

ROI on PHM...Is it Realistic?

Many in industry are beginning to admit that calculating Return on Investment (ROI) for PHM (Prognostics Health Management) is not as straight forward as some may suggest. Parts are omitted. Particularly, the part about ROI analyses that consider the full integrated system design. This is obviously a result of the fact that we don't all agree what is included in costing PHM. First, we need to determine what we mean by PHM - is it limited to the prognostic studies or does it include the full integrated systems analysis, design and support of all system components? Are the ROI studies focused on the complete integrated system, or merely an abstraction of pieces here and there as chosen from within the full integrated design? Do these studies include the many factors involved in the interrelationships and effects of all contributing subsystems, the design and production process, and the operation and support environment?

If the functional interrelationships and full Life Cycle Cost factors are not understood, ROI calculations are missing over 90% of the major cost drivers.

This may seem to be in conflict with many academia studies that claim prognostics centered design and health management reduces operational and support costs. In reality, investing in systems prognostics, based on today's technologies and experience, result in higher acquisition, and operational and support cost. This is not inferring that the prognostics studies are no value, but rather that the studies are not based on specific components of support that are interdependent with other designs and environmental elements unknown or disjointed from the data used in the studies.

There is a need for focused prognostics based on physics of failure, Condition Based Maintenance (CBM). The traditional "failure trend" prognostics is of minimal value in attempting to determine remaining useful life of a specific operating function. Even with the application of CBM for management of critical failure modes, it has become clear that a shotgun type selection of prognostics analysis results in project risk with high cost, and excessive maintenance down time from false prognosis.

To bring out a point to this discussion, the following is based on an article on needed acquisition reform published entitled "Weapons Acquisition, Spending Too Much, Getting Too Little", in IEEE Spectrum in November 2008:

"Behind the deterioration (of the acquisition process) is a convergence of factors, say analysts both inside and outside the Defense Department. New military systems are more technologically complex than ever before, and they rely increasingly on unproven technologies.

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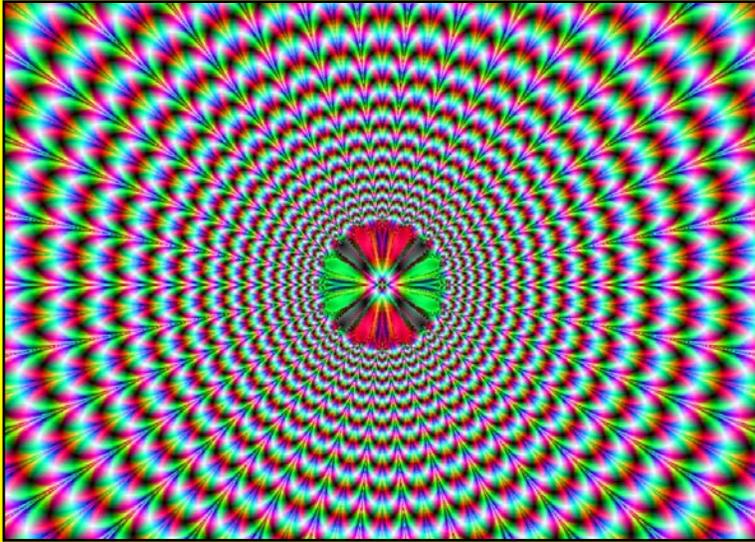
Defense programs are now "so massive and so fanciful we don't know how to get there," says Katherine Schinasi, the GAO's managing director of acquisitions and sourcing management. And engineers, scientists, and technicians skilled enough to design, build and debug such complex systems are scarce."

"Too often, also, politics trumps technology and even common sense. DOD managers and service brass aren't the only people who have a stake in which military systems get developed and which don't: congressmen, defense contractors, lobbyists, and economic development officials are all aggressive players in the weapons-acquisition process, all pushing for their pet projects. The result is a proliferation of (academia type technologies and unrealistic requirements) that the Pentagon cannot fully fund and that are nearly impossible to cancel. Politics also leads contractors to overpromise on what they can deliver and this leads DOD staffers to turn a blind eye when those promises aren't met."

The solution to effective and low cost systems health management is the Integrated Systems Diagnostics Design (ISDD) Process®. ISDD is very effective in optimizing the balance of PHM with Diagnostics for Health Management on new Integrated Systems designs. The ISDD Process is also very effective on Legacy systems that are undergoing updates for technology infusion, obsolescence, or correction of field problems. ISDD uses proven technologies that reduce Total Ownership Cost and improves Safety, Mission Success, and Operational Availability. An important outcome of the ISDD Process is a recommendation for selective CBM based on failure mode criticality. This process needs to be implemented using a proven Integrated Diagnostics tool that supports a Systems Engineering design. The **eXpress** Diagnostics Engineering tool is the core of the ISDD Process. As such, **eXpress** is the diagnostics design and assessment tool of choice throughout industry and is being used in the US, Europe and Asia.

