET - in wiring installation mode

is the same tool for QC testing and maintenance

**Standard TBU**
- Circuit analyzer
- Tracks degradation
- Fault locator
- Rapid intermittent
- LAN or wireless

- All in 1

**Standard interface cables**
- Generic family with eID
- Low cost / turnaround

**Standard TPS**
- Import existing database
- Auto-learn
- No programming skills
- Low cost / turnaround

**Standard process**
- Validate Sub-systems
- Full production QC
- Baseline for maintenance over lifecycle of ship

-US patents 7,368,919 & 7,728,605 & 8,547,108
THS standard TBU and cable interface family

Patent 8547108

2 X 150 testpoints
AMUET Test Units (TBU)
EXAMPLE 1: Harness only

Here’s how the test sequence is accomplished:

1. Test of all contacts to Ground: TBU 1
   a) A-GND
   b) B-GND
   c) C-GND: Link found

2. Test of all contacts to Ground: TBU 2
   a) 1-GND
   b) 2-GND
   c) 3-GND

3. Test of all non-grounded contacts against each other (Test unit test all combination possible to identify links and diode) TBU 1&2
   a) A-B
   b) B-A
   c) 1-2
   d) 2-1
   e) A-1: Link Found
   f) A-2
   g) B-1
   h) B-2: Link Found

4. Resistance and Impedance measurements

5. Once All contacts of those 3 pins and 2 pins connectors have been scanned the result is then showed on the screen in this format

<table>
<thead>
<tr>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector P0 to GND</td>
</tr>
<tr>
<td>Contact C-GND GND</td>
</tr>
<tr>
<td>Connector P0 To P1</td>
</tr>
<tr>
<td>Contact A-1 Link</td>
</tr>
<tr>
<td>Contact B-2 Link</td>
</tr>
</tbody>
</table>
EXAMPLE 2: From Computer to component

This is how the test sequence is accomplished:

1. Test of all contacts to Ground
   a) A-GND
   b) B-GND
   c) C-GND: Link found

2. Test of all non-grounded contacts against each other (Test unit will test all combinations possible to identify links and diode)
   a) A-B: Link Found
   b) B-A: Link Found

3. Resistance and impedance measurements of the links found

4. Once all contacts of this 3 pins connector have been scanned the result is then shown on the screen in this format:

RESULT:
Connector P0 to GND
Contact C-GND   GND   0,025 ohms
Connector P0 To P0
Contact A-B     Link   23 ohms
Once we deploy these solutions, we have observed that about 15% of all test present deviations (unreported by aircraft) in any of the sub-systems tested in the following order of occurrences:

- High resistive wire connections short to ground (2KOhms)
- High resistive wire connections shorted with other wires (2MOhms)
- Components outside tolerances (proximity switches, coils)
- Resistive values exceeding 25% over fleet average levels (often ground stud, or components such as coil)
- Deviation from schematics (new installations or effectivity mods deviations)
- Opens (broken wire or internal component)
High level overview

- Typically, Automated electrical tester are only used at QC level (1d).
- AMUET will be used from day 1 of production to sustainment

1. Standardized software capabilities:
   a. Automated test program builder
   b. Paperless assembly processes
   c. Assisted production for contact insertion - electrical validation
   d. Complete electrical test (QC)
   e. Completion progress- by sub-assembly and ship sub-system
   f. Maintenance post-delivery

2. Standardized hardware:
   a. Test equipment- TBU300 (wireless or wired)
   b. Interface cables- Model ZIF150 vs Optional 2nd ID level
Modernization program

Development set-up: 1 day
Test time: 1 hour (prior 48 hours)
Line troubleshooting: A-check, Gate

Test time: 30 minutes

TBU1 on wing root

TBU2 on engine ECU

CRJ705 IFE seats

Test time: 20 minutes
Line troubleshooting: A320 flap-slat

Slat motor on wing

avionic bay

Test time: 20 minutes

AMUET technician
C-130 Anti-Skid technician operated laptop next to aircraft controlling multiple test units (TBU) located at 3 different locations on aircraft.

AMUET has 1 TBU connected to multiple harnesses in cargo / avionics bay.

Footprint on bench table: portable computer, all interface cables and 4 TBUs. Test requires 3.

AMUET has 1 TBU on each side connected to wheel sensors and harness.

Georgia Tech Business Case Analysis:
- Annualized AMUET costs 68% less than handheld meters (HHMs) and 38% lower than conventional ATE
- AMUET and ATE advantages over HHMs: less error prone, less test time, more test capability and data tracking
- AMUET advantages over ATE: moderate investment, shorter TPS prep time, smaller footprint, wireless, less cumbersome, easily adaptable to O-level
Project activities – 9 months
1. Kick Off Meeting (Austal/ Solavitek)
2. Fabricate the required harnesses (Solavitek /Austal)
3. Pinout/ Termination Trials (Austal/ Solavitek)
4. System evaluation- Multi-Vessel (Austal/ Solavitek)
5. Technology demonstrator- (Austal/NAVSEA or other shipyard)
6. Final report (Austal/Solavitek)
7. Technology transfer plan

Deliverables:
1. Functional demonstrator on 2 ship platforms (JHSV and LCS) in relation to production, QC and maintenance mode.
2. The project will provide a brief investment overview. If the concept is accepted the following will be quantified where possible:
   • Recommendations for Depot and Operational testing
   • Reductions in the man-hours required in the pinout / termination stage of completion
   • A new process to speed-up electrical harness installations for new installations or modernization programs
Potential for Ship Production/Warfare Integration

➢ **Target objectives:**

➢ Payback of less than 1 year, ROI recovered multiple time over life of ship

1. **Acquisition costs**
   ➢ 50% less than conventional ATE, quick turnaround

2. **Production and installation of electrical harness:**
   ➢ 10% to 30% savings over current production processes

3. **Quality control:**
   ➢ 80% savings over manual ring out; QC as you build
   ➢ Reduction of functional tests troubleshooting

4. **Maintenance costs**
   ➢ Reduction of multiple maintenance for same event, trending analysis
SUMMARY - Advantages

Harness shop
1. Reduce investment set-up cost (mate/test programs)
2. Accelerates wiring terminations activities and reduce paper by 10%
3. Provides comparative QC to conventional ATE

Aircraft/Ship
1. Improving post-installation modifications by 50%, especially at FTV level
2. Reducing manual ring out time by 90%
3. Eliminating errors by 100%
4. Produce complete reports of all installations
5. Better turnaround to provide factory time for more deliveries
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