Using Corrosion Design Models to Accelerate the Transition of Alternatives

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
AUG 2012		**00-00-2012 to 00-00-2012**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Using Corrosion Design Models to Accelerate the Transition of Alternatives	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Air Warfare Center,Materials Engineering Division,22347 Cedar Point Road,Patuxent River,MD,20670**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
ASETSDefense 2012: Sustainable Surface Engineering for Aerospace and Defense Workshop, August 27-30, 2012, San Diego, CA. Sponsored by SERDP/ESTCP.

14. ABSTRACT

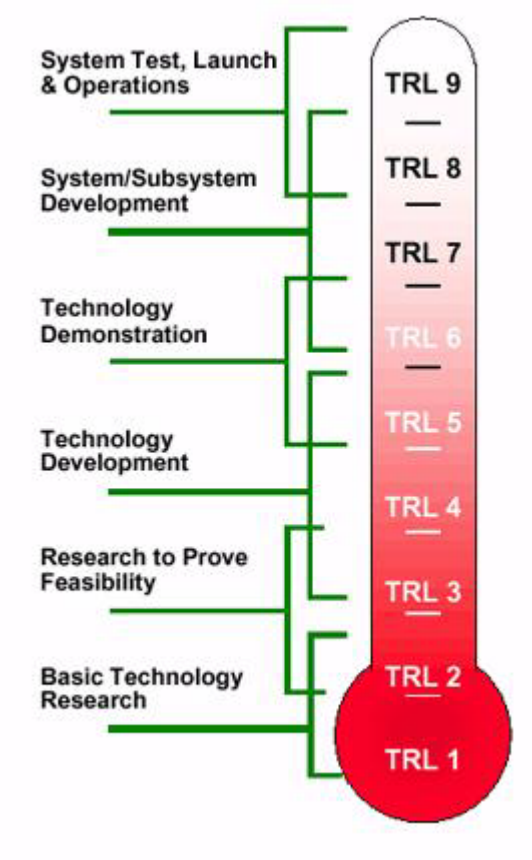
15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**10**	

Agenda

- ✈ Current Time to Develop, Validate and Implement Alternatives
- ✈ Corrosion Design Models
- ✈ Potential Ways to Use Models to Speed the Process
- ✈ Other Benefits from the Models

Current Time to Develop, Validate and Implement Alternatives



Technology Readiness Level

Typical Time per interval

2- 5+ yrs

2- 3 yrs

2- 4 yrs

1- 4 yrs

2- 3 yrs

2- 4 yrs

Total Time- 11-20+ yrs

Example

TCP ~18 yrs from initial discovery to first use

- Original R&D started in ~1990
- Original Patent- 1994
- Follow on R&D- 1999-2004
- Additional Patents- 2002-2010
- Field Demos- 1999-2005+
- Licensing and qualified products- 2004-2005
- First Authorization- 2006
- First NAVAIR Implementation- 2008

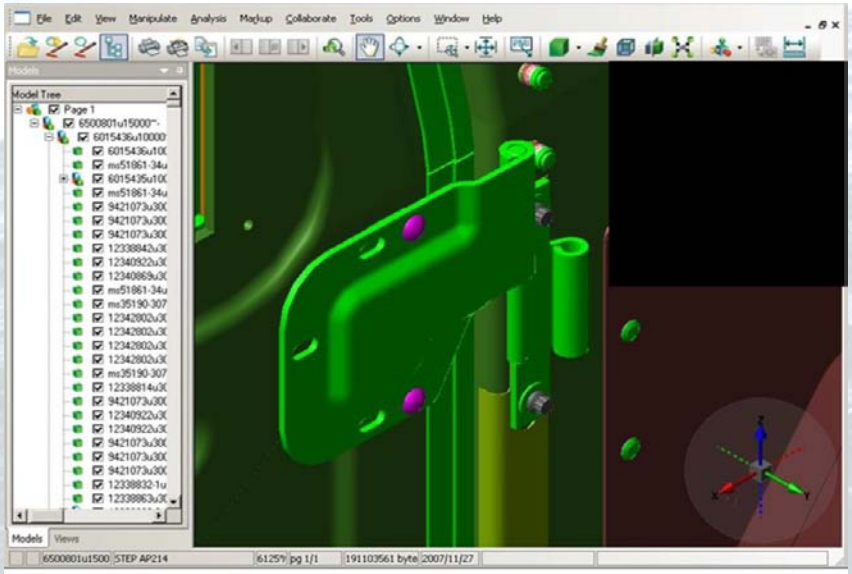
NAVAIR

Corrosion Design Models

- **Three main efforts underway to develop computational corrosion design models to aid in material selection and reduce corrosion risk during initial design**
  - GCAS: ACES program, initially supported by TACOM/Army
    - NAVAIR Phase II SBIR, modifying software to include light metals/aviation interfaces
  - Corrdesa/Elsyca: GalvanicMaster
    - ONR Phase II SBIR: program being modified for aviation weapon systems
  - Beasy/Computational Dynamics: Corrosion Technology
    - Plan to support comparison to ACES and GalvanicMaster in future

