Chair's Message

Happy 2020, SER²AD Members!

Our division had a great set of presentations and papers at IMECE 2019 in Salt Lake City. I especially enjoyed the opportunity to present awards to our undergraduate and graduate student winners of the Student Safety Innovation Challenge at our annual awards dinner. We are busily planning a year of content and activities for 2020 including our traditional track at IMECE in Portland, Oregon in November. In addition to that, there is a workshop planned on Prognostics and Health Management systems coming up in April, and we are working on a symposium on Autonomous Vehicle Systems to likely take place in November in parallel to IMECE.

I am personally interested in growing participation in SER²AD activities over this year including increasing student and professional participation. To do that I need your help. The work that our division supports is critically important to our organizations and to society at large. The engineered systems that support modern civilization depend on skilled technologists effectively managing risk. If you would like to get involved or have ideas for how SER²AD can be more relevant to your career, please contact me. I want to hear from you.

Wishing you a safe and reliable 2020,
Jeremy M. Gernand, PhD, CRE, CSP
ASME SER²AD Chair, 2019-2020

Hot Topics

Developing resilience metrics has emerged as a new and important topic in maintenance and resource management. In Research News, Dr. Ayyub explores development of resilience metrics in specific topical areas. See more in Emerging Risk: Impact of Flexible Operation on Power-gen Industry.

SER²AD IMCE 2019 top article awards were presented at the IMCE Conference. Check out the winners SER²AD awards, IMCE 2019

SER²AD hosted a briefing on Capitol Hill to inform legislators about the current design issues and topics confronting safety of Autonomous Vehicles. Several members presented their views and their thoughts are summarized in Congressional Briefing.
System Resilience: Definitions, Quantification and Associated Economics

Bilal M. Ayyub, PhD, PE, Hon.M.ASME, Dist.M.ASCE

The concept of resilience is applicable to systems with anticipated performances and subject to disturbances. Understanding and quantifying resilience enable societies to use resources efficiently for enhancing or maintaining the performance of systems such as infrastructure. For example, natural disasters as disturbances resulted in worldwide direct damages of US$366 billion and 29,782 fatalities in 2011 alone. Storms and floods accounted for up to 70% of the 302 natural disasters worldwide, with earthquakes producing the greatest number of fatalities. Managing these risks and others rationally requires an appropriate definition of resilience and associated metrics.

This presentation starts with a resilience definition that meets a set of requirements with clear relationships to reliability and risk as key relevant metrics. Resilience notionally means the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from disturbances of the deliberate attack types, accidents, or naturally occurring threats or incidents. Formally, the resilience of a system is the persistence of its functions and performances under uncertainty in the face of disturbances. The resilience of a system’s functions can be measured based on this persistence under uncertainty in the face of disturbances.

![Diagram](image.png)

**Figure 1. Performance, Resilience and Economic Valuation**

Resilience metrics should provide a sound basis for informing decision- and policy-making practices in multi-hazard environments for various system types including lifeline, environmental, financial, etc. systems. The metrics are based on Figure 1 that shows performance with aging as a function of time with a disruption caused by a stressor. Measuring resilience is based on areas under the performance curves. Two approaches are offered in the presentation: (1) metrics based on times to disruption, and time periods for failure and recovery including their respective profiles; and (2) simplified metrics based on stochastic processes with performance loss accumulation models. The former offers a strong basis for characterizing uncertainties in resilience; but require more rigor in
the probabilistic treatment that the latter. The simplified metrics are introduced for the use of practitioners to meet logically consistent requirements drawn from measure theory. The simplified metrics are based on stressors modelled by stochastic processes, and performance loss accumulation. The paper also examines recovery, with its classifications based on level, spatial, and temporal considerations. Three case studies are developed and used to gain insights to help define recovery profiles. Two recovery profiles, linear and step functions, are introduced. Computational examples and parametric analysis illustrate the reasonableness of the metrics proposed. The metrics offer a strong basis for the rational management of resilience including recovery. Also, the presentation provides a framework for the economic valuation of resilience by society at large, methods for benefit-cost analysis based on concepts from risk analysis and management. Although resilience valuation is in its infancy and additional work is necessary along with case studies, this article offers a basis for such efforts. The presentation included a case study on the resilience of networks focusing on urban rail transit systems with Shanghai and Washington DC Metros as examples.