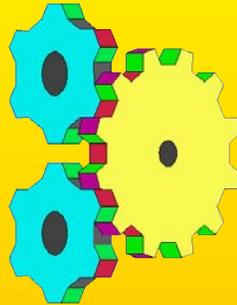
Any investment into Prognostics in an attempt to address PHM requirements needs assurance that it will indeed be visible and not inadvertently obscured by other interrelated subsystems that can interfere with the sensor interpretation at the system level at any time as a result of the nature of an integrated system design and/or environment. This is never obvious or available when the Prognostics studies for PHM requirements are being performed outside of the ISDD Process. The ISDD Process makes known all such inadequacies within and inclusive of the integrated system at any and all levels of the integrated systems design. This inclusive characteristic of the ISDD Process properly adjusts the ROI studies so that they can be appropriately performed and not so subjective or biased by merely ignoring the interrelatedness of many systems components not possible to consider in other methodologies.

“PhM Disturbia”



Technical and economic accountability and responsibility for PHM (Prognostic Health Management) at the Integrated Systems level has yet to be the primary concern for DoD funded PHM activities. Apparently, the appeal of exotic new technologies, specifically, PHM, has blurred the vision away from this Integrated System's attachment to the real world. Instead, we are blissfully distracted with the hope and luster of escaping into the promise of brilliance at the lowest levels of design at any expense.

As such, the PHM activities continue to be of high risk at the integrated System level due to the lack of the appropriate level of accountability to produce a convincing argument that they are equally capable of integrating the entire diagnostic and prognostic concerns at the integrated system level. From our view, this is the “PhM Disturbia”



For some time now, people have been altering the “label” of their expertise to be more closely synchronized with DoD's apparent funding mood swings. This is just the typical re-posturing game that calls for another quick jump on the band-wagon of another DoD funding cycle caught spell-bound between exotic story-telling and a PhM paper-writing frenzy. Welcome to the PhM Disturbia, tattooed with an impressive line of jargon buzz embossed in hypnotically PhD vernacular. We've seen this too many times where these studies ignore many operation and support factors and result in high cost and risk concepts.

However, we are disturbed. We see too many inconsistencies and omissions in the story telling of prognostics – the good, the bad, and, well, let's just say, the disturbing.....

- What does “prognostics” mean to you?
And, what does PHM mean and/or include?
- Where should Diagnostics get involved with PHM, if at all, and how?
- Do we really know if, when, and where prognostics is better than CBM (Condition Based Maintenance)?
- Where is the best mix of prognostics, diagnostics and/or CBM?

- Do we really know if prognostics is using economic wisdom, or does our customer really care?
- Are the customer's PHM requirements understandable and accountable at all levels of the integrated design, or do we effectively confuse him and those around us with our use of exotic vernacular?
- How do we verify that we meet the prognostics objective in any variable (uncontrolled) environment – at the integrated system level and over time?
- How do we verify that our PHM investment maintains proper sensor and signal interpretation at the integrated system level?
- How do we protect our PHM investment(s) so it remains clear and unambiguous among nested subsystems that may interfere with our ability to discern among other interrelated systems and (dirty/damaged) sensors in our integrated systems design?
- Do we have a plan to validate any items replaced due to a prognostic event to determine if the replacement was within the required prior-to-failure window?

While there are many more questions similar to these that can be imagined, it may be disturbing to know that these 10 questions are not getting equal DoD attention and “hot air time”. When and after we work the answers to these questions, then, maybe, we can hope for promise in adopting some responsible, accountable, measurable, and ascertainable level of prognostics in our integrated system design process. But first, we have to shake the confusion and PhM Disturbia.

As learned from witnessing this sort of “we-do-it-while-its-vogue revolution” so many times in the past, the specific name of the new technology will continue to evolve or change as some struggle with competency, terminology, approach and a story to tell.

While this may sound a bit disturbing to some of you not quite so familiar with the game, you can always find comfort in the 35-year track record at DSI – a cornerstone fixture in Industry through all these vogue funding cycles and mood swings. With the solid Diagnostic Engineering infrastructure using **eXpress** in the Integrated Systems Diagnostics Design (ISDD) Process®, PHM will be replaced with PHM and take on responsibility and accountability at the integrated systems level, setting the STAGE for any of these exotic high-Technology Risk Level methodologies to be just a bit less risky.

Ensure and leverage the investment into PHM. **eXpress** takes the “PhM Disturbia” out of the PHM by working all of the diagnostic and prognostic data and concerns through and across multiple subsystems within the Integrated System. PHM can then be fully supported by the Integrated Systems Diagnostic Design, which is better tooled to account for the possible effects of environmental variables, and the economics of responsible support practices (including CBM) and the handoff of Integrated Systems knowledge to a host of embedded systems, Reasoners and advanced field support IETMs.

