



ALACARTE™

Reliability

News



RAMS



CMSE



SigmaQuest



Webinar

TOP EVENTS:

Fall-Winter, 2007

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EVENTS - Reliability and Maintainability Symposium (RAMS), Components for Military and Space Electronics (CMSE), SigmaQuest-Ops A La Carte Webinar

SPECIAL OFFERS - Free Admission to any upcoming Ops a La Carte event

NEWS - Patent Application for Leading Indicators: A More Effective Method of Accelerated Life Testing; Successful fall seminars through Asia; Ops ASTR Presentations now on-line

FEATURED SERVICE - Leading Indicators: A More Effective Method for ALT

PROBLEM SOLVER - Lottery Probability

ADVERTISEMENTS - SigmaQuest, LinkSV, and DfR Solutions

JOB OPENINGS - Many companies are now hiring. See the job openings below for more details.

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Website: www.opsalacarte.com

Theme this newsletter:

**LEADING INDICATORS:
A Better Accelerated Life Test**

COURSES

- ▶ **Certified Reliability Engineer (CRE) Preparation Course** (pdf) - **Jan 8-Feb 26, 2008**
To register, email us at CRECourse@opsalacarte.com
- ▶ For details see the [Ops A La Carte Schedule](#)

SEMINARS

2008 Reliability Symposium ([click here for more details](#))

▶ We will be holding our 2008 Reliability Symposium the week of April 7-11 and we are putting on the following seminars:

- ▶ [Design for Reliability \(DfR\)](#), Apr 7-8
- ▶ [Best Accelerated Reliability Test Methods: HALT, ALT, and RDT](#), Apr 9-10
- ▶ [Design for Climatic Conditions](#), Apr 7-8
- ▶ [Design for Testability \(DfT\)](#), Apr 9
- ▶ [Design of Experiments \(DoE\)](#), Apr 7-8
- ▶ [Design for Warranty Cost Reduction \(DfW\)](#), Apr 10
- ▶ [Mechanical Design for Reliability \(MDfR\)](#), Apr 9
- ▶ [Root Cause Analysis \(RCA\)](#), Apr 10-11
- ▶ [Software Reliability](#), Apr 11
- ▶ [Statistical Process Control \(SPC\)](#), Apr 11

▶ Inquire if interested at seminars@opsalacarte.com

▶ All our seminars, including those being offered during the symposium as well as those that are not, are offered as **in-house tailored** seminars. To view a list of all our seminars, go to [Ops A La Carte Course List](#)

▶ Inquire if interested at seminars@opsalacarte.com

▶ For details see the [Ops A La Carte Schedule](#). We just announced our schedule for 2008.

EVENTS

► Reliability and Maintainability Symposium (RAMS) - January 28-31, 2008, Las Vegas

Ops A La Carte is on the management committee for this year's symposium being held in Las Vegas. We shall be presenting 1 Tutorial and 3 Papers at this event.

Our Tutorial is entitled "*Software Design for Reliability*" by Mike Silverman and George de la Fuente

Our three papers are as follows:

1) "*How to Develop a Qualification Test Plan for RoHS Products*", by Mike Silverman and Fred Schenkelberg of Ops A La Carte and Dr. Craig Hillman of DfR Solutions

2) "*Competitive Analysis*", by Mike Silverman and Doug Farel

3) "*Design for Warranty Cost Reduction*", by Bob Mueller

We shall also be exhibiting at this symposium so please come by our booth. For more details, please go to [RAMS](#). Email us at events@opsalacarte.com for more information on this event (including a copy of the paper).



► Components for Military and Space Electronics - February 11-14, 2008

Ops A La Carte shall be presenting a paper entitled: "*Timely Resolution to Parts Obsolescence and Substitutions using EDA*" by Bryan Stallard, JW Smith, and Mike Silverman. We have been given the Wednesday afternoon slot in the section 5.6 entitled "Design & Process Improvements"

We shall also be exhibiting at this symposium so please come by our booth. For more details, please go to [CMSE](#). Email us at events@opsalacarte.com for more information on this event (including a copy of the paper).