Flexible operation in general has negative impact to component durability, structural integrity and at a higher level, machine reliability of the power-generation equipment. Such impact is particularly prominent for heavy industrial equipment such as heavy-duty gas turbines and steam turbines that are traditionally designed for baseload operations. A 2013 NREL report assessed a 33% renewable penetration scenario, and found an annual increase of cost of maintenance and forced outage at western US power plants at around 13–24%, due to the flexible operations.

Biography  
Dr. Ayyub is a University of Maryland Professor of Civil and Environmental Engineering, Professor of Reliability Engineering, and Professor of Applied Mathematics and Scientific Computation. Dr. AyyubÔs main research interests are risk, resilience, uncertainty, decisions, and systems applied to civil, mechanical, infrastructure, energy, defence and maritime fields. Dr. Ayyub is a distinguished member of ASCE, and a fellow of the Structural Engineering Institute, the Society for Risk Analysis, ASME, and SNAME. Dr. Ayyub completed projects for governmental and private entities, such as the National Science Foundation, Department of Defence, Hartford, Chevron, Bechtel, etc. Dr. Ayyub is the recipient of several awards and research prizes from ASCE, ASNE, ASME, ENR, the Department of the Army, etc. He has authored and co-authored more than 650 publications including 8 textbooks and more than 15 edited books. He is also the founding Editor-in-Chief of the ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems.  
His most recent 2018 edited book on Climate-Resilient Infrastructure published by ASCE was selected as an Engineering-News Record Newsmaker in 2017. The following papers provided additional information on concepts covered in the presentation:


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Established in 2014 by the current Editor-in-Chief, Professor Bilal M. Ayyub from the University of Maryland College Park, the ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering and Part B: Mechanical Engineering, serves as a medium for dissemination of research findings, best practices and concerns, and for discussion and debate on risk and uncertainty-related issues in the areas of civil and mechanical engineering and other related fields. The journal addresses risk and uncertainty issues in planning, design, analysis, construction/ manufacturing, operation, utilization, and life-cycle management of existing and new engineering systems.

The journal has been accepted into the Emerging Citation Sources Indexed by Clarivate Analytics, formerly Thomson Reuters, and it is eligible for indexing in 2018. From 2016 onward, all articles will be included in Web of Science. They are also included in Scopus.
Recognitions & Awards

Awards for Papers

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<tr>
<td><strong>Editor's Choice Paper</strong></td>
<td>“Time-Dependent Probability of Exceeding a Target Level of Recovery” by Fabrizio Nocera, Paolo Gardoni, Gian Paolo Cimellaro by Yanjie Tong and Iris Tien</td>
<td>“The Application of Downhole Vibration Factor in Drilling Tool Reliability Big Data Analytics–A Review” by Yali Ren, Ning Wang, Jinwei Jiang, Junxiao Zhu, Gangbing Song, Xuemin Chen</td>
</tr>
<tr>
<td><strong>Most Read Paper</strong></td>
<td>“Climate Impact Risks and Climate Adaptation Engineering for Built Infrastructure” by Mark G. Stewart and Xiaoli Deng</td>
<td><strong>Most Cited Paper</strong></td>
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Outstanding Reviewers

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<th>Part A 2018 Outstanding Reviewers</th>
<th>Part B 2018 Reviewers of the Year</th>
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<td>Nii O. Attoh-Okine</td>
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<td>Athanasios A. Pantelous</td>
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<td>Nicola Pedroni</td>
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Best Paper Award

Starting in 2019, the Best Paper Award will be given annually to one paper in Part A and one paper in Part B appearing in the preceding volume year. Papers published in 2018 have been evaluated by the Editorial Board members based on the following criteria: fundamental significance, potential impact, practical relevance to industry, intellectual depth and presentation quality.

