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Society for Machinery Failure Prevention Technology
A Division of the Vibration Institute




MFPT forum

ANNOUNCEMENT and CALL FOR PAPERS for MFPT 62

62nd Meeting of the Society for Machinery Failure Prevention Technology Sheraton Oceanfront Hotel in Virginia Beach, Virginia

May 6-8, 2008

THEME: Failure Prevention for System Availability

INTRODUCTION

'MFPT 62', the 62nd Meeting of the Society for Machinery Failure Prevention Technology (MFPT) will be held May 6-8, 2008, at the Sheraton Oceanfront Hotel, Virginia Beach, Virginia, Tel (757) 425-9000. **Please note the new hotel venue for 2008.** The Sheraton is much closer to the center of the shoreline "strip" and offers better access to amenities as well as superior accommodation, parking and facilities.

In the planning of MFPT 62, the Program Committee will continue to promote the Society's policy of cooperation with organizations that have related technical interests. These organizations include professional societies such as SEM, STLE, ASM, IEEE and ASME; the Shock and Vibration Information Analysis Center (SAVIAC); and a number of Universities and Centers of Excellence, in particular the ISM at the University of Cincinnati. Chris Pomfret, Executive Director of the Society, is the Conference Manager.

As always, MFPT encourages the creation of written papers and will publish papers that are received by the deadline in a hard bound set of proceedings, available at the conference, and in electronic CD format (with the non published presentation material and keynote speeches) after the conference. While a Powerpoint presentation is a perfectly acceptable format for the conference and CD, we do encourage potential presenters to write a paper and receive the appropriate professional recognition and publication.

THEME

The 2008 Program Theme was chosen in response to the growing importance of availability to system operators' performance, efficiency, competitiveness and, ultimately, "bottom line". The conference will thus focus on how failure prevention technologies beneficially influence availability, and therefore effectiveness, support cost and through-life value of the systems that they support.

TECHNICAL SESSIONS

The technical sessions at MFPT 62 will be developed by the Technical Program Committee based upon the abstracts submitted. In keeping with the theme, we would especially like abstract submitters to address in their papers how their sciences and technologies contribute to improving availability of the higher level systems they serve. Technical Committee Chairs will organize the sessions, which will be part of three parallel technical tracks. Suggestions and questions should be submitted to MFPT Headquarters. Paper topics for the conference include, but are not limited

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at a glance

The MFPT FORUM is published by the MFPT Society. It is distributed to members of MFPT and the Vibration Institute. Others who wish to receive subsequent issues should contact the MFPT Headquarters.

Visit our home page at: http://www.mfpt.org

The MFPT Society is a division of the Vibration Institute. The Institute, including the MFPT Society, has been approved by the IRS as a not-for-profit corporation. This means that the MFPT Society pays no income tax and can accept tax-deductible contributions from corporations and individuals. Any yearly surplus in MFPT Society revenue is used to maintain continuity of operations and to provide new programs for members.

Society for Machinery Failure Prevention Technology (MFPT), 5100 Springfield Street, Suite 420, Dayton, OH 45431

from the chairman's desk

Deterministic vs. Empirical Diagnostics

By William D. Marscher

Many approaches to machinery diagnostics have developed over the years, engendering a wide spectrum of opinions about where future research dollars would best be spent. One genre of approach, which I call the *empirical approach*, involves diagnosing potential machinery problems based solely on a comparison of the STATISTICS of current measurements to the statistics of prior measurements on either the machine in question, or on similar machines in similar circumstances. An alternative or supplemental approach known in the field as the *deterministic approach*, involves using detailed knowledge of specific components and processes inside a machine to provide perspective on any diagnostic data, based on the PHYSICS of the system. Deterministic approaches use the laws of physics to predict how a given machine should behave, as well as how it might mis-behave. The actual system behavior is then compared not only to the ideal behavior, but to modeled predictions of system response to various "what-if" system flaws.

Both the empirical and deterministic approaches apply comparisons to actual operating data, allowing logical conclusions concerning machinery health based on actual real-time behavior. Examples of the empirical approach include various implementations of neural net methods, other forms of "adaptive learning" (normally this involves various levels of statistical analysis of the data in order to perceive trends in a "fuzzy" manner), and most types of artificial intelligence (AI) such as troubleshooting-database expert systems. It is surprising, but philosophically correct, to include in this category machinery acceptance standards and vibration specifications. All types of empirical methods make the assumption that the system under scrutiny behaves consistently enough that the "pattern" of its behavior can be recognized. In the case of neural net or adaptive learning schemes, the further assumption is that any malignant pattern can be recognized as such, without false alarms. For complicated systems such as turbomachinery, that is a very tall order. Is it realistic to assume that any serious fault that the machine is likely to encounter during its useful life will have been encountered earlier in its life, or at least in some other similar machine, so the fault type and its severity always can be categorized?

