



2014 Workshop on Accelerated Stress Testing and Reliability



Biography

Essex Fowlks V

Raytheon Integrated Defense Systems: Senior Manager Systems Engineering Systems Validation Test and Analysis Directorate Staff (Present-2007), Department Manager Air Defense System (ADS) Department (2007-2006), Program Manager III (2006-2003) Upgraded Early Warning Radar Integration and Test Cross Product Team Lead, Senior Systems Principal Engineer THAAD radar integration and test (2003-1998).

Coleman Research Corporation: Senior Systems Engineer (1998-1996), National Missile Defense Program Office; United States Army: Test and Evaluation Staff Officer Test and Evaluation Management Agency (1996-1994), Test and Evaluation Staff Officer Operational Test and Evaluation Command (1994-1991), Test and Evaluation Officer Army Material Test and Evaluation Directorate (1985-1990).

Education: DAWIA Level 3 Test and Evaluation, DAWIA 3 Systems Engineering, Command and General Staff College, M.S. Systems Management, Field Artillery Officer Advance Course, Armor Officer Advance Course; Field Artillery Officer Basic, M.S. Systems Management, Florida Institute of Technology, B.S. General Engineering United Military Academy.

David Sgro

Raytheon Integrated Defense Systems: Senior Mechanical Engineer. Has over 10 years of experience in mechanical engineering focusing on Environmental Testing in the defense industry. His education includes a Bachelor's degree in Mechanical Engineering from Wentworth Institute of Technology in Boston, MA. He is a member of the Institute of Environmental Sciences and Technology (IEST) organization and is a working group and session chair for the shock and vibration test fixture design portion of the IEST. David has published papers for both the IEST and internal Raytheon Symposiums.

September 8, 2014

ASTR 2014, Sep 10 - 12, St. Paul, MN



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How To Plan An Accelerated Reliability Growth Test

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Goal Of This Presentation

“What Does It Takes To Plan An “Accelerated Reliability Growth Test”.

- **Why ARGV Testing?**
- **ARGV Drivers**
- **What Does It Take To Plan An ARGV?**
- **Lessons Learned**
- **Conclusions**



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Why Accelerated Reliability Growth Testing?

We need to determine a meaningful Reliability Measure (A_i) for the Unit Under Test (UUT). ARGV provides an efficient means to collect credible reliability data during early engineering research and development in a cost effective manner that will be used to understand and improve the product.



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ARGT Drivers

- Current Business Environment
- UUT (CRAD, IRAD, POD, POM)
- Customer Requirements
- Schedule
- Resources

CUSTOMERS WANTS PROOF OF RELIABILITY



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What Does It Take To Plan An ARGT?

- Scope
- Team
- Objectives
- Assumptions
- Resources
- Risks
- Opportunities

PLAN ARGT JUST LIKE ANY OTHER TEST



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Scope

Subject one sample of each type UUT to accelerated environmental stresses thus aging and revealing life expectancies and design weaknesses

- The test is designed to simulate a pre-determined lifetime
- When failures occur, the UUTs will be repaired or, if necessary, spared to make continued testing possible
- Modifications may be made to mitigate the problem and permit test continuation
- ARGV provides life expectancy data and generates a list of potential design changes that may contribute to increased product life and reliability
- ARGV will consist of repetitive thermal cycles incorporating extended high temperature dwells, cyclic humidity, and random vibration
- During the temperature and humidity phases of testing, the UUTs continuously operates and undergo functional tests
- A vibration test phase is performed with the un-powered UUT
- Operational checkouts will be performed after each axis
- The ARGV does not include supply-power-related stress factors



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Team

- Customer
 - Government
 - Raytheon Program Management Office
- Engineering Management
 - Business Unit Engineering VP
 - Engineering Discipline Director
- Systems Engineers
- Mechanical Engineers
- Reliability Engineers
- Electrical Engineers