► Ops A La Carte Joint Webinar with SigmaQuest - February 15, 2008, 9-10am Pacific Time (PST)

Ops A La Carte and SigmaQuest are teaming up for their 2nd combined webinar. This one is entitled "*Managing Outsourcing Quality Risks*". The webinar is FREE. Please email us at events@opsalacarte.com if you would like the link to this webinar.

SPECIAL OFFERS

► **\$1000 off** your next **Accelerated Life Test** using our new **Leading Indicators methodology** *to the first individual that introduces us to a new consultant that we bring on to our team*. We are growing rapidly and are looking for the best technical operations' consultants out there. If you know of anyone, please pass their name to us at events@opsalacarte.com.



- Nov 30, 2007

Ops A La Carte gets paper accepted to CMSE Conference. Ops A La Carte shall be presenting a paper entitled: "*Timely Resolution to Parts Obsolescence and Substitutions using EDA*" by Bryan Stallard, JW Smith, and Mike Silverman. It is very fitting for this conference due to the increasing issue of obsolescence. We have devised a way to use Electronic Design Analysis to quickly determine if the parts proposed for substitution will work in the existing circuitry. Of course, the

product will need to be re-qualified, but EDA is a much quicker and less expensive approach that can be used as a first step in the qualification, and can also be used to disqualify a proposed part. See the [events](#) section for more details.

- Nov, 2007

HALT and HASS Shows No Slowdown. As the holiday season approaches, we normally experience a slowdown in the test lab side of the business, but this year has been exceptionally busy. We are booked out through the end of the year and customers are even starting to schedule into January. "First we had a busy summer and now a busy holiday season. This is a good sign that the economy in Silicon Valley continues to stay hot" says Managing Partner Mike Silverman. "Most of our work at the lab comes from development groups, and if there are a lot of products being developed, that sends a real positive note to the health of the economy." Ops A La Carte's other divisions - the consulting division, the contractor division, and the educational division, is also showing no sign of slowdown this holiday season. For more information on our lab, please visit our website at www.haltandhasslabs.com.

- Nov 1-2, 2007

Ops A La Carte presents 3 papers at annual Accelerated Stress Testing and Reliability (ASTR) Workshop in Washington DC: The three presentations we gave were:

- 1) "*Early Reliability Testing: Increasing the Effectiveness of a Reliability Program by Moving Reliability Testing Upstream*", by Mike Silverman
- 2) "*Enhancing Accelerated Life Tests with Prognostics*", by Arthur Zingher
- 3) "*HASS Profile Fine Tuning Using Field Data*", by Mike Silverman

Copies of each of these are located on the [Resources](#) page of our website.

- Oct, 2007

Ops A La Carte files a patent on Leading Indicators: To resolve client problems in life test and operational maintenance, Arthur Zingher and Mike Silverman of Ops A La Carte file a patent application on Leading Indicator Methods for Accelerated Life Testing. Companies struggle with real-world challenges and constraints on life test and operational maintenance, as we have seen during our years of Reliability Engineering services for our clients. To resolve this, we invented a practical and more effective method for Accelerated Life Testing, and filed a patent application in October 2007. This introduces Leading Indicators Methods that resolve common challenges and constraints. To strengthen your engineering and your product, Ops can thus provide you with engineering leadership skills and services. For more details, see the [Featured Service](#) section for more details.

- September, 2007

Asian Tour a Huge Hit: In September, we gave seminars on Design for Reliability in both Taiwan and Singapore, and they were a huge success. Working with our local partners SGS and Rel Pro in Asia, we did a 2 week tour, consisting of both seminars and customer visits. This is really strengthening our position in Asia and proving the consulting model in the area. Next year, we shall be giving similar courses in China as well.

► **For more information** on news, please visit our [News Page](#) or call (408) 472-3889.



Leading Indicators: A More Effective Method of Accelerated Life Testing

Real-world problems motivate engineering leadership: Our clients must overcome real-world challenges and constraints in life test and operational maintenance. Therefore Ops A La Carte has invented a practical new technology, using a “Leading Indicator”, and a patent is pending. To strengthen your engineering and your product, Ops can provide you with engineering leadership skills and services.