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submitted to MFPT Headquarters. Paper topics for the conference include, but are not limited to, the following:

- Diagnostics and signal analysis
- Data usage, manipulation and creation of information/knowledge bases
- Prognostics (machinery, structures, electronics)
- Selection and application of metrics
- Fault detection and failure prediction
- Standards, definitions and terms of reference
- Corrosion detection and prevention
- Remaining useful life determinations
- Tribology (wear, lubrication, coatings applications, etc.)
- Distributed system architecture
- Structural health management
- Sensor technologies and applications
- Practical case histories

CONFERENCE AGENDA

The Agenda will comprise an Opening Plenary Session designed to highlight the current and future cutting-edge technology needs that challenge our technical community. Three parallel technical tracks will then follow for the next two and one half days. Conference sponsors and/or exhibitors will be able to present their capabilities in a special 'New Products and Services' Session.

A preliminary conference program will be posted on the MFPT website in **December 2007**, including complete hotel and registration information, and will be periodically updated to include the latest details. This *Call for Papers*, along with an on-line Abstract Submittal form, can be found on the MFPT web site now.

SUBMISSION OF ABSTRACTS

Please **submit your abstract on-line** at www.mfpt.org by **September 14, 2007** using the MFPT 62 Abstract Submittal Form. If the paper has been published or presented before, please give the circumstances.

PREPARATION AND PUBLICATION OF PAPERS

Principal authors of accepted papers will find full instructions for paper preparation under *Author Guidelines* on the MFPT web site. Authors must submit their final papers on the MFPT website by **1 February 2008** to meet the deadline for publication in the case-bound black and white Proceedings, which will be available at the Conference. In addition, a CD of the entire Conference Proceedings, containing all the written papers and PowerPoint presentation charts, will be issued after the conference. **For all contributed papers published in the proceedings, a speaker will be required to attend the conference, present the paper and pay the required registration fee.** Publication of the paper is contingent upon the payment of the fee. The Henry and Sallie Pusey Award, introduced at MFPT 61 in April 2007, will be presented to the author of the paper judged to have the best technical content.

EXHIBITS AND SPONSORS

Technical exhibits form an integral and important part of the MFPT conference and ample time will be scheduled for participants to visit the exhibits. The number of exhibits is limited and will be assigned on a first-come, first-served basis. Exhibitors may reserve a 3' x 6' table-top exhibit for $900, or an 8' x 10' booth for $1300—see the Exhibitor Layout plan on the MFPT website. Once registered as an exhibitor, the company logo will be displayed on the MFPT website, along with a brief company description and contact details. Exhibitors are also encouraged to give a 10-minute presentation in the New Products and Services Session. Furthermore, an Exhibitors' Reception will be held on the evening of the first day of the conference. Lunches and breaks will also be served in the exhibit area each day. To participate, please complete the *Exhibitor Registration* form on the MFPT website. Exhibitors who reserve space by **January 15, 2008** will be profiled in the MFPT 62 feature issue of *Sound & Vibration* magazine. Exhibitors will receive one free admission to the Conference.

As a new venture in 2008, and as an alternative to exhibiting, companies and organizations are welcome to sponsor a break or meal during the conference:

- Morning and afternoon breaks: $500
- Breakfast: $750
- Luncheon: $1,000

Companies interested in so doing can negotiate, with the Conference Manager, the publicity, advertising and "podium time" that they would like in return for their support and in keeping with the level of sponsorship selected.

If you have questions on any of the above information, please contact:

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5100 Springfield St, Suite 420
Dayton, OH 45431-1264
Tel: (937) 256-2285
Fax: (937) 256-2603
Email: chris@mfpt.org, rick@mfpt.org
URL: http://www.mfpt.org

This is the Final Paper Newsletter.

Please Give Us Your Email Address!

In the interests of enhancing our communications with you, reducing our call on natural resources and controlling MFPT printing and mailing costs, this will be the last *MFPT Forum* newsletter that we shall be mailing. Note also that it is the first edition of *Forum* that is available in color (in electronic form only). So, if you have not received this newsletter electronically, *please, please, please* **'Join Our Emailing List'** using the box at the bottom of our homepage at www.mfpt.org, or send your email address to rick@mfpt.org.

Diagnostics

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Because of this difficulty, some AI methods assume that, even if the particular fault being diagnosed hasn't been encountered previously and therefore cannot be identified specifically, the degree of change of the operating characteristics of the machine are sufficient to red-flag the machine as "sick."The machine can either be taken out of service or additional diagnostics can be performed. A couple years ago, I was involved in the diagnosis of a steam turbine with an oil seal that was harmlessly coking up, causing a shift in the operating behavior of the machine. To shut the machine down prior to the intended plant outage would have cost the plant $250K per day, and the machine would be apart at least 6 weeks for repair. By using a deterministic approach (a detailed rotordynamics analysis run through a variety of "what if" scenarios), engineers iterated inputs until the analysis matched the actual behavior, and diagnosed the internal fault without machine shut-down and disassembly. Do you think that the plant owner would have/ should have been happy with an approach of "Its behavior is unusual and involves relatively high vibration levels, so let's shut it down to be safe"? Perhaps so if there were no alternative-a cratered machine is an expensive proposition, and involves human safety concerns. However, because deterministic evaluation provided a high degree of assurance that the machine could keep running and showed on a worst-case basis that any failures associated with the anomaly would be safely contained, a risk-based evaluation could be made that saved the plant's profitability for the year.