CUSTOMERS MUST BE ON BOARD TRAIN EARLY



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Team Cont'd

- Finance
- Facilities
- Security
- Safety



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Objectives

- Demonstrating UUT reliability and maturity
- Collecting data that proves UUT reliability and maturity



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Assumptions

- ✓ Labor budget approved
- ✓ Material budget approved
- ✓ Will use existing environmental chamber for ARG T
- ✓ Environmental lab will instrument UUTs
- ✓ Existing UUT vibration fixtures are not sufficient
- ✓ Will switch UUT from environmental chamber fixture to vibration fixture as required during ARG T
- ✓ Three chillers with heating capability required
- ✓ Purchase chillers
- ✓ Need to revise ARG T testing code and tools
- ✓ We can have breaks in ARG T to perform repairs
- ✓ Spare UUT and CCAs available for repair



Assumptions

- ? Program(s) provides vibration and shock requirements flow down (TBD)
- ? Customers concurs with ARGV thermal, humidity and vibration profiles (TBD)
- ? Customer concurs with electronics road vibration requirements based on Aberdeen accelerometer data (TBD)
- ? Automated UUT diagnostics checks conducted twice daily 7 days a week (TBD)
- ? Automate UUT for unattended operation (TBD)
- ? ARGV approved for unattended 24/7 (TBD by Safety)
- ? ARGV Facility will not require construction (TBD by Facilities)

**VALIDATE ASSUMPTIONS EARLY TO PRECLUDE
DISCONNECTS**



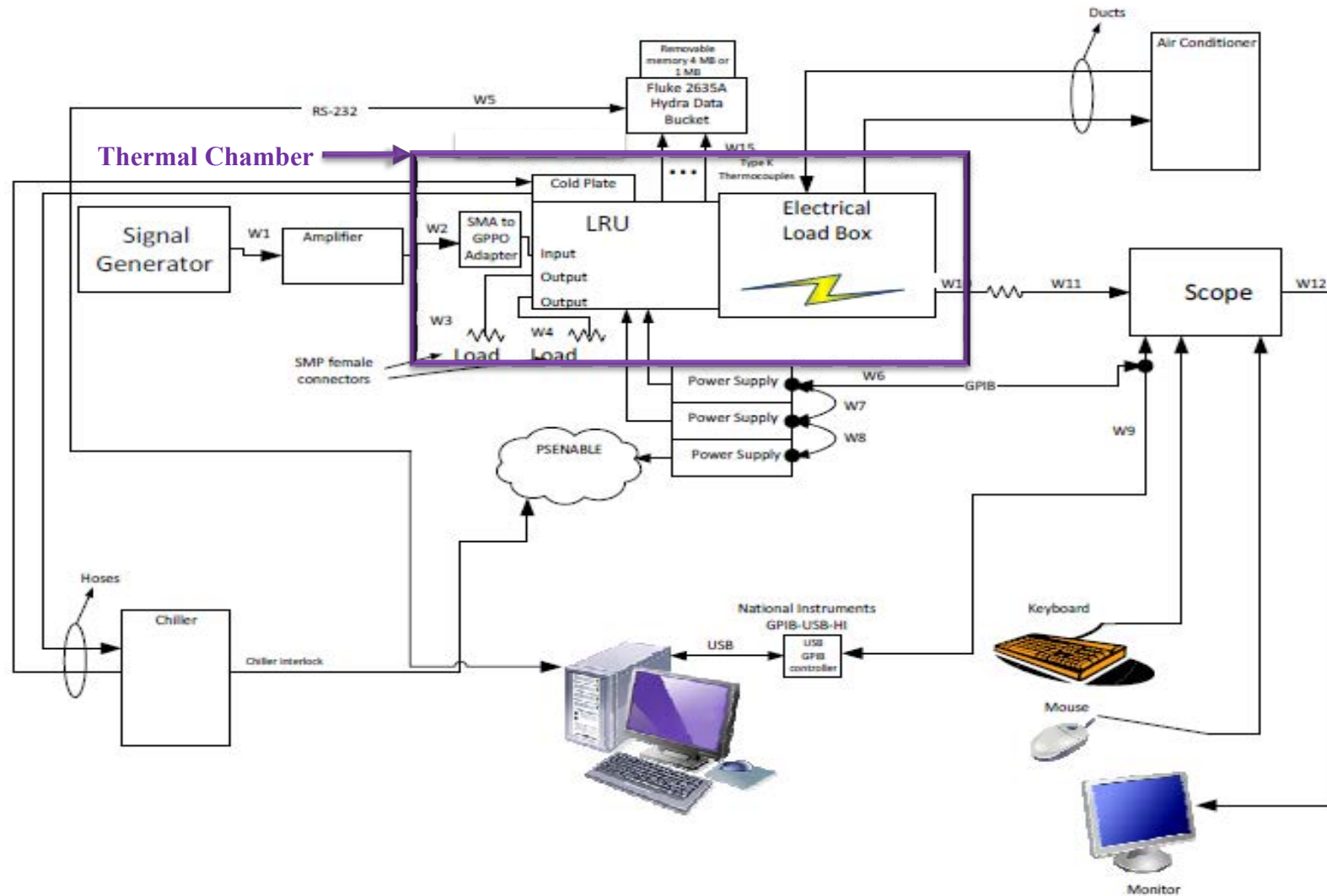
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Resources

