

MINUTES
MODEL-ASSISTED POD WORKING GROUP
OCTOBER 23, 2009
COLUMBUS, OHIO

Attendees:

A list of attendees is attached as [File 1](#).

Agenda:

The meeting agenda may be found in [File 2](#).

Minutes:

INTRODUCTION AND REVIEW OF CHARTER

Forsyth opened the meeting by providing an Introduction and Review of the Charter ([File 3](#)) as well as reviewing the agenda. Thompson apologized for being so slow in distributing the minutes from the previous meeting.

As discussed during the 2008 meeting, we are finishing Phase I and the group discussed how to document the progress in the public domain as a part of the close out of that initial effort. Thompson volunteered to write a short executive summary, to which could be attached all of the minutes, presentations, etc.

The discussions broadened to future directions. Rummel suggested working within ASNT. He noted that he had been advocating adding an NDE Engineering arm to the organization.

Goldfine suggested seeking more vendor involvement, perhaps as sponsors of some aspects of the MAPOD activities. He wondered if it would be possible to broaden the activities to include fully-empirical statistical analysis, leading to a means to get an unbiased statistical sign-off of POD studies.

Rummel suggested that Phase II activities should include the development of a protocol to deal with false calls.

RELIABILITY EFFORTS WITHIN OTHER AGENCIES

NRC: Jeff Hixon had originally been scheduled to attend but had to cancel because of other commitments. However, he had provided the slides from a talk that he had presented at the ASNT meeting, which were provided by Forsyth. These may be found in [File 4](#). A key point is that NRC is considering a damage tolerance / fracture mechanics based approach to managing risk. Therefore, determination of POD will likely become more important to them. Existing “POD” work done within the agency consists of a very limited inspector qualification program.

NASA: Thompson discussed with the group a request from Generazio. Generazio had requested comment on the Logit & Probit Methodology chart attached as [File 5](#). Questions posed to the group were the following:

- Is this an accurate representation of what is required for proper execution of the methodology?
- Is external validation of the estimated models (by using new data) required (or appropriate) to assess the predictive ability of the model, or is new data only to update estimated models? Does an updated model still need to be updated?
- When performing transforms on the original data (and before estimating models), original nonconstant variance is transformed to be constant to meet a model assumption. Where or how is the variance in the original data ultimately represented in the estimated model or statistical statements?

Some elements of the ensuing discussion follow.

- It was suggested that the intent of this diagram ([File 5](#)) is to help the user decide whether a proper DOE has been used, i.e., to ask the question “Have I thought through all of the things that I need to take into consideration?” In other words, it is intended to provide an overview of what is needed to do a POD. This purpose needs to be better defined before detailed comment can be offered.
- Setting up designed experiments and interpreting the results requires fairly sophisticated statistical expertise. Do we want to create a chart that entrusts this to a Level III inspector?
- It is relatively hard to assess “goodness of fit” for a hit/miss model, model diagnostics are difficult.
- One would need different flow charts to deal with hit/miss and \hat{a} versus a data. The title seems to refer to hit/miss but the flowchart seems to include elements of \hat{a} versus a .
- It is not clear what is meant by the “external validation” box.

REVIEW OF EUROPEAN/U.S. WORKSHOP ON RELIABILITY

Thompson and Forsyth reviewed the European/U.S. Workshop on Reliability (File 6). Thompson summarized the paper that he had presented, on behalf of the MAPOD Working Group, as may be found in File 7. Thompson and Forsyth also led a breakout session during that workshop which generated a list of areas identified by the participants as needing further discussion (end of File 6). One area identified was the use of in-service inspection data to estimate POD. It was noted that a NATO RTO body has already addressed this issue. The report is in the public domain and may be found at <http://www.rta.nato.int/pubs/rdp.asp?RDP=RTO-TR-AVT-051>.

The papers presented at the European/U.S. Workshop on Reliability will be issued on a CD. Christina Mueller of BAM is a point of contact. Plans are to hold the next of this series of workshops at Southwest Research Institute in a couple of years. Jay Fisher is the point of contact.