Excessive vibration amplitudes imply either that internal forces within the machine surpass its design capabilities or that, because of sufficient displacement at close running clearances, the machine is merrily machining new clearances for itself and leaving an aftermath of wear debris and greatly reduced thermodynamic performance. Therefore, vibration is a common measure number used by both empirical as well as by deterministic diagnostic systems.

As a simple example of the application of the empirical approach using vibration measurement, consider the ISO machinery specifications such as ISO 10816: a mean vibration velocity of 0.12 inches/sec RMS indicates that an industrial turbomachine is outside of its normal behavior, 0.25 inches/sec RMS indicates that it is in distress, while 0.5 inches/sec RMS indicates that the same machine is in grave danger. While such limits make sense for machinery in general, high energy density machinery such as boiler feed pumps, rocket turbopumps, and aircraft gas turbine engines are known to be able to tolerate much higher levels of vibration, in many cases over a very acceptable lifetime of the system. At the opposite end, for pumps and compressors operating at very low flow rates even the 0.12 inches/sec is an unacceptably high level for long-term survival. The message: If what is going on inside these machines can be evaluated in a high fidelity deterministic fashion, a much more reliable diagnostic system would result.

When knowledge is weak concerning the specific physics of a machine, then an empirical approach is all that is available (other than just plain guess-work). If you think that I am merely making a joke, please keep in mind that many plants around the world perform most of their diagnosis at least in part by guess-work, and do it successfully the great majority of the time. If the guesser has an intimate knowledge of what is inside the machine and how this relates to the noises and structural "frequency-feel" of the machine at certain operating conditions in the face of certain faults, he can develop a superior track record to empirical techniques. This is really a form of the deterministic approach: the guesser uses his/ her knowledge of the guts of the machine together with whatever sensory input is available to assess the state of health of the machine.

The past problem with computer-based deterministic methods was the impracticality of the computer resources required to exercise them in a high fidelity fashion. Because of the tremendous progress made in the last decade in the areas of time-effective, detailed, finite element analysis and rotordynamic analysis, it is now practical to apply these tools in real-time, in an accurate and cost-effective manner, to reliably predict how a complex machine will behave as-built, as well as in response to various metallurgical and tribological flaws. It is not enough to simply use such methodology during the original design process or for follow-on troubleshooting. To not take advantage of such capability in advanced health monitoring systems for machinery would be the equivalent of not including anatomy as part of a medical school's curriculum- why would anyone make health judgments without taking internal component operation and design into account?

Ten years ago, perhaps even five, computers of reasonable expense were too slow to provide real time "physiological" evaluation and interpretations for machines. Multiple-core 64-bit systems and the huge arrays of inexpensive high-speed memory that they can access has opened up a sudden frontier in diagnostics. Deterministic methods can be brought to bear and even take the lead from empirical methods in diagnostic assessment and prognostic extrapolation. My vote is for synergy-coupled together, empirical and deterministic methods promise to be incredibly powerful and reliable in their evaluations.

The detailed general deterministic model can be made specific to a particular system through what-if iterations that are calibrated and guided by empirical real-time information from a variety of appropriate sensors ("data fusion"). Clearances, cracks, local wear, and so forth can be postulated and evaluated, with the model adjusted on a real-time basis to remain consistent with the data. Tribological and fatigue models then can be applied to the current situation to predict remaining useful life, with a high degree of fidelity. Prognosis is a natural by-product when the laws of physics are used in place of guesswork and stand-alone statistics.

Many OEM's have made good strides towards including deterministic models in their diagnostic and prognostic systems, and their efforts are facilitated by the solids model databases they have of their own components.

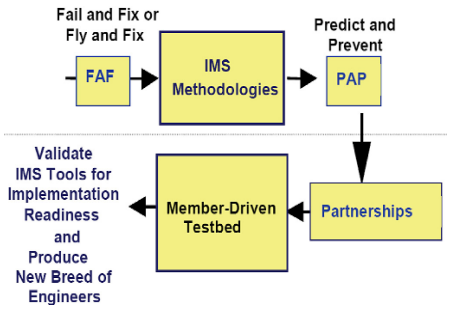
When a non-OEM is the health monitoring system developer, you may wonder where the deterministic models will obtain their geometrical information. The equivalent of the physician's text Gray's Anatomy might exist for a given machine in the OEM's CAD database, but the OEM is typically unwilling to share this information, for reasonable fear of his designs being copied. However, whether it is fair or not, reverse engineering tools have now become inexpensive and ubiquitous. Parts can be scanned in 3-D to a high level of detail. Material properties are available in NASA handbooks and other publicly available books and on-line databases (perhaps hardness measurements need be taken in harmless areas to quantify heat treat). Therefore, required information will be available to the users of high fidelity deterministic systems, with or without OEM cooperation. In fact, the best path for the OEM is likely to be sharing his information in return for NDA agreements where he retains legal control of the database.