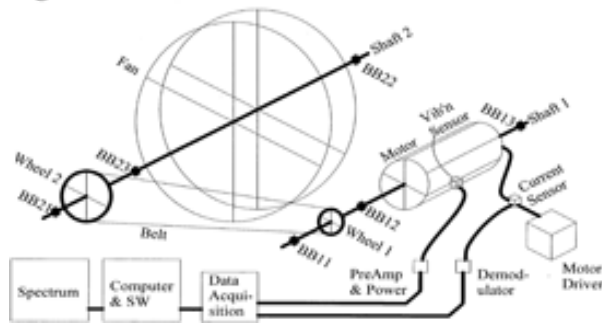
Leading Indicators can improve common challenges and constraints:

- There are too few specimens and too little time available for life testing.
- For a life test to be meaningful, the acceleration must be mild.
- Life testing results are too late to improve product development.
- Maintenance is too expensive and too disruptive.
- Maintenance ought to be based on the real-time status of each specific unit.
- By contrast, engineering methods typically describe the average status of a population of similar units in similar operation.

Leading Indicators to provide advance warning: For some degradation mechanisms, there are “Leading Indicators” (L.I.’s). These can provide nearly real-time measurement of wear and fatigue, and thus provide advance warning for future failure.

In an electro-mechanical rotary system, Vibration Spectrum Analysis (VSA) uses an accelerometer to directly measure mechanical vibrations. Motor Current Spectrum Analysis (MCSA) measures fluctuations in the motor current. These correspond to vibrations in the drive train and mechanical load. VSA and MCSA each start with a wide-band time-domain signal. This is transformed into a frequency spectrum. This can measure simultaneously but separately the vibrations for each bearing, shaft, wheel, fan, pump, belt, gear, lead-screw, motor, frame, structure and more. VSA and MSA are shown in Fig 1 below.

Fig1: VSA and MCSA



Often each vibration mode has a distinct spectral peak, and its height is related to the degradation. In many cases, these measurements provide advance indication of future failures. Thus these are Leading Indicators.

This example is directly applicable to electro-mechanical rotary systems in many products. More generally, there are analogous techniques for wear, fatigue and future failure involving electrical and electronic hardware.

For a rotary mechanical system, Vibration Spectrum Analysis (VSA) uses an accelerometer and signal analyzer to measure and to analyze mechanical vibrations. For an electro-mechanical rotary system, Motor Current Spectrum Analysis (MCSA) measures fluctuations in the power current into the motor. These correspond closely to vibrations in the motor, drive train and load.

VSA and MCSA each transform the signal from time-domain to frequency-domain. This frequency filtering helps to separate, to identify, and to measure many different vibration modes. Thus the vibration of each and every physical item labeled above can be measured separately but simultaneously. VSA and MCSA are well known and very useful in maintenance engineering and mechanical engineering.

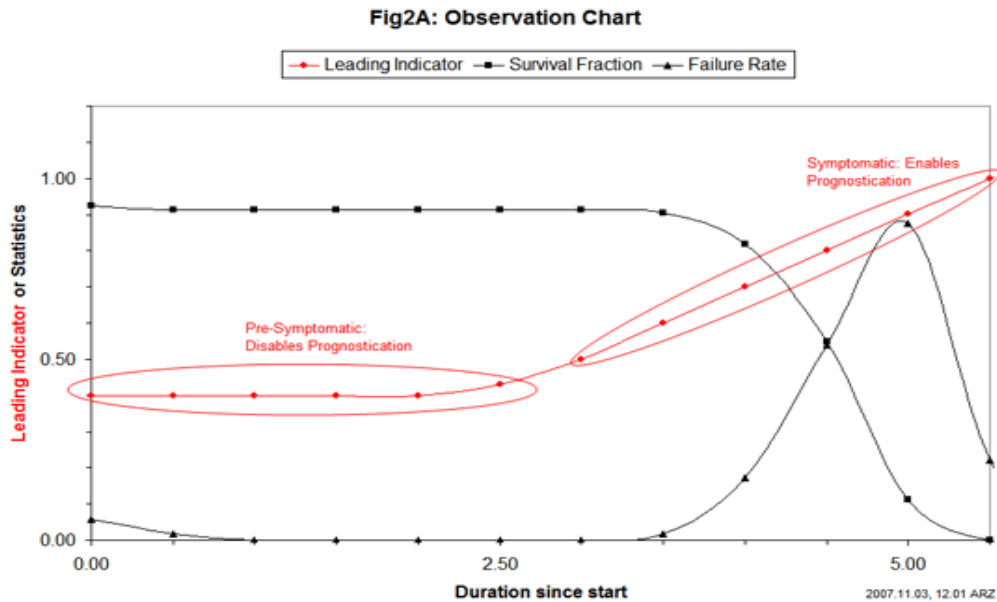
Leading Indicators to improve Accelerated Life Testing: An accelerated life test should use a L.I. together with exaggerated stress. This can provide earlier feedback, more informative feedback. These enable better product engineering, hence better product quality and reliability. Also earlier feedback enables stronger reduction (“acceleration”) in time required for accelerated testing. (A patent is pending.)

