



A Pragmatic Approach to V&V

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Testing Maturity Phases

The purpose of testing¹ is:

- **Phase 0: No difference between testing and debugging.**
- **Phase 1: Show the software works.**
- **Phase 2: Show the software doesn't work.**
- **Phase 3: Reduce perceived risk of not working to an acceptable level.**
- **Phase 4: Testing is a mental discipline that results in low-risk software *without* much testing effort.**

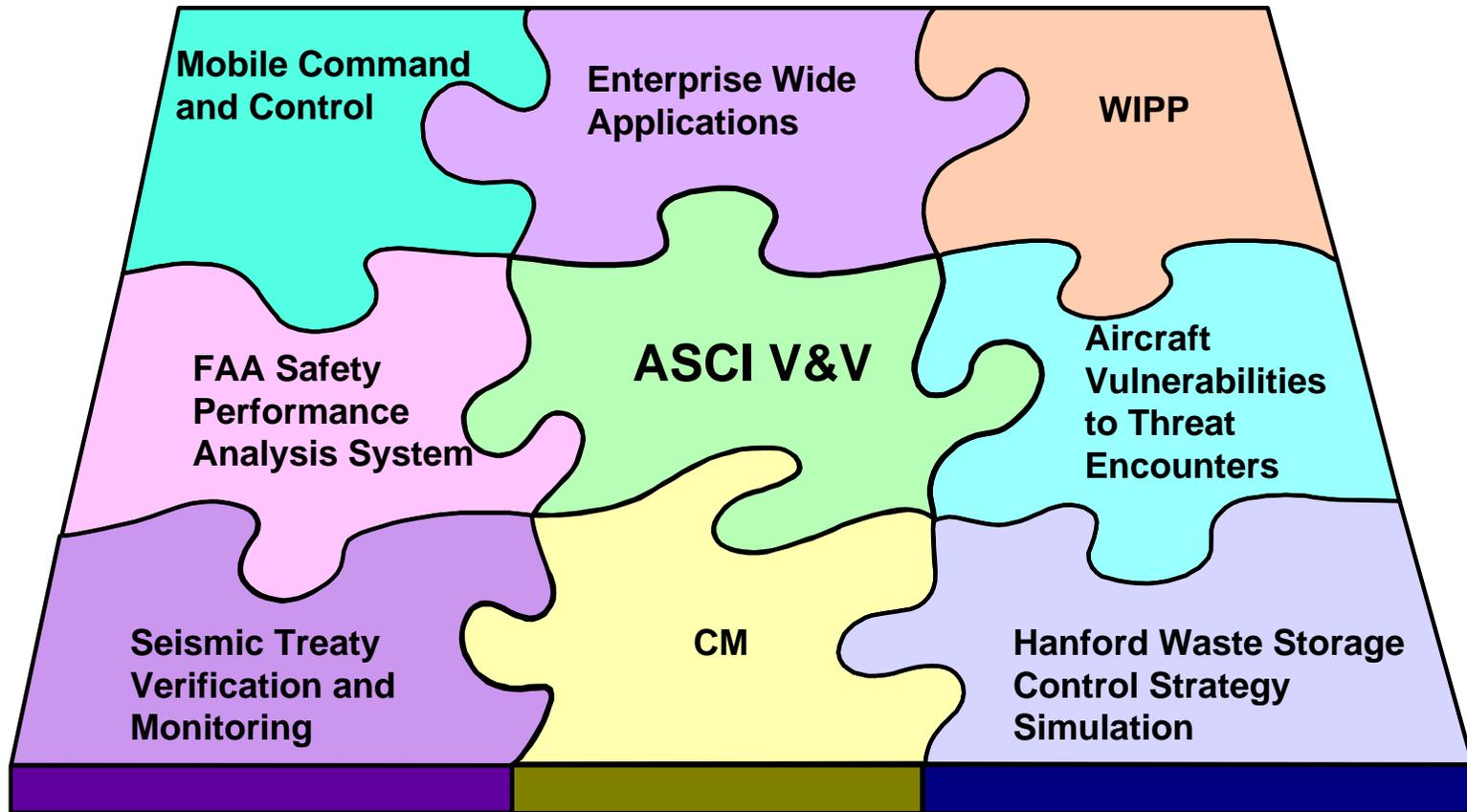
¹Boris Beizer, Software Testing Techniques, 2nd edition, Van Nostrand Reinhold, 1990.