I will close with a question. Obviously, you want the person servicing the internals of your turbine to know the dimensions and construction of the turbine components, when a problem has been diagnosed. Don't you want the person performing the diagnosis and prognosis in the first place to have the same advantage? If not, suppose you are riding that turbine at 35,000 feet-does that change your perspective?

Industry/University Cooperative Research Center for Intelligent Maintenance Systems (IMS)

By Dr. Jay Lee (Director of the Center for Intelligent Maintenance Systems) and Chris Pomfret

The Center for Intelligent Maintenance Systems (IMS) was established in 2001 as a National Science Foundation Industry/University Cooperative Research Center (I/UCRC), through a partnership between the University of Cincinnati and the University of Michigan. In 2005 the center expanded to add a new satellite site, the University of Missouri-Rolla. To date, the center has conducted 65 research projects and test beds in partnership with over 45 member companies and sponsors.



Vision and Mission Statement

The mission of IMS is to serve as a center of excellence for the creation and dissemination of a systematic body of knowledge in intelligent e-maintenance systems and ultimately to impact next-generation product, manufacturing, and service systems with six-sigma quality. The Center serves as a catalyst as well as enabler to assist company members to transform their operation strategies from today's "Fail-to-Fix/Fly-to-Fix (FAF)" to "Predict-and-Prevent (PAP)" performance. The Center brings value to its members both by validating high-impact emerging technologies and harnessing business alliances through collaborative test beds.

The vision for IMS is to enable products and systems to achieve and sustain near-zero breakdown performance, and ultimately transform maintenance data to useful information for improved closed-loop product life cycle design and asset management.The Center is focused on frontier technologies in embedded and remote monitoring, prognostics technologies, and intelligent decision support tools and has coined the trademarked Watchdog Agent® prognostics tools and Device-to-Business (D2B)™ infotronics platform for e-maintenance systems.

How IMS Works

IMS works because of collaboration. Each member company pays an annual membership fee of $40,000 (large company), or $12,000 (small company). The membership money is used to support the key research of the IMS Center, as proposed by the IMS Center researchers. The companies hold an Industrial Advisory Board (IAB) meeting every six months. At this meeting, IMS researchers present the latest results of the research they are currently carrying out. Discussion and poster sessions maximize interaction among companies and researchers during the 1½ day meeting, and the outcome is twofold: First, the 'level of interest" that each company has in each of the research areas is determined by feedback on a "LIFE" form. Second, votes are cast to determine each company's recommended level of financial support for each area. IMS researchers and staff use the feedback during these biannual meetings to steer research towards meeting the goals and objectives of member companies.

Decision Support Tools

Decision Support Tools help you determine what to do when machines are wearing out or have failed. A DST can help you balance your resources when

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IMS

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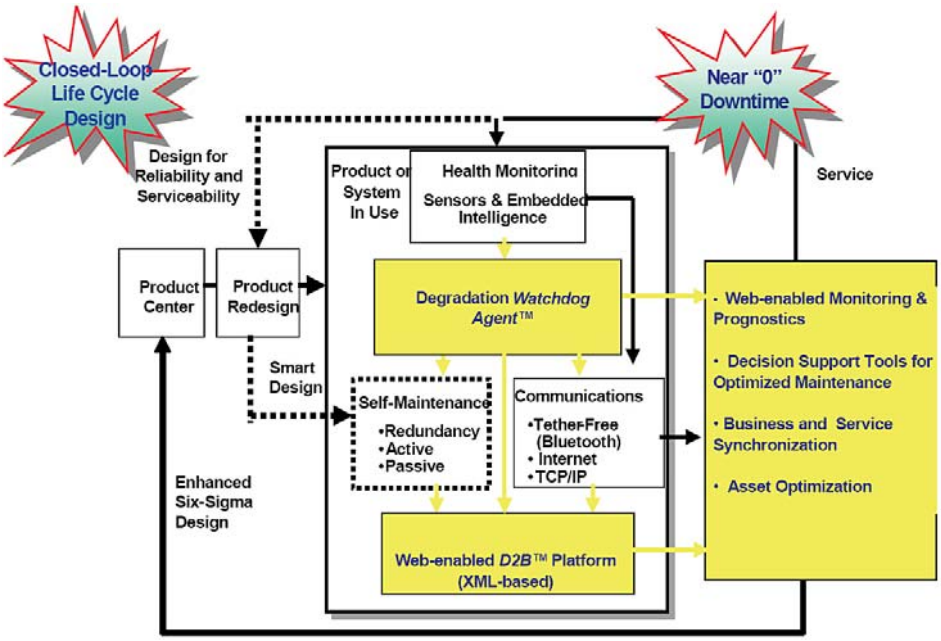
one or more machines are likely to fail by constantly looking ahead. For example, if your production line has three processes A, B and C, such that A has one machine, B has three machines, and C has one machine, what would you do if you could anticipate that one of the machines at station B was going to fail in 30 minutes? Perhaps you'd arrange a staging area for output from A, perhaps you'd ramp up production on the other two machines at station B. Whatever the case, you'd be making your decision before experiencing the impending breakdown.This means that your maintenance and process people are staying ahead of the game; balancing limited resources with constant production demand. A DST helps you minimize losses in productivity caused by downtime, and helps you optimize your maintenance schedule to minimize the length of downtime.