Knowing the vernacular of a technology is great. However, being able to synchronize the PHM technology transparently within the ISDD Process in a collaborative design environment, regardless of who, what or when other designs are included or may surprisingly intervene, is the fundamental infrastructure property leveraged within the **eXpress** diagnostic engineering tool.

eXpress: A sort of “Get out of ‘PhM Disturbia’ NOW ticket”.

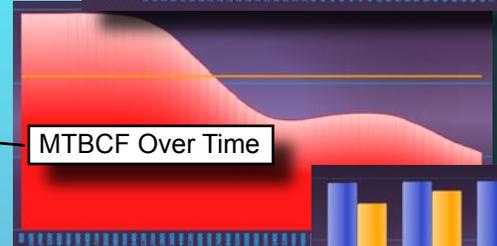
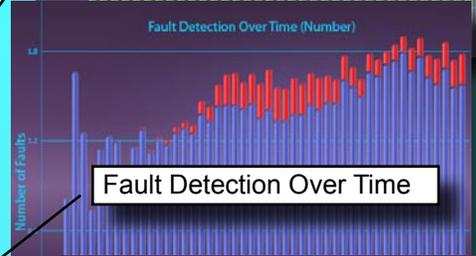
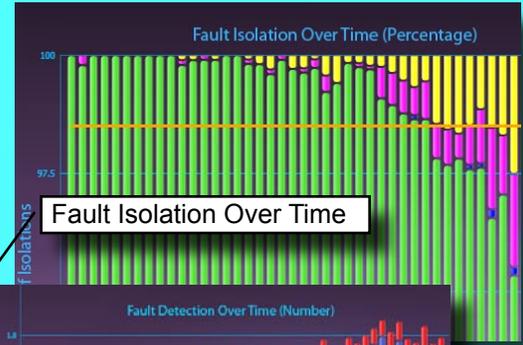
STAGE - Operational Simulation & Support Analysis Tool

STAGE is a turn-key engineering solution for System Health Management and Support, providing simulation-based assessments of the combined effects of different approaches to Design, Test, Diagnostics, Prognostics, Maintenance and Support. No other tool provides comparable support for diagnostic engineering trade studies.

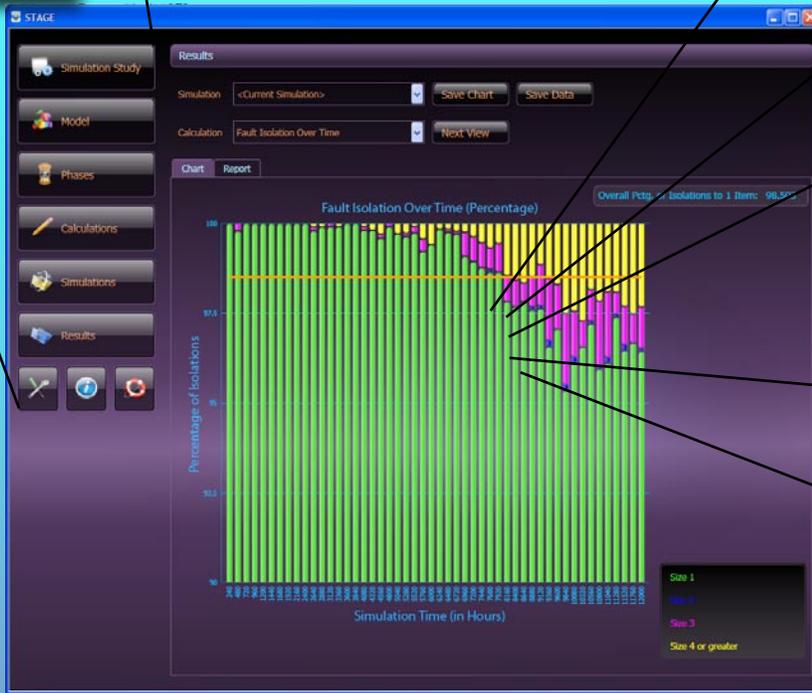
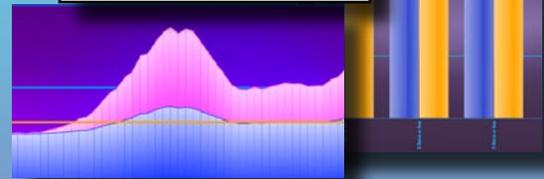
Over 100 graphic assessments of system behavior over time, including testability, failure, replacement and severity metrics. Use STAGE to reduce the cost of premature replacement or to eliminate false alarms that result from inadequate diagnostics (15-40%).