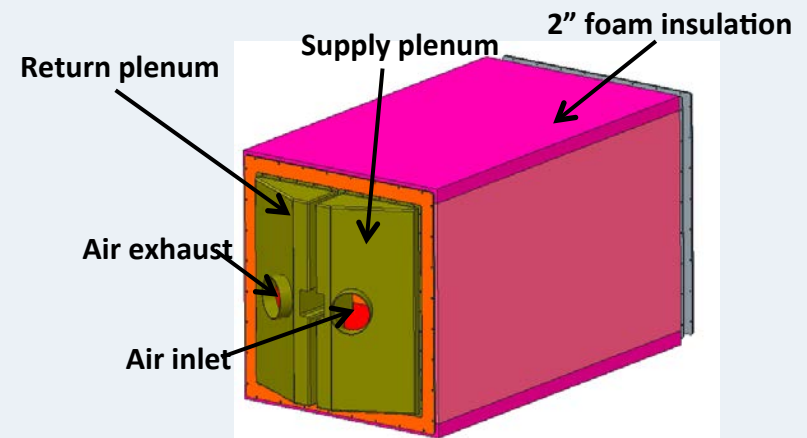
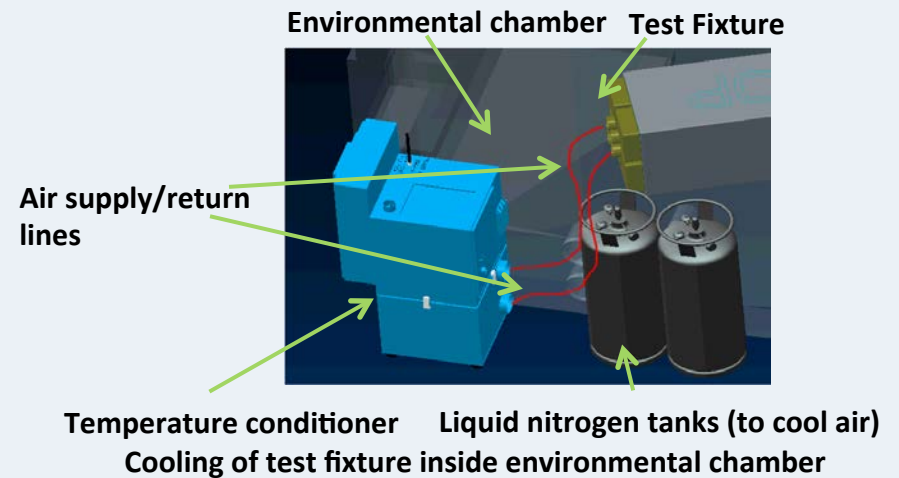
- UUTs/Spares
- Test Profiles
- Facilities
- Materials
- Test Stations
- Software/Firmware
- Data Collection Process
- Instrumentation
- Analysis Tools
- Staffing