Corrosion Design Models

- **All moving to incorporate light metals, composites and other aviation materials**
- **Maturation includes effect of protective materials**
- **All depend upon DC polarization data**
  - Common method to acquire data needed- being supported through ONR Sea Based Aviation efforts



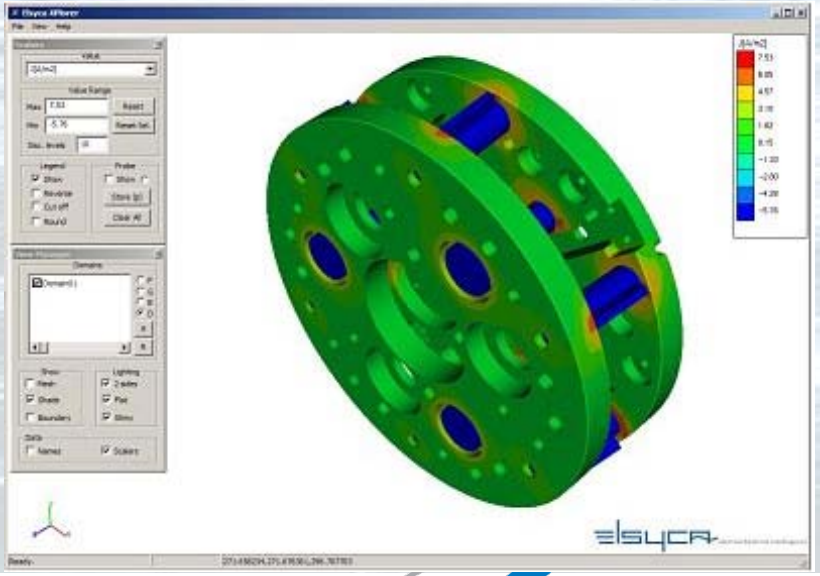


Figure 5: Zoom of Door Hinge on the Mid-Size STEP- HMMWV Model

NAVAIR

Potential Ways to Use the Design Models to Accelerate the Process

- **Use galvanic test assembly and DC polarization/electrochemical data to predict performance of new materials**

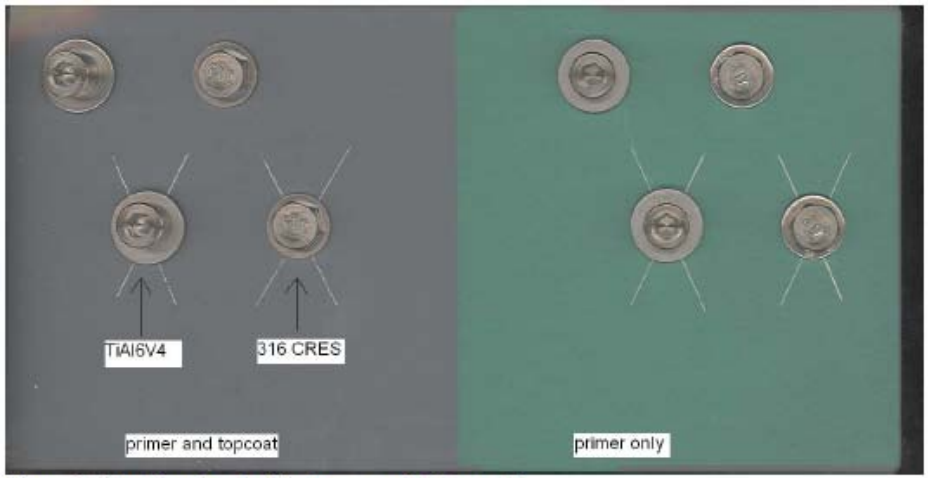
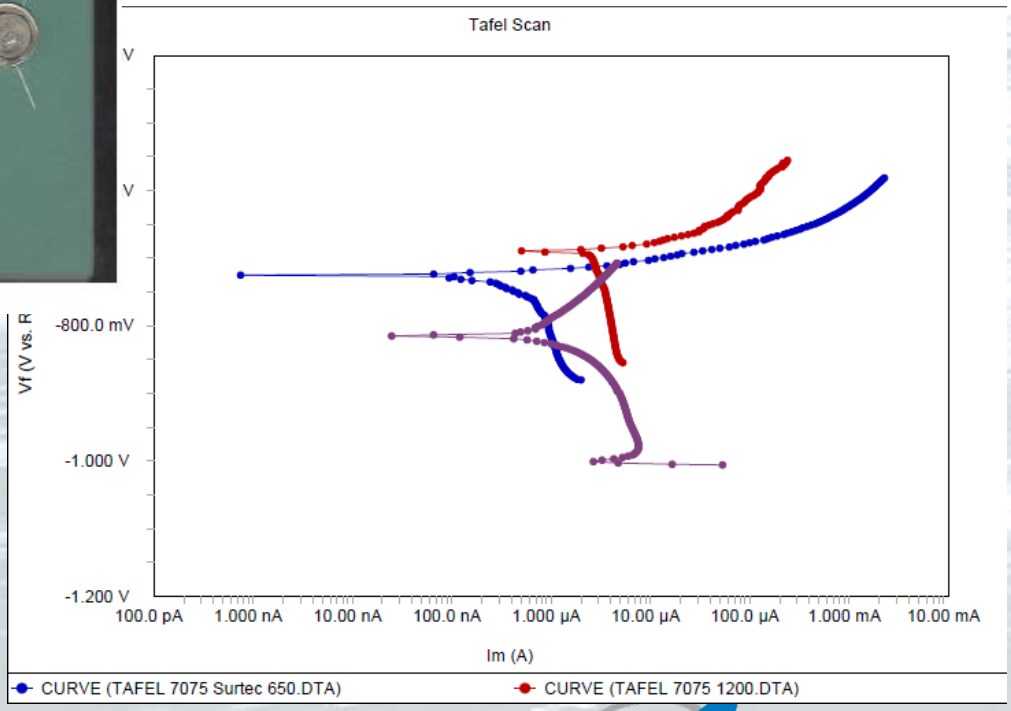