Watchdog Agent and Device-to-Business (D2B) are Trademarks of IMS Center

"Watchdog Agent®"

The Watchdog Agent® can assess and predict the performance of a process, or piece of equipment, based on the input from the sensors, historical data, and operating conditions. Performance-related information can be further extracted from multiple sensor inputs; through signal processing, feature extraction and sensor fusion techniques. The historical behavior of process signatures can be utilized to predict their future behavior, and thus enable forecasting of the process or machine's performance. Based on the forecasted performance, proactive maintenance can be facilitated through the prediction of potential failures before they occur. The goal is to transform the traditional maintenance practices of "fail and fix" to a "predict and prevent" methodology, and ultimately to enable products and machines to achieve zero-breakdown performance and productivity.

Relationship with MFPT

IMS serves primarily the manufacturing and industrial world where efficiencies in production are vital for competitiveness, and equipment downtime is extremely expensive. IMS pursues R&D with its limited financial resources from its members and so use of these resources to fund truly new endeavors is necessary to ensure maximum efficiency of the funds. ISM's attendance at and participation in MFPT will enable its members to see what P&HM capabilities already exist and can be leveraged and possibly built upon. Such synergies between compatible organizations is invaluable for many reasons:

- Maximum value from completed R&D efforts is extracted
- User needs become better understood by a wider community
- DoD-generated technology is transitioned to non-military users, thus meeting DoD's prescribed commercialization goals and justifying future additional R&D funding
- IMS-generated capabilities could be viable solutions to other non member needs, thus generating possible new members or activities for IMS

We look forward to seeing a core of participation from IMS at MFPT 62 next May.

Find out more about IMS at www.imscenter.net.

corporate members

Honeywell

IMPACT

PCB PIEZOTRONICS INC.
A PCB GROUP COMPANY

Wilcoxon Research

MEGGiTT

NASA

More members are welcome!
Contact MPFT HQ for details.

MFPT 61 . . . a look back.

By Rick Wade and Chris Pomfret
Photos by Stella Wade

The sixty-first meeting of the Society for Machinery Failure Prevention Technology took place at its familiar home in the Ramada Plaza Resort Hotel in Virginia Beach from Tuesday to Thursday, 17 to 19 April 07. Despite a number of unfortunate last-minute disruptions to people's travel arrangements, the conference attracted the usual diverse group of around 140 failure prevention specialists, including many new faces, from commercial and military fields, aerospace and industrial arenas, and organizations large and small.

MFPT 61 opened with two excellent keynotes addresses; for the first, the Executive Director ably stood in at the last minute to present the 'Integrated Systems Health Management' vision of Dr. Tom Cruse from the US Air Force Research Laboratory, whose flight had been cancelled because of a mechanical fault (precisely the type of failure we are working to prevent!); this was followed by Telcordia's Dr Adam Drobot who gave an extremely informative overview of Health Monitoring and Diagnostics in the fast changing world of the telecommunications industry.

From Tuesday afternoon through Thursday evening, four parallel tracks showcased the excellent work being undertaken by the participating authors and tutors. The 12 technical paper sessions had drawn 62 presentations on topic areas ranging from sensor integration through electronic prognostics and failure analysis to maintenance and health management. In addition, 9 tutorial sessions covered subjects as diverse as PHM, electronic prognostics, wireless sensors and vibration analysis.

In addition to the technical sessions, 15 exhibitors provided an impressive presence in the Exhibitor Hall. A number were 'old hands' at MFPT but several were newcomers whom we hope to see

Detail Explained at an Exhibitor Stand

A Technical Session in Full Swing

Lunch in the Atlantic Ballroom

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returning next year. Located in the Atlantic Ballroom, the Exhibitor Hall also provided the ideal venue for much of MFPT 61's lively social and networking activity. This included a busy Exhibitor Reception on Tuesday evening, and lunches and morning and afternoon breaks on each day. We also enjoyed the traditional "Open House" Social Event kindly hosted by Oceana Sensor at their premises in Virginia Beach on Wednesday evening. In addition to BBQ and cold beer, an impressive series of demonstrations were on display throughout the company's facilities and ably explained by Oceana Sensor employees.

A Well Earned Break!

The MFPT 61 organizing committee would like to extend their genuine thanks to all those of you who were involved in the conference—authors and speakers, tutors, session chairs, board members and attendees, for making MFPT 61 such a success. Without your hard work and support, nothing would be possible and MFPT would not be in a position to grow and make an ever greater contribution to the failure prevention community. We look forward to seeing you again next year—and your colleagues! As you can see from the Call for Papers, planning is already well under way for MFPT 62.

Note that the MFPT 61 program will continue to be available on the MFPT website, and copies of the Proceedings, both the hard-bound edition, and the new CD version (which contains all the papers, in color, along with just about all the material presented at the meeting) are available from MFPT HQ—just go to www.mfpt.org to find out more.