During early system development, there is an accelerated life test of a sub-system vulnerable to degradation. Simultaneously, the L.I. is measured. This observes the relation between the measured L.I. and failure for this mechanism. This validates and calibrates this L.I. as a Leading Indicator for this failure mechanism.

Later, when a more complete system becomes available, it is life-tested using exaggerated stress and L.I. measurement. Often this provides engineering feedback that is more informative and considerably faster, compared to classical life testing.

Furthermore, this L.I. measurement plus L.I. calibration predicts the time until future failure due to this degradation mechanism. Often this prediction can be done considerably before manifest failure actually occurs. This “prognostication” is a new way to reduce (“accelerate”) the time required for life test. Also, this new factor multiplies the time-reduction factor due to exaggerated stress during accelerated life test. This is shown in Fig 3. This enables accelerated life tests to have stronger time reduction but also to correspond to normal operation and normal failures.

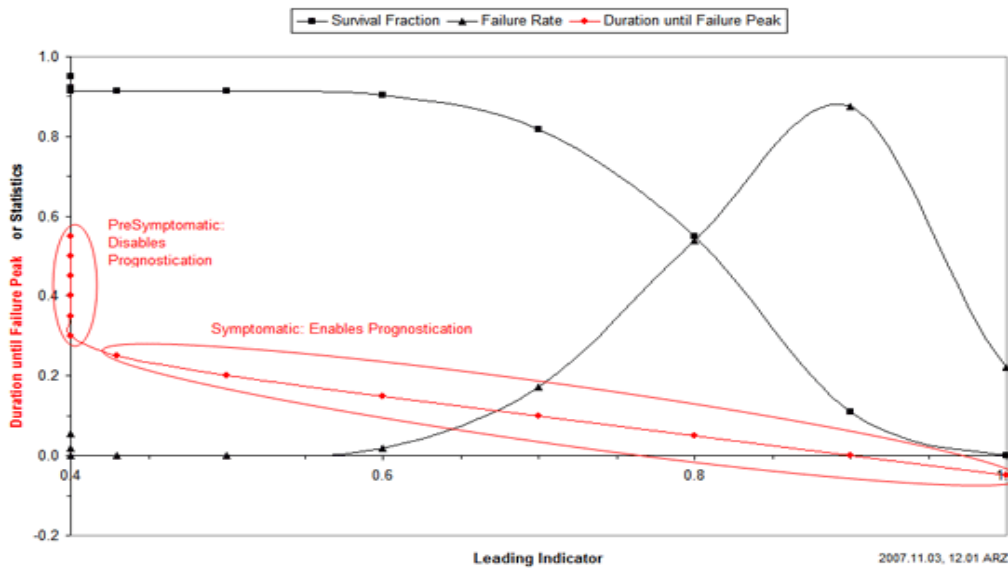
These better accelerated life tests can be combined with Early Reliability Test (ERT) tactics, as described recently in OALC newsletter issue Summer 2007. These provide better engineering feedback earlier in product development, and this facilitates better product engineering and better products, and also prevents problems during late development.



“Duration” is defined as operating time, adjusted for relative duty factor and relative speed. Fig 2A shows the observed L.I. value, failure rate and survival fraction as functions of duration since start. This is transformed into the calibration graph Fig 2B. This shows L.I. value, survival fraction and failure rate as functions of duration until failure peak.

A real-time L.I. measurement and its change rate enable prediction of future L.I. measurements. Combined with calibration Fig 2B, this can enable prediction of the time until future failure. This is called “prognostication”.