Figure 1: Coated and scribed fastener panel before testing.



Potential Ways to Use the Design Models to Accelerate the Process

- **Compare to actual performance at beach exposure site (KSC) and with accelerated cabinet tests**
- **Advantages:**
  - Allows predictions with many different substrates, coatings, and combinations of materials
  - Rapid validation using beach data
  - Potential for quicker transition from lab to weapon system testing
- **Disadvantages**
  - Immature: models themselves have low TRL and only currently account for time zero
  - Does not account for MRL
  - Unknown factors

Potential Ways to Use the Design Models to Accelerate the Process

- **Path Forward:**
  - Work with GCAS and Corrdesa through SBIRs to model NAVAIR's galvanic assembly
  - Develop DC polarization and other data needed for individual coatings and input into models
  - Feed model actual beach, B117 and SO_2 corrosion data for a large variety of coating combinations
    - Anode/substrate: 7075-T6 and 2024-T3 aluminum
    - Cathode/fasteners: TiAl6V4 and 316 CRES
    - Aluminum surface treatement: Bare, anodized, conversion coated (various), adhesion promoters
    - Primers: Various Class C and N from MIL-PRF-23377 and MIL-PRF-85582
    - Topcoat: Various from MIL-PRF-85285
  - Repeat predict/test/validate cycle with new/unknown materials
  - Modify/improve galvanic assembly or add new types to account for 3 or 4 major interface types on aircraft (raised, countersunk, rivets, threaded, etc.)
  - Long term: Link to effect on structural life/stress corrosion cracking/corrosion fatigue

Potential Ways to Use the Design Models to Accelerate the Process

- **Payoff/Potential Uses**
  - Acquisition: enable prediction of effect of material selection or substitution on weapon system performance
    - Life-cycle cost/maintenance impact
    - Structural life impact
  - Life Extensions: enable more accurate prediction of remaining life with current and alternative protection schemes
    - Requires the development of pitting models which link to structural degradation
    - Underway in separate projects
  - Product Qualification: enable higher quality test requirements for protective materials
    - Potentially enable less field testing before implementation
    - Encourages the development of higher performing products
  - Research and Development: enable more rapid progress through TRLs
    - Less subjective data
    - More efficient screening
    - Better feedback to product developers

Other Benefits of Models

- **Potential Use to Track Hazmat on Weapon Systems**
  - Programs already required to complete PESHE and track hazardous materials
  - Very laborious to determine impact of changing protection schemes
  - Models will be able to estimate substrate volume and surface area and coating volume and surface area, weight, and location very accurately
- **Potential to be included as a contract deliverable**
  - Potential to improve negotiations between OEM and DoD customer over design trade offs
  - Color coded visual output much more effective at conveying risk compared to showing pictures of corroding test panels, and is similar to how structural loads are predicted and communicated today
- **Potential to Simulate Aging of Weapon System over Time and Predict Maintenance Intervals**
  - Models will be able to simulate environment of asset over its life using relative corrosivity data
  - Potential to simulate damage and less effective repair of factory applied materials
  - Potential to study effect of wash and rinse intervals, basing, sheltering, etc. and tie to protection scheme life
  - May help better tailor field testing