Environmental Chamber Layout



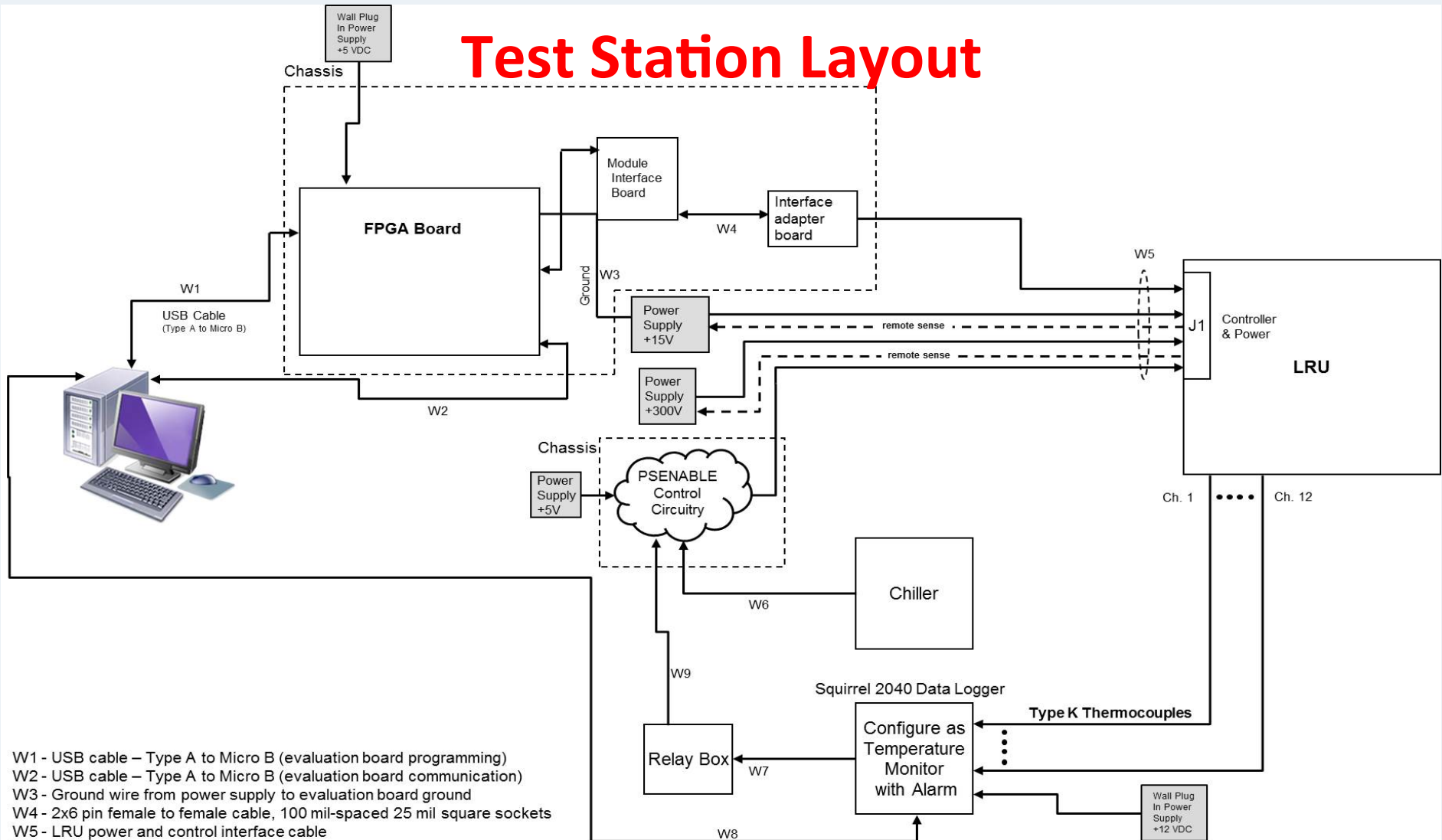
Chamber Test Fixture Design

- The test fixture will be used inside of an environmental chamber, which operates primarily at 115°C for long periods of time
- Thermal fixtures mimic gravitational orientation. The UUTs are not air cooled as they are in the system but rather liquid cooled. Chiller carts will allow the proper adjustment to flow and cooling to best replicate fielded conditions.
- A UUT is mounted at one end of the test fixture and it dissipates heat into a heat sink located on the opposite wall of the test fixture and into thermal absorbent material, which covers the inside of the box
- The outside of the box is covered with 2" thick foam insulation to protect from external chamber high temperatures
- Due to possible over heating of load boxes, conditioned air will be pumped into the load box at 21.1°C (70°F) or cooler which is supplied to the air plenum at the horn end of the box, circulates within the box to cool the absorbent material, then exhausts out the same side



Test Fixture

Test Station Layout



- W1 - USB cable – Type A to Micro B (evaluation board programming)
- W2 - USB cable – Type A to Micro B (evaluation board communication)
- W3 - Ground wire from power supply to evaluation board ground
- W4 - 2x6 pin female to female cable, 100 mil-spaced 25 mil square sockets
- W5 - LRU power and control interface cable
- W6 - TBD (Chiller to control circuitry)
- W7 - Twisted pair wire
- W8 - USB cable – Type A to B
- W9 - Twisted pair wire



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Risks

Type	Sub-IPT	Title	Description	Mitigation/Capture Steps
Risk	Test/Analysis	Test Facilities	Facilities modifications to conduct ARGV are not completed by test execution date.	Work with facilities to mitigate impact to schedule
Risk	Test/Analysis	Unattended ARGV Testing	Safety or security preclude 24 hour autonomous testing resulting in creased test cost for 24 hour staffing.	Work with safety and security to establish means to test 24 per day without around the clock staffing.



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Opportunities