The recipients of the Award for the Best Paper published in 2018 in Part A and Part B have been announced at the ASME Safety Engineering and Risk Analysis Division (SERAD) award reception meeting at the International Mechanical Engineering Congress & Exposition (IMECE) on November 13, 2019 in Salt Lake City, Utah, https://event.asme.org/IMECE.

2019 Part A Recipients

Authors: Arvid Naess, F.ASCE, and Harald Svandal Bo
Title: “Reliability of Technical Systems Estimated by Enhanced Monte Carlo Simulation”
URL: https://ascelibrary.org/doi/10.1061/AJRUA6.0000937
Summary This paper deals with computing reliability of large technical systems. There are many techniques to approximate exact reliability with very complicated procedure. In this paper, a new method based on Monte Carlo simulation for efficient calculation of system reliability is presented. Standard Monte Carlo simulation forms a simple and robust alternative for calculating system reliability, while the computation is very time consuming. The authors introduce a parameterized system that corresponds to the given system for a specific parameter value. By using regularity of the system reliability as a function of the introduced parameter, the system reliability for our original system can be predicted accurately from relatively small samples.

2019 Part B Recipients

Authors: S. Wu, P. Angelikopoulos, C. Papadimitriou, P. Koumoutsakos
Title: “Bayesian Annealed Sequential Importance Sampling: An Unbiased Version of Transitional Markov Chain Monte Carlo”
URL: http://risk.asmedigitalcollection.asme.org/article.aspx?articleid=2647605

Summary The paper demonstrates a bias emanating from the resampling steps in the transitional Markov chain Monte Carlo (TMCMC) algorithm which has not been recognized and explicitly studied in the literature. The so-called Bayesian Annealed Sequential Importance Sampling (BASIS) approach is proposed to remove this bias and at the same time increase the parallel efficiency of the traditional TMCMC. The proposed method is clearly presented and substantiated by numerical results concerning problems of engineering interest. The BASIS approach has a potentially high impact, since it improves the applicability of the traditional TMCMC which is an attractive tool for uncertainty quantification in engineering problems.

Calls for Papers

Categories

Part A: Active Calls for Special Collections

Part B: Active Calls for Special Issues
Special Issue on “Response analysis and optimization of dynamic energy harvesting systems under the presence of uncertainties”. Paper submission deadline: January 31, 2020.

Submission links

Part A: https://ascelibrary.org/journal/ajrua6
Part B: http://risk.asmedigitalcollection.asme.org/journal.aspx
Since 1984, ASME SER\textsuperscript{2}AD has been hosting an annual challenge to undergraduate and graduate students to submit papers on Safety Engineering, Risk and Reliability Analysis topics. The papers are peer reviewed by experts in these areas. Winners are honored at an awards banquet during the annual ASME International Mechanical Engineering Congress and Exposition (IMECE). Recognitions also include cash honorariums and reimbursement with a limit for conference related expense. The SER\textsuperscript{2}AD Awards Dinner was hosted on November 13, 2019 at Buca De Beppo restaurant in Salt Lake City, Utah during IMECE 2019.

Undergraduate Group Winners:

- 1\textsuperscript{st} place: Team of Yuchen Zhu, Hanghang Wei, Jiang Zhu Supervised by Dr. Dengji Zhou from Shanghai Jiao Tong University;
- 2\textsuperscript{nd} place: Team of Crystal Murray-Weston, Jordan Cossette, Joseph Wilson, Theodore Magrum, Patrick Jauregui supervised by Dr. Arthur Miller from Gonzaga University.
Graduate 1st place: Qinbo Yao Supervised by Dr. Dengji Zhou

Graduate 2nd place: Mohammad Pourmostafaei Supervised by Dr. Mohammad Pourgol-Mohamad

Graduate Group Winners:
- 1st place: Qinbo Yao Supervised by Dr. Dengji Zhou from Shanghai Jiao Tong;
- 2nd place: Mohammad Pourmostafaei Supervised by Dr. Mohammad Pourgol-Mohamad from Sahand University of Technology.

