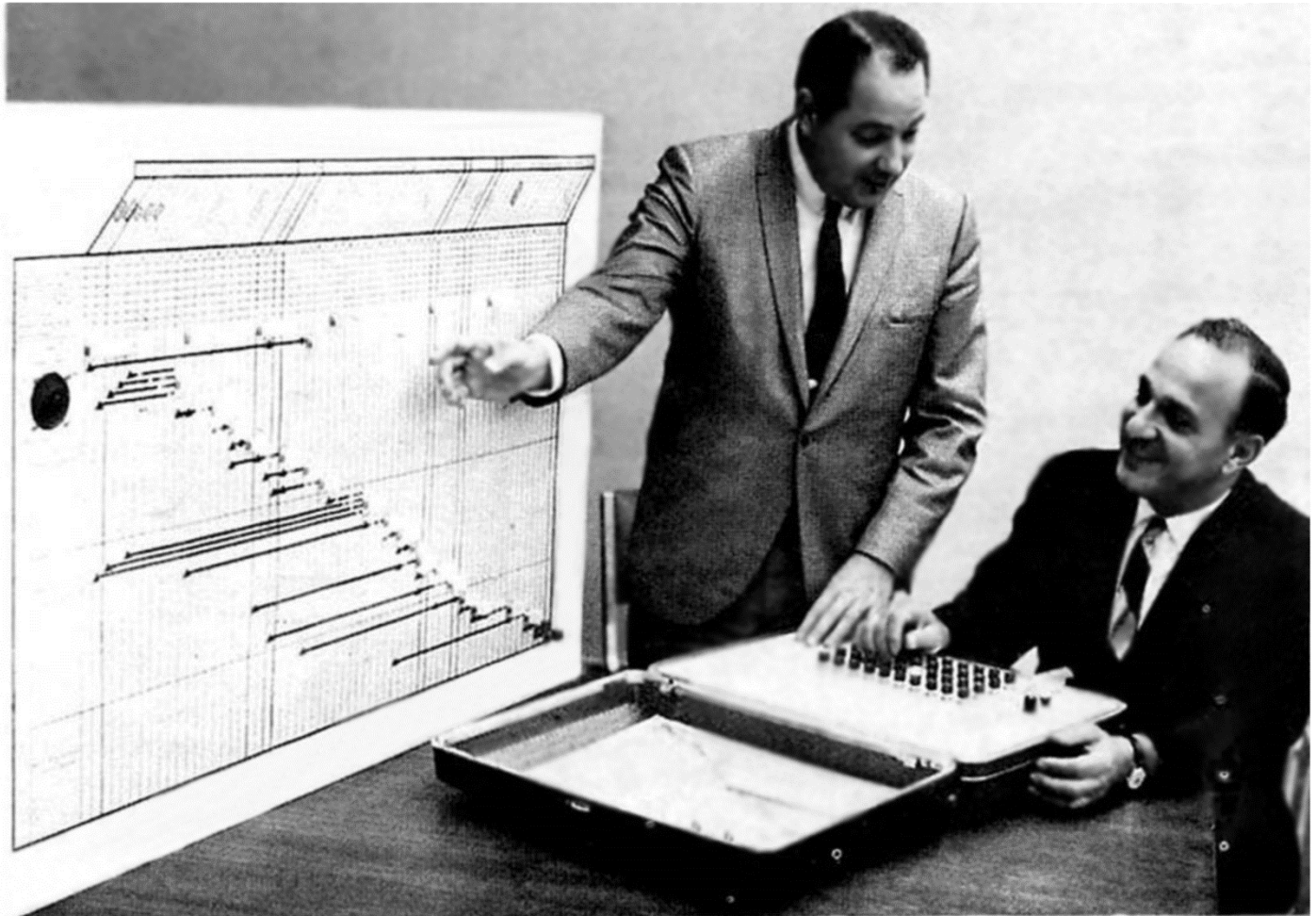# Ever Wonder how or when Testability and DFT Originated?

MIL-HDBK-2165 History

Many of us simply learn what's involved in a technical skill, and get on with the task at hand. This is exactly what management requests as well, and for good reason.

But today, you're going to be briefly introduced to how the concept of Testability ever got started.

LOGIC MODEL — Ralph De Paul (standing) and Gus Daskalakis display logic model for the XM140 gun, which assists in equipment maintenance. A model also has been constructed for Chaparral weapon system.

April, 1969

We travel back to 1965 when Ralph A. De Paul, Jr. first disclosed a method to represent how all functional or failure dependencies in any domain could be represented by the use of three basic geometric symbols – the circle, square and the triangle. This was conceived and proven by De Paul, long before the Personal Computer was introduced as a term. Even today, you'll notice DSI's tribute to those three symbols in its company branding and logo.

The progression towards Testability, as we know it today, was born!

De Paul would form DETEX Systems, Inc. in 1975, where he began his personal commitment to establishing how the performing of any "Testability Analysis" would be an integral proactive activity for the purposes of influencing the fielded design to be more effective tested and maintained. As one could imagine, he would have many hurdles in the lane that led to his work leading to the publishing of the MIL-STD 2165 "Testability" Standard, as authored by William Keiner – one of De Paul's earlier DoD students of the late 1970's.

The timeline below will provide many hyperlinks to documents that blazed the trail along the way. Yes, De Paul had to work through a local US Congressional Representative to move this along – this was not an easy trail.

Since that time, and with our ears open wide to the sharpest minds in industry, we were able to take this concept of defining the functional and failure interrelationships of *any* design, and organize and formalize the structuring of that data into a comprehensive dependency model. This structure was extended to capture, not just the documented data relevant to form the system models, but include data and knowledge often only existing in the minds of the Subject Matter Experts, and places this knowledge in a form of *property*, or *asset*, that is extensible in perpetuity.