Fig 2B: Calibration Chart

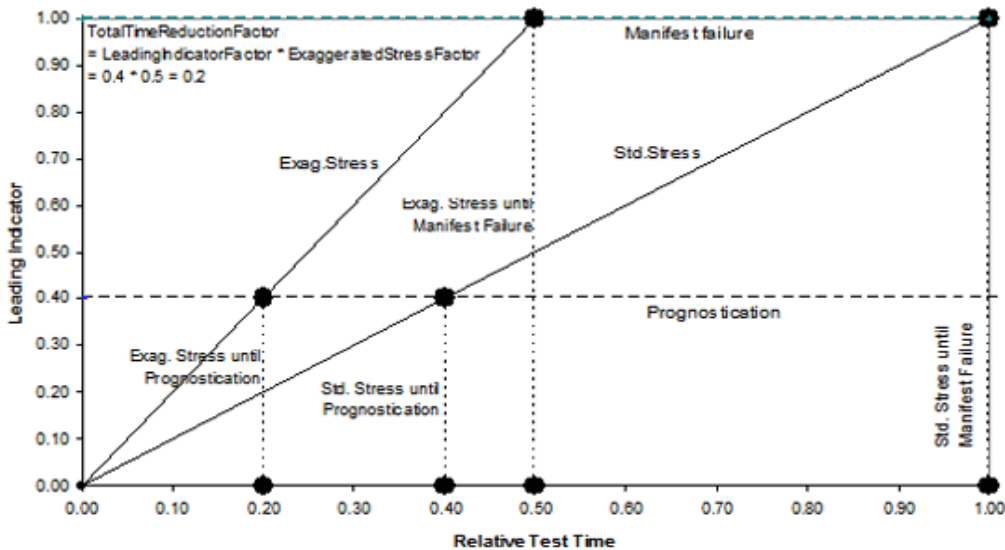


Exaggerated stress reduces (accelerates) test-time until manifest failure. A Leading Indicator reduces (accelerates) test-time until prognostication of future failure. Accelerated life testing should simultaneously use both L.I. measurement and exaggerated stress. A patent is pending. In some cases, the degradation mechanism is one-dimensional. Therefore time-reduction (acceleration) factors combine by multiplication. This can be quite useful as shown in Figure 3 below.

TotalTimeReduction = LeadingIndicatorFactor * ExaggeratedStressFactor = $(1/2.5) * (1/2) = (1/5)$.

In other cases, the leverage may be even more useful: $(1/2.5) * (1/8) = (1/20)$

Fig 3: Time Factors Multiply



Leading Indicators to improve Operational Maintenance: For system operation with maintenance, a L.I. can be very useful. L.I. measurement provides real-time observation of wear and fatigue. Combined with the L.I. calibration described above, this also provides real-time prediction of lead time until future failure. This is sometimes called “prognostication”.

This enables “predictive maintenance”. This skips devices that are far from failure. This selects and services only devices predicted to fail. However this provides considerable lead time, and thus enables maintenance service when it is most convenient and least disruptive. This reduces maintenance costs for hardware, labor

and disruption. Even so, this enables improved overall reliability.

Invitation: This describes just a few examples out of many. For example, we already have good solutions for fans and diverse rotary electro-mechanical sub-systems. Also we have other solutions: for degradation of a Printed Wire Board (PWB); for degradation in electronic packages; and lots more.

Please tell us about your real-world problem. We probably can provide a suitable L.I., plus related technology and technical services. Even if your product is unique and test acceleration is difficult, we are interested in collaborating.

Leading Indicator methods offer practical but leading edge technology. Using this, we can help your team to transcend prior challenges and constraints in reliability engineering, and thus provide more competitive products.

Mention this article and receive 5% off your next Accelerated Life Test service.

PROBLEM SOLVER

LOTTERY PROBABILITY

The Lottery draws six numbers from 1 to 50. No number is repeated. How many unique combinations are possible?

Send Responses to:

You can email us at events@opsalacarte.com. The first individual that emails us a correct solution shall receive **\$1000 off** your next **Accelerated Life Test using our new Leading Indicators methodology**.

Solution to **Last Quarter's Problem of the Month on Prognostics:**

PROBLEM: REDUNDANT RELIABILITY

An airline maintains a fleet of 4-engine aircraft. Its maintenance records show that on the average an engine fails 3 times in 10,000 operating hours with normal preventive maintenance. What is the Poisson distributed probability that 2 or more engines on an aircraft will fail during a typical flying period of 8 hours?