Best ASME Journal Papers

Starting in 2019, the annual Best Papers from preceding volume in ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering and Part B: Mechanical Engineering was each given an award. Papers published in 2018 have been evaluated by the Editorial Board members based on the following criteria: fundamental significance, potential impact, practical relevance to industry, intellectual depth and presentation quality. The recipients of the Award for the Best Paper published in 2018 in Part A and Part B were announced at the award reception meeting at the same venue. Harold Svandal Bo received a plaque from Prof. Bilal Ayyub with travel support offered by ASME during this event for the paper: Arvid Naess, F.ASCE, and Harald Svandal Bo Title: “Reliability of Technical Systems Estimated by Enhanced Monte Carlo Simulation.”

Harold Svandal Bo receives 2019 Best Paper Award from Dr. Ayyub.

Harold Svandal Bo presents ‘Reliability of Technical Systems Estimated by Enhanced Monte Carlo Simulation.”

Dr. Ayyub announces Best Paper Award 2019.

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ASME Congressional Briefing on Advancing Safety Technologies for Autonomous Vehicles
By Mohammad Pourgol-Mohammad, Ph.D

ASME recently sponsored a Congressional briefing on Capitol Hill on “Advancing Safety Technologies for Autonomous Vehicles,” with the purpose of informing Members of Congress and congressional staff on safety challenges associated the advancement of AV technology. The event was hosted by the ASME Safety Engineering and Risk Analysis Division with support from the Congressional Robotics Caucus, co-chaired by Congressmen Mike Doyle (D-PA) and Rob Woodall (R-GA). ASME brought together this panel of experts in the fields of risk, reliability, and safety technologies to share their thoughts and insights on opportunities and challenges facing the future of autonomous vehicles, as well as to identify and address the relevant safety technology, policy, and regulatory development needs.

Connie Lausten, chair of ASME’s Committee on Government Relations, kicked off the event with welcoming remarks. She introduced some of the major hurdles facing AV technology, including questions of safety, licensing, and security. Lausten asserted that, until these safety gaps are closed, there is a long way to go until the deployment of truly driverless cars. ASME Past-President Dr. Said Jahanmir echoed this sentiment, adding that safety standards have not been keeping pace with technological advancements, presenting a need for more formalized approaches to studying AV technologies.

The focus of the briefing was on three general issues with AV technology: risk, reliability, and resilience. A short summary of each speakers remarks are included below:

- **Dr. Vasily Krivtsov**, Director of Reliability Analytics at Ford Motor Company, began the panel discussion with a presentation addressing the reliability and resilience issues facing AV as:

  Amongst many reliability aspects of AVs, one can isolate major three: (i) duty cycle and design life implications resulting from the usage rate increase, ii) reliability enhancements via redundancy architectures (which are not otherwise prevalent in conventional vehicles), and iii) prognostic health management of AVs critical systems. These three aspects are briefly described below.

  According to the published research, the usage rate of AVs compared to conventional (privately owned) vehicles is expected to grow from 5% to at least 75%. This has some profound implications on the reliability design life targets. The currently used target in the automotive industry is 10 years | 150K miles. The AV fleets (primarily engaged in a ride-sharing and ride-hailing services) are expected to exhaust the 150K mile limit in less than a year (not 10). This poses new challenges in enhancing AVs reliability life targets with respective implications to component design, material properties, etc.

  The main reliability strategy of the automotive industry has traditionally been focused at the component-level robustness and systems engineering. Unlike the aerospace industry, achieving reliability goals through redundancy has not been in the focus, an exception being for some safety-critical systems, primarily due to cost and because a human driver has historically been the main “control unit”. With AVs not relying on human redundancy solutions, whether hot, cold, or k-out-of-n, gain a larger relevance in the automotive applications. The third reliability-related aspect is prognostic health management (PHM) of AVs critical systems. Again, traditionally, the automotive sector has been relying on interval-based preventive maintenance (e.g. oil change every 5000 miles) to maintain vehicles’ reliability and availability. AVs connectivity capability, for example, vehicle-to-cloud communication, provides continuous health monitoring of its critical systems thus enabling a possibly self-administered preventive intervention for any specific AV. This custom-tailored and targeted maintenance approach would certainly result in higher autonomous vehicle levels of reliability and availability than a “one-size-fits-all” constant interval approach.