Type	Sub-IPT	Title	Description	Mitigation/Capture Steps
Opportunity	Test/Analysis	Reuse Existing UUT Vibration Fixture	ARGT UTT will require a vibration fixture.	Verify vibration fixture design does not require mechanical design changes to accommodate UUT. Purchase vibration fixture using existing drawing package.
Opportunity	Test/Analysis	Reuse Existing UUT Controller	ARGT UTT will require a controller.	Verify controller design does not require electrical design changes to accommodate UUT. Purchase controller using existing drawing package.
Opportunity	Test/Analysis	Reuse Existing UUT Firmware And Software	ARGT UUT will require firmware and software to conduct test.	Verify existing UUT firmware and software does not require update to operate ARGT.
Opportunity	Test/Analysis	Reuse Existing UUT Data Analysis and Collection Tools	ARGT UUT will required data analysis and collection tools.	Verify existing UUT data analysis and collection tools do not require update to support ARGT.
Opportunity	Test/Analysis	Reuse Existing UUT Environmental Test Pre/ Post Test Checkout Procedures	ARGT UUT will require procedures to establish baseline and identify changes resulting from test.	Verify existing UUT DVT checkout procedures are adequate for pre/post checkout.

ARGT IS NOT CHEAP USE RISK & OPPORTUNITIES



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Lessons Learned

- Customer must understand why ARGV and not
 - Highly Accelerated Life Test or,
 - Environmental Stress Screening or,
 - Highly Accelerated Stress Screening
- Identify the number of UUTs and spare circuit card assemblies required to support ARGV early
- Use ARGV to target customer reliability concerns and drive to ground early



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Conclusions

- Testing has not begun but planning, design, and material procurement is well underway
- ARGV planning requires meticulous, systematic and cost efficient approach
- ARGV provides excellent data capture / design validation
- An ARGV is a complex undertaking requiring many different disciplines to plan, design and execute a credible and successful test

CONDUCT ARGV EARLY IN DEVELOPMENT PROCESS