REVIEW OF NEW EUROPEAN ACTIVITIES

Philippe Benoist of CEA reviewed some new European activities related to MAPOD. Included was a discussion of a recently completed program, SISTAE (Simulation and Statistics for Non Destructive Evaluation), sponsored by the French government. The purpose of this was to develop modeling tools that would allow several random factors to be added to the deterministic effects of flaw shape on the observed signal. Those factors were metallurgy, flaw morphology, beam distortion, and microstructural noise. The approach was fully model based.

A second European program, PICASSO (imProved reliabIility inspeCtion of Aeronautics Structure through Simulation Supported POD), directed towards the improved reliability of the inspection of aerospace engines is just beginning. The motivation is to minimize unscheduled maintenance and increase the accuracy of damage tolerant life management. Objectives include increasing the accuracy and reducing the cost of POD determination, taking into account the effects of such things as defect morphology. A component of this program involves the transfer function approach.

Benoist also discussed recent development in the European Network for Inspection Quality (ENIQ). For some time, this has allowed technical justification based on models. Up to now, this has been a deterministic analysis based on consideration of a “worst case.” However, the approach is evolving to technical justification based on a simulation assisted POD approach.

Finally, a new activity of the International Institute for Welding (IIW) was described. This is a large international group whose responsibilities including developing documents (handbooks,

guidelines, etc.), ISO Standards. IIW Commission V deals with NDE and has 15 committees dealing with various aspects of Quality Control and Nondestructive Testing. A new group has been formed to consider NDE Reliability, including simulation. The simulation activity is underway and is developing guidelines for the use and validation of simulations, including the development of an international data base and benchmark results. There is strong support for this activity in the nuclear industry, including EPRI. The reliability activity is just getting underway. Among its objectives are the development of guidelines for determining POD assisted by simulators and the consideration of a number of advanced topics such as how to consider the effects of multiple parameters, combine empirical and simulated data, address the POD of images and treat situations in which detection is not based on signal amplitude. Most of the work of these groups is conducted by email.

The slides used by Benoist may be found in [File 8](#).

Benoist expressed a desire to cooperate with the MAPOD Working Group. There was general agreement that this was a good idea and an extended discussion about how this cooperation might take place followed. Based on past experiences in other areas, a number of the attendees felt that informal collaboration could be very beneficial but a formal collaboration might be very hard to put in place because of various legal issues.

As a part of this discussion, several issues were discussed. Included was the need to include master gauge measurements in the comparison of data obtained on common samples, the need for proper characterization of the inputs to models, and the need for proper characterization of noise.

It was agreed that discussion of the exact nature of such collaborations should continue in the succeeding months.

REVIEW OF ONGOING U.S. EFFORTS

Lindgren noted that the updated version of MIL HDBK 1823, as led by Annis, was issued in September, 2009.

On behalf of Nakagawa, Thompson presented a review of ISU work on the relative eddy current responses of cracks and notches. This presentation may be found in [File 9](#). Included were the effects of load on the response of cracks. Good results were shown for model predictions for notches with poorer results for cracks. The latter depended on material and load levels. Work is in progress to improve the understanding of these effects.

Lindgren briefly reviewed recent AF experimental work on the relative eddy current responses of cracks and notches. He noted that eddy current results have already been published (Shearer, J., Heebl, J., Brausch, J. and Lindgren, E., “Progress in Developing Transfer Functions for Surface Scanning Eddy Current Inspections,” Review of Progress in Quantitative Nondestructive Evaluation, D. O. Thompson and D. E Chimenti, eds., Vol. 28B, pp. 1870-1877, American Institute of Physics, Melville, NY, 2009.) and that ultrasonic measurements were beginning on the same specimen set.