Geoffery Zhang, Intelligent Automation Inc. Receives the Henry & Sallie Pusey Best Paper Award from Vern Fox (see article on page 10)

Failure Fan-alysis

Failure Analysis Photographic Documentation—Film vs. Digital?

By Marc Pepi, US Army Research Lab

Just recently, a past customer inquired about a series of photographs we had taken approximately twelve years ago in support of a failure investigation. It turns out that one of our recommendations was being incorporated into a new procurement package, and our photographs were going to be used for reference.The customer needed our original photos for this task. Original photos? They were taken with the Polaroid® system we had back at the old Watertown Arsenal. Although we have all the paper files related to this program still on hand (the one good thing about being a pack rat), our policy was to send final reports to our customers with the original photos, and color copy the final document for our records. As such, we were not able to track down the original photos. This got me thinking about film vs. digital and how far we have come in a short number of years in this area. If we were digital back then, would we still have the original photos? Maybe, maybe not; we have had many computer changes over the years; however, we probably would have saved final reports and original photos to disk.

How has digital photography helped the failure analyst? ARL is currently digital in the area of failure analysis, as are all of NAVAIR's failure analysis teams and the Materials Directorate at the Air Force Research Laboratory to name a few. Are we better off? In comparing digital to film in a laboratory setting, there are several characteristics to keep in mind: cost, quality, ease of use, environmental impact, turnaround time and longevity of the final product.

In making these comparisons, I looked at digital vs. Polaroid® film, not 35mm film. This is because most lab equipment was set up for and used this type of film before digital arrived. As we all remember, film was expensive back in those days, not to mention the cost of developing negatives particular study [1]. However, there was

Characteristic	Digital	Film
Cost	☑	
Quality	☑	
Ease of Use	☑	☑
Environmental Impact	☑	
Turnaround Time	☑	
Longevity of Final Product		☑

another opinion stating that digital actually costs more, based on the additional costs of the digital camera, computer equipment, software, photo paper, backup storage equipment, CD's/DVD's, batteries, training and time spent editing, processing and manipulating the image files [2]. I believe if you look at it from a recurring vs. non-recurring cost standpoint, digital is cheaper.

As far as quality is concerned, for macro- and microphotography, as well as fractography utilizing an electron microscope, digital is much better than Polaroid® film in my experience. Not to mention the fact that I can place a digital photo on the server in the lab and retrieve it at my desk when the analysis is complete. Again, the field is divided in this area. The hardcore from each camp insists that their method leads to higher quality photos. One study [3] performed an in-depth study of digital vs. 35mm film. The author discovered that "in virtually every aspect, the digitally captured image file thoroughly out-classed the file scanned from film." He explained this as follows, “Film has grain and grain seems to obscure a great deal of detail that digital capture completely eliminates. This combined with the far wider dynamic range of digital cameras seems to put conventional film to shame." Ease of use I considered a tie, since to the expert, it is just as easy to learn the fine points of taking a shot with film as it is to learn all the bells and whistles of today's digital cameras. Although different subtleties exist for each method, one is no more complicated than the other.

Processing negatives onto photo paper generates chemical waste, and these chemicals did not last long once exposed to air. These solutions often contain elements such as chromium, selenium, silver and formaldehyde which must be treated as a hazardous waste. To this end, digital is more environmentally friendly than film.

Reference [1] indicates that turnaround time utilizing digital photography is approximately three times faster compared to film capture. NAVAIR failure analysis investigations that used to average 70 days as late as 1997, now average only 22 days. This difference was attributed to digital photography.

Which lasts longer-a digitally captured image or film and its negative? I have heard that CDs can last anywhere from two to thirty years, depending on quality of manufacture and how kindly the user treats it. But as is the case with all technology, what will be the next great step? Will CDs become obsolete in the near future? What will happen to all those stored images? Film negatives can last over 50 years if stored correctly [2], which is why I give the advantage to film in this instance.

As listed, there are many advantages for the failure analyst in going to digital capture. The initial hurdles of knowing which camera to buy, how to use both the camera and the software to process the photos are easily overcome. The results of going digital in our lab have led to drastically improved final reports, not to mention a real-time means of documenting particular aspects of a failure to send electronically to our customers. Also, we are able to keep the original digital photos in our possession. What ever happened with our customer inquiry you ask? We were able to find a Polaroid negative taken with 55 film of one of the photos that was requested. But unfortunately, we did away with the capability to develop these years ago!

References

[1] McKellips, S.W., "NAVAIR Failure Analysis Labs Go Digital," Currents, Summer 2006, p. 31.

[2] Harris, D. "Film Capture vs. Digital Capture," http://www.danharrisphotoart.com/digital.html, date unknown.