Populate simulations by importing **eXpress** or other diagnostic data using the Diag-ML format.

STAGE is a tool in DSI's ISDD™ Applications Suite.



...and Many Many More



Training Schedule

Course Number	Pre-requisite	Course Description	Dates	Location	POC
100		System Diagnostics Concepts and Applications	20 Apr, 2009	Orange, CA	Denise Aguinaga , DSI
110	100	Basic Modeling & Introduction to Testing	20 Apr, 2009	Orange, CA	Denise Aguinaga , DSI
120	110	Introduction to Testing & Analysis	23 Apr, 2009	Orange, CA	Denise Aguinaga , DSI
200	120	Advanced Diagnostic Development & Assessment	4 May, 2009	Orange, CA	Denise Aguinaga , DSI
205	200	Advanced Test Development & Importing	6 May, 2009	Orange, CA	Denise Aguinaga , DSI
210	205	Advanced FMECA Development & Assessment	8 May, 2009	Orange, CA	Denise Aguinaga , DSI
100		System Diagnostics Concepts and Applications	22 Jun, 2009	Orange, CA	Denise Aguinaga , DSI
110	100	Basic Modeling & Introduction to Testing	22 Jun, 2009	Orange, CA	Denise Aguinaga , DSI
120	110	Introduction to Testing & Analysis	25 Jun, 2009	Orange, CA	Denise Aguinaga , DSI
200	120	Advanced Diagnostic Development & Assessment	27 Jul, 2009	Orange, CA	Denise Aguinaga , DSI
205	200	Advanced Test Development & Importing	29 Jul, 2009	Orange, CA	Denise Aguinaga , DSI
210	205	Advanced FMECA Development & Assessment	30 Jul, 2009	Orange, CA	Denise Aguinaga , DSI

DSI Executives to Visit China in May

DSI will be visiting with its Chinese representative, MTCS Systems Engineering Co Ltd, May 11-20, 2009. Those of you who are interested in joining in this opportunity to discuss **eXpress**, STAGE and the ISDD Process with DSI, please contact either Robert Wang and/or Hongwei Shi.

Please find their contact information at the bottom of this Newsletter.



ROI on PHM...Is it Realistic? (Continued from Page 1)

The use of **eXpress** in the ISDD Process establishes all of the component and design interrelationships that call out the utility of sensor(s) and Built in Test at the integrated system level.

Integrated systems sensor integrity is also an integrated design analysis prerequisite for health management. This is where **eXpress** excels as a design influence and knowledge resource tool that allows rapid and accurate embedded diagnostic Test Executive and Reasoner development. The Diagnostic Markup Language (DiagML) interface between **eXpress** and third party applications enables the efficient reuse of design knowledge that was developed in **eXpress**. Using this integrated systems diagnostics information from **eXpress** with STAGE allows the integrated systems designs to benefit from influencing the optimum diagnosable/prognosable design to begin with; thus, synchronizing the repair/replace/remediate/reconfigure/downgrade mission decision-making into the integrated system and beyond to the Systems of Systems level. This makes the association to simulation calculations more relevant, accountable and paramount for evolving the Maintenance Planning capabilities with the requirements of the integrated systems design.

It is now apparent that others are beginning to admit to the painful price for not previously institutionalizing responsibility when considering PHM. This is an implied concession evidenced by the alarming costs being scrutinized today that are associated with such high-risk, exotic technologies employed on such programs as the F-35, Joint Strike Fighter.

It is no secret that we are in a period where dollars are at a premium and should be highly scrutinized. Far too much has been expended with little realized actual Return of Investment, which presupposes any possible Return on Investment. Much of these PHM study activities have been funded through research programs and have not previously been required to think in terms of ROI. But it is clear today that those days are fast approaching an end – Thank Goodness! Now, it's time for PHM to think in terms of ROI, which is nothing new for DSI or how it has been fully engaged in this concept before SBIR was ever a thought.

The good news is that YOU have the opportunity with **eXpress** and STAGE to actually perform unbiased ROI analyses – in your own facility, using your own resources, and your own expertise. You can be better equipped to evaluate the ROI of PHM without any third party telling you their answer for you. This is where the funds invested in ISDD would not only promote prudent risk management and cost control, but also provide a realized benefit internally as well as to industry. This inherent “checks and balances” capability can also serve as the fundamental “ROI staging” for mapping the requirements of PHM at the Integrated System level from an economic perspective – and over time. The institutionalizing of the ISDD Process, particularly where PHM is a requirement, adds the salt and intelligence at the integrated systems level for PHM as well as for any complex Reasoning capability – the common sense piece missing from the faltering Acquisition process bewildering DoD today.



eXpress™ Users Group Meeting

Date: Friday, September 18th, 2009

More details soon to be announced!

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