OPEN DISCUSSION OF PATH FORWARD

MAPOD for SHM: Lindgren discussed a presentation that he had previously made in September at the Stanford workshop on SHM, [File 10](#). Therein he introduced some new language to unify the field, with Structural Health Monitoring being defined to integrate three elements: structural models, flight loads, and Structural Damage Sensing (SDS). Lindgren also discussed some of the steps that SHM would have to pass through to be incorporated into AF practice. Included would be laboratory verification and real world validation in accord with ASIP Manual 1530C. Issues would include gaining sufficient statistical data to prove the case, dealing with such things as the variability of individual aircraft, and drawing the right conclusions from lessons learned. He noted that, because of the critical need to minimize risk for ASIP managed structures, it would be essential to build confidence through experience. Determination of POD will be a critical ingredient in this process.

HOW DO WE THINK OF ACCURACY

Little time was devoted to this topic. Interested readers are referred to File 14 of the minutes of the November 16, 2007 MAPOD Working Group Meeting for the results of a previous discussion.

DOCUMENTATION OF BENEFITS VIA CASE STUDIES

The documentation of cost saving achievable in MAPOD demonstrations was discussed. Some were significant, i.e., Australia needed to use the approach to justify the continued safe operation of F-111 fleet. Thompson will inquire from all the study authors regarding what are they able to document in terms of cost savings. Categories would include savings due to reduced specimen sets, tests and increase in availability of the fleet.

Lindgren agreed to assist in the development of an economic model/business case that could be outlined in the Phase I report.

Further discussions were held regarding how to convince regulators of value/accuracy of the MAPOD approach. Strengthening validation efforts was identified as a key ingredient. In this context, it was noted that this needs to be a community effort. A challenge is the fact that a number of validation studies that have been supported by commercial users do not find their way into the public domain for competitive reasons. There is also a need for a process to guide verification/validation efforts. In the context of this discussion, it was noted that the amount of work required to validate a physics-based model within the realm of interest in a particular POD study would have to be significantly less than the effort of a fully empirical POD study for the user to save any money. A number of other related issues that will need to be addressed to justify the practical use of this new approach were discussed.

It was noted that, in the update of MIL HDBK 1823, a section on “grades” of POD acknowledges that various studies are done to various levels of validation. This may have a positive influence on the acceptance of MAPOD.

FORMAL PROTOCOLS FOR ENGINEERING PRACTICE

It was agreed that the update on of MIL HDBK 1823 has served as the first step. This document includes an appendix describing the MAPOD approach.

Another step in progress is an AF SBIR Phase II effort at Texas Research Institute in Austin, which has as a deliverable a documentation of the MAPOD process.

Concern was expressed with respect to the question of extrapolation. This must be done very carefully to avoid the influence of factors that we do not fully understand. One needs to define the bounds of validation to ensure that the user of the resulting data does not extrapolate (or at least does not extrapolate unknowingly).

A discussion was held regarding the level of detail that needs to be shown in the protocol. It was felt that we do not have enough experience yet in the use of MAPOD approach to write a final protocol yet.

Thompson will capture these issues in the Phase I report. This will provide a basis for discussion at the next meeting.

PLANNING FOR THE NEXT MEETING

A straw vote indicated that the attendees wished to hold the next MAPOD Working Group Meeting at the ASNT Fall 2010 meeting.

Actions needed prior to that meeting included the following.

- Thompson to write up the “Phase I” report, which would be in the form of a short executive summary, supported by many appendices that reside on the web site. This would include our MAPOD flowchart, and a description of the process based on a recent Materials Evaluation paper. Also a basic economic model will be suggested, with Lindgren and Thompson to formulate.
- Thompson to seek cost benefit information from various MAPOD study leaders.
- There is a need to develop commonly understood definitions of fundamental concepts. It was felt that the ASNT Reliability Committee is the appropriate place to define terminology.
- We need to start thinking about more fully defining the Phase II Objectives in a way that would include discovery of assumptions, justifications, etc.

Next Meeting:

The next meeting will be held in conjunction with the 2010 ASNT Fall Conference and Quality Testing Show the week of November 15 in Houston, Texas.