[3] Rodney, A., "Film vs. Digital," PEI, Sept. 1999, pp. 34 and 43, http://www.digitaldog.net/files/Filmvsdigital.pdf.

calendar of events

June 19-22, 2007
Vibration Institute—National Technical Training Symposium
The Menger Hotel, San Antonio, TX
www.vibinst.org

August 6-9, 2007
AFRL Integrated Systems Health Managment Conference
Millennium Hotel, Cincinnati, OH
www.usasymposium.com/ishm

September 10-13, 2007
36th Turbomachinery Symposium
George R. Brown Convention Center, Houston, TX
http://turbolab.tamu.edu

September 11-13, 2007
6th International Workshop on SHM 2007
Stanford University, Stanford, CA
http://structure.stanford.edu/workshop

September 11-13, 2007
PdM-2007 The Predictive Maintenance Technology Conference and Expo
The Orleans Hotel and Casino, Las Vegas, NV
www.maintenanceconference.com/pdm

October 9-11, 2007
E32 Aerospace Propulsion Systems Health Management Committee Meeting
Kona Kai Resort, San Diego, CA
www.sae.org

October 22-24, 2007
International Joint Tribology Conference
Marriott Mission Valley, San Diego, CA
www.stle.org

November 4-8, 2007
78th Shock & Vibration Symposium
Sheraton City Center, Philadelphia, PA
www.SAVIAC.org

December 4-7, 2007
22nd International Maintenance Conference-"Manufacturing and Process Reliability"
Hilton Daytona Beach Ocean Walk Village, Daytona Beach, FL
www.maintenanceconference.com/imc/index.htm

January 28-31, 2008
The 54th Annual Reliability and Maintainability Symposium
Palace Station Hotel & Casino, Las Vegas, NV
www.rams.org

February 4-7, 2008
IMAC XXVI: SEM Annual Conference & Exposition on Structural Dynamics
Rosen Shingle Creek Resort & Golf Course, Orlando, FL
www.sem.org

March 1-8, 2008
IEEE Aerospace Conference Dedicated PHM Track
Big Sky, MT
www.aeroconf.org

Last year, the MFPT Society established the Henry and Sallie Pusey Best Paper Award to recognize the outstanding contribution of these two people to the growth and reputation of our organization.

We have reviewed the papers submitted to this for MFPT 61 to indentify the Best Paper to receive this important award. The papers were evaluated according to four criteria:

1. Technical excellence
2. Clarity
3. Originality
4. Value to technical or user community

The large number of truly excellent papers submitted made our task difficult. We would like to give honorable mention to two papers:

1. "Physics of Failure (POF) Application in RAM-T Case to Eliminate/Mitigate Machinery Failures," by Vincent Whelan, BAE Systems
2. "Nonlinear System Fault Identification Using Neural Networks Embedded in Differential Equations," by Yimin Fan and C. James Li, RPI

The MFPT Society takes this opportunity to recognize the best paper presented at the 2007 MFPT conference by awarding the author(s) the Henry and Sallie Pusey Best Paper Award. The paper has been selected for this top honor from the 43 papers submitted and is judged to be the best paper by peer professionals. The Best Paper exemplifies the highest levels of excellence in technical contribution, clarity, and professionalism. Through papers such as this we strive to maintain the outstanding reputation of MFPT and recognize the significant contribution of this paper and of Henry and Sallie Pusey to MFPT. We are proud to present the MFPT 2007 Henry and Sallie Pusey Best Paper Award to: **"Agent-based Health Monitoring Architecture for Power Systems," by Guangfan Zhang, Bulent Ayhan, Roger Xu, Margaret Lyell, William Krueger, and Leonard Haynes, Intelligent Automation Inc.**

CONGRATULATIONS!

Failure Analysis Technical Committee

By Marc Pepi, Failure Analysis Chair,
US Army Research Lab

MFPT 61 had a great technical program, with a turnout of approximately 140 attendees at the annual conference.

One improvement that generated a lot of interest was the committee overview presentations given by the committee chairmen after the keynote speakers on the first day. The presentations gave full exposure to each of the committees and a chance to market to the majority of those in attendance. I recommend keeping this format in the future.

Many sessions at MFPT 61 were of interest to the failure analyst, including Session 2D, "Engineering Solutions for Failure Prevention," Session 3D, "Failure Analysis and Tribology," and Session 4D, "A Comprehensive Tutorial in Tribology." As always, I focused on the failure analysis sessions but did venture into the "Maintenance" track on Tuesday afternoon.

Here are some notes of interest taken from the week at MFPT 61:

- Six new members joined the FA (Failure Aanalysis) Technical Committee as a result of this meeting. I want to welcome the following new members:
  - Glenn Harmon (RJ Lee Group)
  - Bob Ware (WPAFB)
  - Nate Brown (Luna Innovations)
  - Ben Phillips (WPAFB)
  - Solomon Berman (IBC Coatings)
  - Karen Cassidy (GasTops)

- The Maintenance session included a presentation by John Berry, US ARDEC entitled, "Army Aviation Path to Condition Based Maintenance." It was interesting to find out that 400 Army helicopters (out of the fleet of 3,000) currently have CBM demon stration systems. They have had success with bearings, but fatigue is still a big problem to monitor (possible MFPT 62 track: "The Problem of Fatigue"...we tried this year, but didn't receive enough papers). The paper by Paul Howard, PL Howard Enterprises, entitled "CBM Plus Enabling Technology Assessment Program" was also of interest. He mentioned that 43,000 ship days are lost by the Navy due to *unplanned* maintenance-a huge problem.