V&V/Test Programs Experience

**Decision
Support**

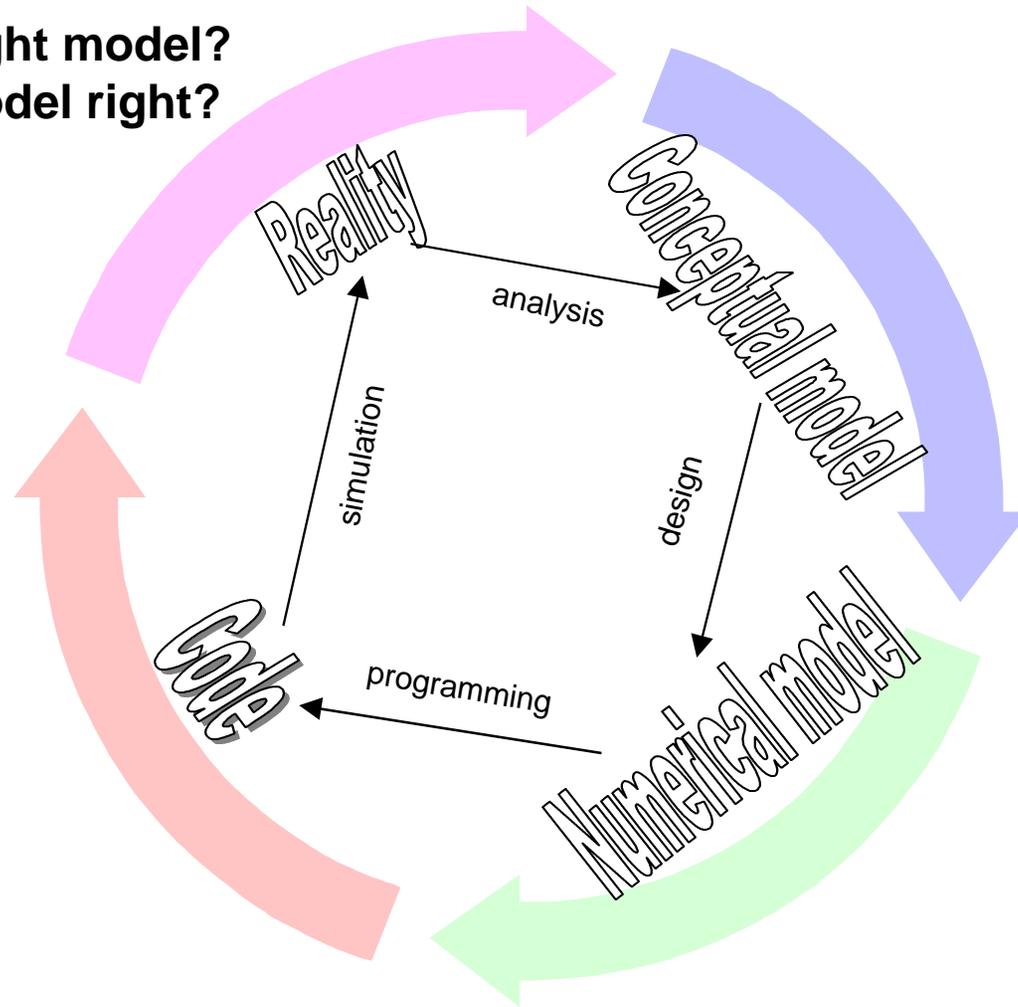
**Modeling and
Simulation**



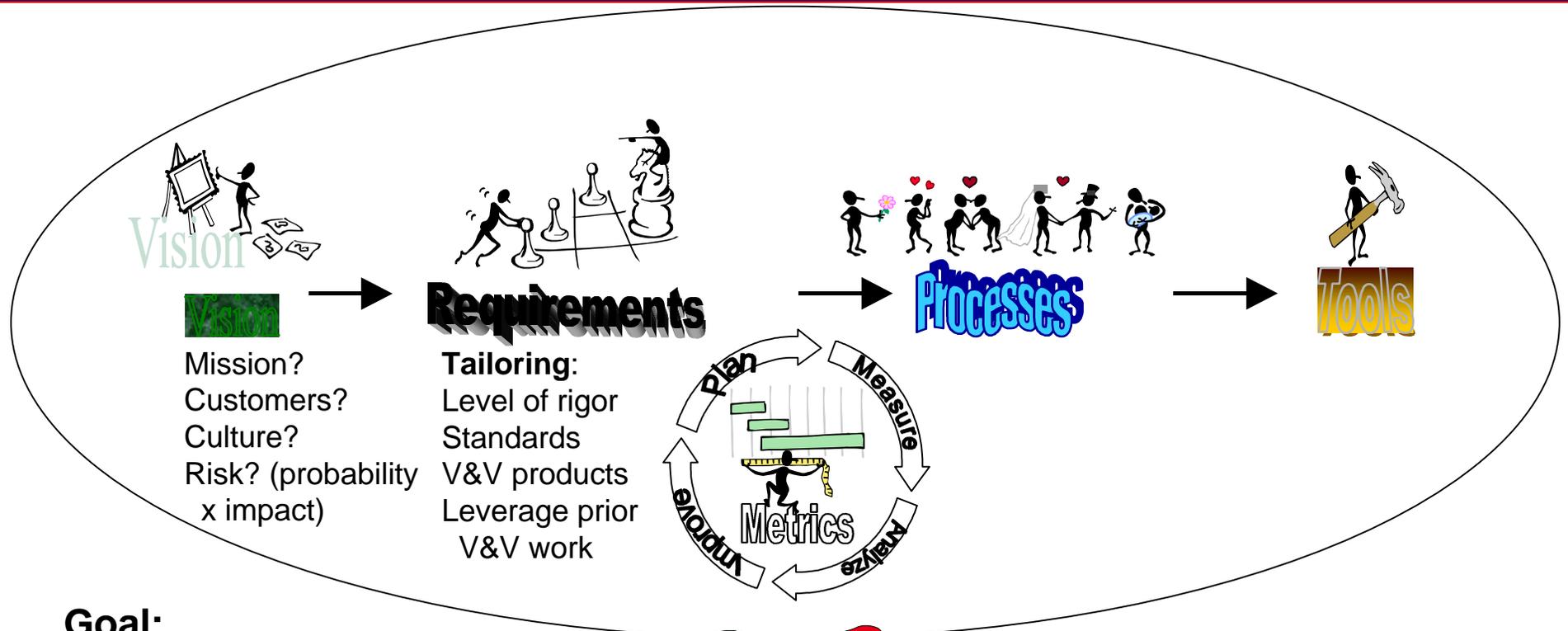


V&V of Scientific Software

Validation: Is it the right model?
Verification: Is the model right?



Process of Developing a V&V Program



Goal:

- Determine right level of V&V
- Most cost/time/resource efficient
- Justification for V&V level





Mobile Command and Control System

- **Fault Isolation Built In Test Equipment for MBB system**
 - C3 system
 - secure
 - interconnected via broadband LAN
 - FIBITE controlled test equipment to test and report on devices
- **Security Test Plan**
 - based on security path analysis
 - systematic approach to testing
 - Test procedure for each piece of the path
 - Evaluated by external agency
 - run through tests
- **CM**
 - different customers, different software - customer build ID
 - different test environments
- **Testing maturity phase 0->1**



Seismic Treaty Verification and Monitoring

- **Validation**
 - requirements-based tests for Air Force DT&E
 - test plan maps to test procedures
 - analysis, demo, test procedures
- **Operational testing**
 - live data experiments
 - OT&E
 - comparison with current operational system
- **CM**
 - appreciation for promotion model
 - build ID - “tip” version
 - issue tracking
 - home grown
 - DDTS