We refer to these models today as, "***eXpress***" Diagnostic models. They have captured the functional and failure interrelationships of some of the largest and most complex designs in the US military.

But the first amazing trick, is to enable the same Model-based structure to actually *integrate* (as opposed to only *incorporate*) the data from all design disciplines and domains, and form an integrated knowledgebase ***property*** that produces independent and interdependent, push-button design assessment outputs, including:

Systems Engineering: Integration with MBSE through SysML-***eXpressML***
Testability or DFT: Fault Detection, Fault Isolation, False Alarms, Test Point Placement
Diagnostics Engineering: BIT and Diagnostic Validation, all basic and all complex or custom assessments
Reliability: FMECA, Fault Tree Analysis, RPN, Sneak Path Analysis, MBSA
Maintainability: MTTI/MTTR, Fault Code Assignment/Management, RCM-PdM-CBM Trade Studies/Simulations
Test & Troubleshooting: Diagnostic Sequencing for ATE, TRDs or TPS

And the amazing trick continues to impress as this same integrated knowledgebase ***property*** can be dressed up or dressed down to perform as an integrated ***Diagnostic Reasoner*** in operational and maintenance roles, including:

On-board Diagnostic Reasoning: Integration with Health Monitoring or Health Management Systems
Automatic Test Equipment: Integration with Test Executive for Health Monitoring
Guided Troubleshooting: Integration with Portable Maintenance Aids, History and Session Recording databases
Variable Reasoning: Static, Dynamic, Design-based, Empirical
Continued/Integrated Reasoning: Unique Fault Codes integrate Diagnostic Conclusions to all operational paradigms.

Enjoy connecting the dots with the timeline and be sure to challenge your audience on how all of this came into fruition and to how it led to where it evolved today!

MIL-HDBK-2165 History

A detailed chronology of the history of DETEX Systems, Inc., its founder, Ralph A. De Paul, Jr., in its intrinsic role in the maturation of Testability, MIL-STD 2165, Design for Test, Integrated Diagnostics, MBSE and Designing for Sustainment.

- **04/1965**: De Paul prepared a Design Disclosure Format (DDF) document that was incorporated into MIL-M-24100(A);

- **06/1966:** MIL-M-24100(A) Published;

- **09/1967:** DDF was enhanced by De Paul to include Fault Isolation and "Performance Monitoring" with Semi-Automated techniques. "FIST" documented to refer to "Fault Isolation and System Test" - still a precursor to ML-STD 2165;

- **01/1974:** Release of MIL-M-24100B, co-authored by De Paul. This is the final precursor to MIL-STD-2165. The DDF was the first document to formalize the use of failure, function, test dependency model, known as Maintenance Dependency Charts (MDCs);

- **02/1975:** De Paul forms DETEX Systems, Inc. and formalizes the first computerized use of the MDC in field applications in all branches of DoD. This formalization was identified as an innovation to use this test and isolation representation for Maintenance activities as the Logic Model, or "LOGMOD";

- **05/1977:** LOGMOD hosted on Portable Computerized Device for Maintenance was first introduced to the US Army at Moffett Field. US Army concludes that *"The logic modeling concept is considered to be an engineering innovation;*

- **10/1978:** USAF concludes that LOGMOD is an effective tool for Guided Troubleshooting;

- **04/1980:** Letter from Congressional Leaders to US Joint Logistics Command (JLC) stating that *LOGMOD offers accuracy to diagnosis and troubleshooting* that is not limited to size or complexity and could provide substantial savings in cost;

- **08/1980:** Lockheed (Burbank) purchases Source Code (Internal Use) License of LOGMOD from DETEX Systems, Inc. for $375,000.00 to target F-117. Part of the Agreement prohibited DETEX to sell Source Code License in Industry for a limited time;

- **12/1980:** LOGMOD used as a "Testability Tool", declared by Joint Logistics Command (JLC) Panel on Automated Testing (William L. Keiner);

- **05/1981:** DETEX Systems, Inc. supplies US Army with first prototype versions of a (battery-operated, electronic, hand-held) *Stand Alone Maintenance Aid,* or "SAMA" for Guided Troubleshooting;

- **01/1985:** MIL-STD-2165, the first recognized testability standard released. William Keiner (US Navy) was the author of MIL-STD-2165, who authored MIL-STD-2165 after frequent visits to De Paul of DSI International over a 5-year period *(see letter to JLC;*

- **11/1986:** DETEX Systems, Inc. selected to team with Lockheed (Georgia) to co-author MIL-STD 1814, "Generic Integrated Maintenance Diagnostics (GIMADS)";

- **10/1988:** DETEX Systems, Inc. delivers *first Licensed Desktop PC* copy of STAT (System Testability Analysis Tool) to Boeing;

- **03/1989:** DETEX Systems, Inc. contracted to co-develop US Navy's Weapon System Testability Analyzer (WSTA);

- **09/1994:** Ralph De Paul awarded IEEE John Slattery Award for using Testability opening pathways to "Model-Based Diagnostics;

- **05/1996:** DSI International, Inc. resumes for DETEX Systems, Inc. after passing of Ralph A. De Paul, Jr.;

- **02/1997:** DoD releases MIL-STD 1814 and the companion AF Guide Specification, identifying LOGMOD and DETEX Systems, Inc.;

- **08/1998:** DSI releases *eXpress* – the first Model-based based diagnostics targeting the PC that produces diagnostic assessment and test sequencing for ATE and guided troubleshooting using a proprietary functional and failure "hybrid" methodology;

- **09/2003:** Navy recognizes DSI for steering the IEEE Standard 1232-2002 newest Testability Standard (published in 2004);

- **04/2014:** MIL-STD-2165A reclassified as a handbook, MIL-HDBK-2165.