- **Dr. Mohammad Pourgol-Mohammad**, Senior Reliability Manager at Johnson Controls and Chair-Elect of ASME’s Safety and Risk Division presented on SRS Technique State of Art for AV Systems as:

  “What is ‘acceptable risk’?” and, do AVs need to be “as safe as” or “safer than” traditional vehicles? To answer these questions, the specifications of the AVs with respect to their SRS. AV system is characterized with a system of cyber, physical and human with a socio-technical, regulatory and physical environment. The biggest challenge is the heavy interaction between hardware, software and human in various ways like functional, information, physical (matter, energy and force) with many unknowns. A challenge in risk analysis is to identify everything that can go wrong. How can we deal with the unknown unknowns? Specification of AV systems are their (i)

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1 Autonomous Vehicle
2 Safety, Reliability and Security
heterogeneity, (ii) complexity, (iii) openness, (iv) learning ability and (v) too many risk event scenarios.

How should this uncertainty be handled in the design and operation of autonomous systems and operations? There are various assessment techniques currently in place, including software failure modeling and planning for external environmental causes. These techniques include the techniques for SRS assessment of critical mission systems like aerospace and nuclear facilities, phenomenological, event based and logic based methods, hardware or soft casual Relations and many more. Many of the current methods can still play a part in supporting SRS of autonomous systems; however, many areas require new modelling techniques to be developed:

- Traditional modeling and analysis methods have significant limitations;
- Data driven methods are inadequate to demonstrate safety;
- Identification of large number of options of environment, operation modes;
- Methods to address Software failures and security; and
- Inclusion of Complex human role (positive and negative).

However in order for many of safety questions to be answered, new modelling techniques will need to be developed. New Holistically modelling techniques are promising techniques capturing the connectivity and interdependencies. Simulations may assist in the detailed understanding of autonomous systems behavior, identification of SRS issues, and performing system validation. Importance of quantifying SRS may increase in the future to enable real-time decision making and to identify when the system performance drops below the acceptable threshold during operation.

- **Dr. Daniel Metlay**, Senior Fellow at the UCLA Garrick Institute for the Risk Sciences, focused on the potential societal implications of deploying AVs to the public on a large scale:

A recent article in the Washington Post bore the headline: “Silicon Valley pioneered self-driving cars. But some of its tech-savvy residents don’t want them tested in their neighborhoods.” The piece quoted a Waymo spokesperson who said that its vehicles “are programmed to be safe and cautious drivers.” It also cited a resident who urged developers to “heed the social implications of [their] innovations and to not let the technology run amok.”

These two statements reflect well the terms of the social response that will likely emerge should autonomous cars be introduced. Like other risky technologies, autonomous vehicles will contain embedded values. By their decisions, engineers, scientists, designers, regulators, and developers all make choices that implicitly or explicitly enhance or discount certain cultural and societal values. Thus, the technology will be inevitably be the subject of political discourse and debate.

Because those decisions are rarely transparent or accountable, the social acceptability of autonomous technologies ultimately will depend on trust, both in the technology itself and in the organizations that implement and regulate it. Trustworthy private and public governance institutions will need to be put into place prior to widespread deployment of autonomous vehicle technologies. I suspect that doing so will be quite challenging. Part of the challenge is finding the right balance. A rush to deploy products in the market may lead to accidents and failures with unacceptably social and ethical consequences. Over-governance at the earliest stages of technological maturity, however, may stifle innovation and deprive society of potentially significant benefits. Ideally, in a robust pluralistic society, the “right” balance emerges as a result of a transparent and accountable “political” process. In the real world, however, the processes are typically distorted in favor of the interests of one set of parties over another set. Historically, this has meant that industrial interests have prevailed over the broader “public” interest. It remains to be seen whether this historical pattern is repeated with respect to autonomous vehicles.