- Session 2D, "Engineering Solutions for Failure Prevention" had a peak of 19 attendees. I like this theme, and hope to have it again next year.

- Our annual committee meeting at lunch on Wednesday had one hitch—the lunch was sit-down, so we couldn't bring it to the session room. We met nonetheless, over lunch in the exhibitor hall. The following ideas came about as a result of our meeting:
  - It was mentioned that MFPT should seek being linked to and from other failure analysis websites. Members were urged to forward any failure analysis websites you think we should be linked on, to be forwarded to MFPT HQ.
  - Harry Decker indicated that it was about time that the FA Committee recommends a keynote speaker.

To that end, we agreed on George VanderVoort, Director of Research and Technology at Buehler as a potential candidate. This recommendation will be forwarded to MFPT Mangement. He's very busy and popular, so arrangements should be made ASAP if it is decided to pursue this lead.

– Debbie Aliya mentioned that she may give a failure analysis tutorial next year at MFPT 62. Another idea for a tutorial or session was "Cradle-to-Grave," similar to our popular session a few years ago. Other ideas for sessions included "erosion," "damage classification," "physics of failure," "corrosion," and "welding."

– We also kicked around the idea of adding a "List of Recommended Reading" pertaining to failure analysis to the MFPT website. I'm sure everyone could offer a suggestion or two on the textbooks, etc. that they refer to and trust most often. Bob Ware brought an excellent textbook to MFPT 61 entitled, "Failure Atlas for Hertz Contact machine Elements," by T.E. Tallian that I would include on that list.

– Harry Decker suggested I attend another committee's meeting, which I did on Wednesday night ("Signal Analysis" Committee). The idea behind attending this meeting was to ask this committee, "What would you like to see from the FA community that would help you?" The committee agreed that *the current status of failure analysis models, especially in the area of crack initiation* would be most helpful. This would be a great session for next year, if we can generate at least five papers. They indicated that a high-profile case history, such as the Columbia shuttle crash would also be of interest, if it described what was broken in the "process," more than focusing on the actual analysis itself (potential keynote for MFPT 62?). They also expressed interest in failure analysis case histories with open-ended or unsolved problems, where CBM-related answers may be needed. Thanks to Howie Gaberson and his committee for these great ideas.

- The "Failure Analysis and Tribology" (Session 3D) was also popular, with a peak of 18 attendees.

- The "Comprehensive Tutorial in Tribology" generated a peak of ten attendees.

In summary, we have a lot of ideas for sessions, tutorials and keynote speakers for MFPT 62…now comes the task of deciding what papers we may want to present next year. The idea of a "sample preservation paper" appeared to be a popular topic in Session 3D. I think I will prepare something along these lines for the 2008 conference. I would also be able to contribute a paper to another session (Erosion, Engineering Solutions, etc.). Please seriously consider submitting an abstract to the MFPT 62 'Call-For-Papers'. Papers related to any of the aforementioned session themes would be especially appreciated.

Would anyone like to contribute to the next newsletter article? The Failure Fan has been a great way to describe aspects of failure analysis to the lay person, review technical papers, talk of lessons learned, describe new equipment, etc. If anyone would like to write an article (only 1-1/2 typed pages needed), please let me know.

Thanks to all that participated in the sessions, and the Committee Meeting. With your continued support, we can make the Failure Analysis Technical Committee an important arena for session preparation and problem solving, as well as general networking. Anyone interested in participating can contact me at marc.pepi@arl.army.mil.

John L. "Jack" Frarey

We are saddened to report that John "Jack" Frarey died on Friday, April 20, 2007. He was a significant member of our community and will be sorely missed.

Jack was trained as physicist at the University of Minnesota and Macalaster College in St. Paul, Minnesota. He was a registered professional electrical engineer in the state of California; however, he spent most of his professional career in the field of machinery vibration and the processing of vibration data. He held three patents in this area and published over 30 articles on the subject of machinery vibration.

During his professional career, Jack was an instructor in physics at Macalester College and held engineering positions at North American Aviation in California and Curtis Wright in New Jersey. He came to Niskayuna, NY in 1969 as an engineer at Mechanical Technology Inc. (MTI).He helped form Shaker Research Corp. in 1973 and returned to MTI in 1980.

Jack served on the board of directors for the Vibration Institute, whose charter includes the dissemination of technical information on machinery vibration in this country and throughout the world. He gave courses in machinery vibration for the Vibration Institute and for the Electric Power Research Institute. He was a charter member and fellow in the Society for Machinery Failure Prevention Technology. In 2002, he received the Diamond Award from the Vibration Institute for Technical Excellence. He was also a member of the Acoustical Society Of America.

Jack's wife, Joyce, died in 2001. He is survived by two daughters, Heather Frarey of Niskayuna and Christine Garretto of Middletown, NY, and a sister in Rochester, MN.

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