Seismic Treaty Verification and Monitoring

- **V&V strategy and management**
 - Industry standard practices - IEEE
 - Usability of system is more than satisfying requirements
 - Testability
 - requirements - ambiguity (state of art signal processing) ultimately addressed in test procedures
 - design - processing pipeline
 - Coverage and results - “battle map”
 - Combine validation tests with integration testing
 - Test summary report
 - Visibility of problem reports - negotiated with Air Force
 - Training Air Force software maintenance staff



WIPP

- **Pragmatic software engineering**
 - support test activities
 - reverse engineered requirements, design - included in code specific test plan
- **CM**
 - test team had initial VM tool, participated in WIPP's selection
 - architecture for supporting simulations - input, output, sims
 - used by EPA - at Activity Integration Forum, Gary Froehlich reports key to opening WIPP site
 - CM Plan
 - issue tracking



WIPP

Test Strategy

- **Infrastructure**
 - Common test plan
 - Code specific test plan
 - Templates
 - General test procedures
 - design for testability
 - numerical stability
 - tool usage
 - Test tools
 - coverage - used to elicit further requirements, judge test suite adequacy
 - flint
 - structural reverse engineering
 - complexity metrics
 - Training
- **Public safety, EPA compliance**
 - bureaucracy fallout
 - QA requirements
- **Standards - IEEE, NQA**
- **Testing maturity phase 3**
- **Developer partnership**



FAA Safety Performance Analysis System

- **Validation**
 - Functional, operational, physical requirements
- **Verification**
 - traceability analyses
 - evaluation of development products
- **V&V strategy and management**
 - public safety
 - IEEE standards
 - prioritization of requirements validation
 - criticality analysis - risk-based
 - availability of products
 - developer, program office partnership



Aircraft Vulnerabilities to Threat Encounters

- **Pragmatic software engineering**
 - reverse engineered requirements
 - test cases based on requirements/features
- **Validation**
 - cross comparing with another agency's version
 - if differences, explanation
- **V&V strategy and management**
 - position code for wider use
 - **Standards**
 - DoD Modeling and Simulation Office (DMSO) VV&A
 - IEEE



Enterprise Wide Applications

- **Test strategy and management**
 - performance/load testing
 - design for testability
 - transactions traced through distributed components
 - monitoring key architectural components during test (I/O, CPU, threads, cache utilization)
 - automated GUI, load test tools
- **CM**
 - > 50 projects sharing VM, process
 - issue tracking
 - promotion model
 - automated deployment



Hanford Waste Storage Control Strategy Simulation

- **Validation**

- tests comparing to field data, experiments, other models
 - explanation of differences
 - increased understanding of model requirements -> *science didn't stop - aided refinement!!*
- tests based on analyst's expectation of phenomenological behavior
- data validation

- **Verification**

- evaluation of conceptual model
- rederivation of numerical model
- code inspection for scientific principals, model implementation
- traceability between model, requirements, design, implementation (code and data)



Hanford Waste Storage Control Strategy Simulation

V&V strategy and management

- public safety
- ANS, IEEE, Hanford QA standards
- prioritizing V&V test activities for deliveries
 - new models
 - changed models
 - regression tests
- test coverage of all models, software products
- analysts part of V&V team
- issue tracking
 - customer
 - developer
 - V&V
 - reporting
- external review process
- increased reliability of simulations
- increased confidence in simulations
- design for testability - visibility into models (intermediate parameter values)



Pragmatic Approach to ASCI V&V

- **Vision, requirements**
 - **Science Based Stockpile Stewardship**
 - **increase confidence of simulations**
 - **increase reliability**
 - **movement of R&D to product**
 - **support both R&D and production in parallel**



Pragmatic Approach to ASCI V&V

V&V strategy and management

- identify appropriate standard industry practices
 - AIAA, ANS, NQA, IEEE, ...
- establish infrastructure
 - allows code teams to *focus on the science*
 - appropriate level of rigor
 - CM, RM, templates, tailoring guidelines, processes, tools, training, metrics
 - address ASCI-specific areas
- leverage on R&D culture
- reverse engineer to support V&V
- facilitate science
 - model behavior
 - simplifications
 - experiments <-> simulations
- accredited code usage
 - environment
 - simplifications
 - characterize areas of stability
 - training
- design for testability
- COTS
 - acceptance testing - scenarios
 - integration with code



References

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