- **Dr. Roger McCarthy**, Principal of McCarthy Engineering, began by reminding the audience that California is currently the only state that requires AV accident/risk data to be publicly reported. Dr. McCarthy’s presentation consisted of five messages:

1. California is the ONLY state requiring AV accident/risk experience be publicly reported. Unfortunately, because other states wish to replicate the success of Silicon Valley and attract technology companies developing AVs, the result has been a “Race to the bottom:” other states permitting AV testing with NO reporting requirements. This increasingly lax regulatory environment means the results of AV testing in other states is opaque to the driving public that is being put at risk by the AV technologies, except when spectacular events are reported, such as an Uber AV striking and killing a pedestrian in AZ.

2. There are several serious failings of the NHTSA in its oversight of AV development safety The NHTSA has not established and does not require ANY type of AV safety/data reporting from any manufacturer testing AVs on public roads even though this technology puts normal drivers and pedestrians at risk. In this vein the NHTSA has also been far too tolerant of Tesla’s deployment and testing with real drivers on public roads of its “autopilot” mode. The NHTSA does not require Tesla to report the miles or accidents involving Tesla vehicles in the autopilot mode, even though virtually all these data are being reported to Tesla by
its connected fleet of 1/2 million vehicles. The data that do exist appear to indicate the autopilot modes possess significant additional risk to drivers.

3. The significantly higher AV crash rates emerging from the California data show the NHTSA’s laissez-faire approach to AV technology development safety is not increasing public road safety. CA AV crash risk is multiples higher than human drivers driving the same miles. And there is evidence that if the California reporting requirements for AV accidents was stricter, the reported AV crash rates would be even higher.

4. I believe the NHTSA is looking to AV technology to remedy our nation’s deteriorating relative vehicle safety record relative to other industrialized peer nations on its watch. In 1970, the last accident year before the creation of the NHTSA, the USA enjoyed the lowest driving fatal vehicular risk amongst peer nations reporting data. In 2016, after 46 years of NHTSA oversight of national vehicle safety, the USA has fallen to the HIGHEST fatal crash risk of peer nations. The combination of the volume of US driving combined with the highest fatal crash risk has product a public health “vehicle fatality” disease burden on the US public two to four times our peer nations. This is a national disgrace.

5. Unfortunately, “safer than human” AV technology appears decades away; instead the US should be adopting vehicle regulations/technologies that other nations have demonstrated work and start saving lives immediately. Worse yet, the EU poised to deploy numerous vehicle technologies in 2021 that will make US relative vehicle safety performance even worse than it is now.

- **Dr. Mohammad Modarres**, Director of the Center for Risk and Reliability at the University of Maryland, echoed concerns about the viability of teaching AVs how to match human cognitive ability and on-the-fly reasoning. He also stated that a balance is necessary between developers and policymakers, and that better and more transparent evaluation of AV deployments will provide a smoother path to fully autonomous vehicles. He summarized the result of the April 26, 2019 Workshop on Safety and Risks of Autonomous Vehicles as:

> AV navigation technology has been the prime focus of the most recent technology innovations. However, the industry’s advances on the issues of safety, risk, and reliability have been slow. Several accidents and near misses have already occurred, the mean distance driven to an unsafe condition, near miss or accident has been far shorter than the conventional road vehicles.

The public appears to be excited about the AV technologies; however, concerns over safety, software reliability, security, hacking/misuse, and licensing are mounting. Given the vacuum in systematic safety, risk, and reliability considerations in this rapidly evolving technology, the convergence of many related resources involving academia, autonomous vehicle industry, insurance, and associated government agencies would be necessary to identify and address the safety technologies, policy, and regulatory developments needed.

Far more attention by the industry and research by the government would be needed to close these significant safety gaps. Some of the main issues identified by a workshop hosted by the University of Maryland’s Center for Risk and Reliability and sponsored by the ASME and Ford Motor Company highlighted safety concerns. Examples of required safety improvements and initiatives identified by the workshop participants include:

- Driver assistance offers a low hanging fruit as a first step;
- More independent safety transparency and collaboration;
- Minimum performance standards;
- Better autonomy software safety standards;
- Development of more case studies;
- Building incentives for the industry to promote, further satisfy and engage with NHTSA;
- Development of simple top-down safety requirements;
- Reliance on more modern safety and risk-based analysis methods and simulations;
- Avoidance of using the old safety analysis methods practiced in the conventional level-0 and level-1 vehicle technologies, and develop new out-of-the-box safety methods;
- Investigate and optimize using redundancies in the safety equipment of AVs;
- Approaches for better safety enforcement;
- Understand, study and model the role of human behavior and intensions in AVs;
- Collection and transparent evaluation of observed unsafe events;
- Development a clear protocol for information sharing;
- Development of common safety design taxonomy;
- Designation of a demonstration period for safety benchmarking;
- More collaborative safety research between regulators, academics and the industry; and
- Overall Consensus: Full autonomy principle is possible, not imminent.
SER^2AD Member Statistics

2019 third quarter ASME members interested in SER^2AD

Pie chart segment counts

<table>
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Current ASME overall membership from the ASME website.

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<th>Approximate numbers</th>
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<td>100,000+</td>
<td>Individual ASME Members</td>
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<tr>
<td>28,000+</td>
<td>Student Members</td>
</tr>
<tr>
<td>20,000+</td>
<td>Early Career Engineer Members (including Graduate Students)</td>
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Puzzler Winner

In this edition we have included a “Puzzler” generally related to a reliability case from an industrial application although other cases, academic challenges for example, may be included as well. The winner will be announced in the next quarterly edition of the newsletter.

Puzzler Winner

We have not received a correct solution to last quarter’s puzzler (the filter bank protective system design). Therefore, we have no winners for the third quarter puzzler.

Reliability Puzzler

Consider Figure 2. A tank is used to gravity separate water from wet steam out of the final stages of a large turbine connected to a 1500 MWe AC generator. The water is pumped forward to a heater string. The tank is 4 feet in diameter and 10 feet long. Flow into the tank comes from low pressure heat exchangers at 760,000 lbm/hr. The fluid in the tank is about conditions 176 °F and 6 psig. A level control signal is sent to a throttle valve in the pump discharge and is set to maintain the level at 1/2 full.

The pump has been occasionally tripping due to low water level in the tank and no one has been able to understand why. Suzy Serad sends Ricky Reliability out to the field to investigate the pump trips. He returns with some field observations:

- The level in the tank swings up and down, somewhat erratically, almost reaching the low level pump trip setpoint; and
- The level swings roughly occur with about a 1 second period, peak to peak.

After about 1/2 of study Suzy calls Ricky into her office and says here is what is going on and here is what we need to do about it.

- What do you think it is that Suzy tells Ricky?
- What would be any special considerations for the high level dump control?

Figure 2. A tank is maintained about 1/2 full by a pump connected to a level control valve. The valve control signal comes from a differential pressure transducer.

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A friend once told me “all failures are due to wearout” (except something like blunt force trauma). After hearing him say it, I gave it some thought; particularly the implications of this revolutionary (well, to some maybe) statement that we throw out the first third of well-known and pervasively referenced “bathtub curve”!

It seems there cannot be DFR\(^3\) if all failures are wearout. **BUT DFR is observed when equipment data are collected** so what is going on? DFR is simply the result of “mixed” failure modes, combined with effective root cause analysis and followed up with effective maintenance policies. Failures due to manufacturing flaws, inadequate training, design inadequacies leading to early breakdown, and so forth, are eliminated by the organization interested in avoiding production losses or liability claims due to protective system breakdowns. Early breakdowns are eliminated by high-performing organizations that use cost-effective maintenance strategies. By this process, only the end of useful service life failures remain and the bulk of service life is made relatively free of corrective maintenance.\(^4\)

While observation of DFR is good for installed equipment, it is unhelpful for maintenance planning; although it is possibly helpful in equipment purchase decisions. Eliminating early service life breakdowns is more costly than without them, and the prudent engineer is wise to avoid equipment exhibiting this characteristic. On the other hand, the manufacturer is unlikely to indicate the equipment for sale is subject to immediate breakdown. The only way practicing engineers are likely to identify DFR a priori is experience with the equipment or from reported experience from outside their organization. Practicing engineers would like to have equipment with characteristics as shown in green in the figure to the right; equipment that only exhibits IFR\(^5\) after a reasonably long failure-free service life. Given \(\tau\), they can effectively plan for almost failure-free operation by replacement(s) prior to expected failure at time \(\tau\).

It is interesting that (primarily) organizations with effective equipment management strategies would observe DFR (assuming no a priori equipment failure characteristic knowledge). And it could be said that organizations having ineffective maintenance strategies would tend to see failure characteristics similar to those shown in yellow in the figure above. In-service failures at random times put equipment in charge of the maintenance program rather than the other way around. In such organizations, costs rise due to maintenance staffing levels needed to support emergent repairs and for expediting commodity deliveries. CBM\(^6\), a close second-cousin to age-based planned maintenance, is implied by realizing “green characteristic” equipment performance in the figure above. CBM is effective if there is sufficient lead time before failure for maintenance to schedule parts and labor on a non-expedited basis. In this case, CBM would again produce a bathtub curve characteristic assuming root cause is addressed effectively.

What are your thoughts? Let’s talk!
Ernie Kee, SER\^2 AD Editor
Send your feedback/thoughts on this or any reliability subject to ernie@erniekee.com

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\(^3\)Decreasing Failure Rate
\(^5\)Increasing Failure Rate
\(^6\)Condition-Based Maintenance
## SER\(^2\)AD Committee

### Table 1. 2018–2019 SER\(^2\)AD Committee Membership

<table>
<thead>
<tr>
<th>Position</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Chair</td>
<td>Jeremy Gernand, <a href="mailto:jmg64@psu.edu">jmg64@psu.edu</a></td>
<td>Nominating Chair</td>
<td>Open</td>
</tr>
<tr>
<td>1(^{st}) Vice-Chair</td>
<td>Mohammad Pourgol-Mohammad, <a href="mailto:pourgol-mohamadm2@asme.org">pourgol-mohamadm2@asme.org</a></td>
<td>Student Paper Award Chairs</td>
<td>Stephen Ekwaro-Osire, <a href="mailto:Stephen.Ekwaro-Osire@ttu.edu">Stephen.Ekwaro-Osire@ttu.edu</a> Dengji Zhou, <a href="mailto:zhoudj@sjtu.edu.cn">zhoudj@sjtu.edu.cn</a></td>
</tr>
<tr>
<td>2(^{nd}) Vice-Chair-Treasurer</td>
<td>Xiaobin Le, <a href="mailto:lex@wit.edu">lex@wit.edu</a></td>
<td>Newsletter Editors</td>
<td>Ernie Kee, <a href="mailto:erniekee@illinois.edu">erniekee@illinois.edu</a> Mohammad Pourgol-Mohammad, <a href="mailto:pourgol-mohamadm2@asme.org">pourgol-mohamadm2@asme.org</a></td>
</tr>
<tr>
<td>3(^{rd}) Vice Chair-Membership</td>
<td>Arun Veeramany, <a href="mailto:arun.veeramany@pnnl.gov">arun.veeramany@pnnl.gov</a></td>
<td>Webinars / Outreach Chair</td>
<td>Open</td>
</tr>
<tr>
<td>4(^{th}) Vice-Chair-Secretary</td>
<td>Stephen Ekwaro-Osire, <a href="mailto:Stephen.Ekwaro-Osire@ttu.edu">Stephen.Ekwaro-Osire@ttu.edu</a></td>
<td>IMECE2019 Chairs</td>
<td>Dengji Zhou &amp; Mihai Diaconeasa</td>
</tr>
<tr>
<td>Past Chair</td>
<td>Bin Zhou, <a href="mailto:bin.zhou@fmglobal.com">bin.zhou@fmglobal.com</a></td>
<td></td>
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