SOLUTION:

We shall use the Poisson formula:

$$R_t = e^{-\lambda t} \sum_{i=0}^n (\lambda t)^i / i!$$

Given $t = 8$ hours and failure rate $(\lambda) = 3 / 10,000 = 0.0003$

The probability of two or more engines failing during a typical flying period of 8 hours is calculated as:

$$\begin{aligned} P_s &= R_t = e^{-\lambda t} [((\lambda t)^0 / 0!) + ((\lambda t)^1 / 1!)] \\ &= e^{-0.0024} \times (1 + 0.0024) = 0.999997124 \end{aligned}$$

$$P_f = 1 - P_s = 0.000002875$$

COMMENTARY:

Note that we can also solve the problem using the Poisson table (Table 5) in the Appendix of the CRE Primer (also found in most reliability or statistics books).



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LinkSV helps you tap into previously scarce and extraordinarily hard-to-find information on early stage companies and the key people associated with them. This will improve your effectiveness without the hassle and time of trying to do it all on your own. LinkSV is ideally suited to help you quickly identify and leverage your own connections in career search, in identifying new business opportunities, new investors and Board members.



DfR Solutions has world-renowned expertise in applying the science of Reliability Physics to electrical and electronics technologies, and is a leading provider of quality, reliability, and durability (QRD) research and consulting for the electronics industry. The company's integrated use of Physics of Failure (PoF) and Best Practices provides crucial insights and solutions early in product design and development and throughout the product life cycle. DfR Solutions specializes in providing knowledge- and science-based solutions to maximize and accelerate the product integrity assurance activities of their clients in every marketplace for electronic technologies (consumer, industrial, automotive, medical, military, telecom, oil drilling, and throughout the electronic component and material supply chain). For more information visit www.dfrsolutions.com.

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Electronic Design Engineer

Vision Research Inc. is seeking an experienced engineer to help design leading edge image capture products and special adaptations for unique customer needs. As a member of the product development team, you will help develop our next generation of very high speed, wide dynamic range, high sensitivity digital cameras for industrial, scientific, entertainment and research applications. Work will include circuit design and modeling, schematic capture, prototyping, and system performance characterization. The successful candidate will need to have broad experience in areas including analog and digital design circuit design. A high level of analysis and debug experience using standard test equipment is required.

For more info, please email salvatore.rampaul-pino@visionresearch.com



Senior Reliability Engineer

Bloom Energy, a fuel cell company and one of Silicon Valley's most promising startups, is looking for a Senior System Reliability Engineer to join its world class team. This individual should be an engineer who is looking for a rewarding future in one of today's most exciting technologies.

Job Title/Description: Serve as the primary Sr. System Reliability Engineer for a new state-of-the-art alternative energy-producing fuel cell system.

For more info, please email jbraggin@bloomenergy.com



Sr. Reliability Engineer

Advanced Energy develops innovative power and control technologies that drive high-growth, plasma thin-film manufacturing processes worldwide, including semiconductors, flat panel displays, data storage products, solar cells, architectural glass, and other advanced product applications.

We are seeking an experienced Reliability Engineer. In this position you will carry out the duties of verifying product reliability by testing, conducting statistical analysis, stress analysis, DFMEA and MTBF calculations. You must understand component failure analysis and corrective actions to be taken. The position requires the ability to work under limited supervision.

Please apply at: Advanced Energy or email harry.mclean@aei.com



Senior Reliability Engineer

Apply Reliability Engineering principles, tools and techniques to identify and prioritize opportunities related to equipment and process failures of Dolby's Broadcast and Cinema equipment. Advises and confers with engineers in design review meetings to give reliability findings and recommendations. Evaluate new and/or redesigned systems to determine specific minimum number of samples needed to obtain statistically valid data. Analyzes projected product utilization and calculates cumulative effect on final system reliability of individual part reliabilities.

Apply standard techniques and analytical tools to assure the early detection and identification of potential problems with all new or redesigned products, packaging, and processes. Evaluates and makes recommendations for changes (ECR) to existing systems and the usage of components in their application based on RXO (Return and exchange) activities.



Senior Reliability Consultant

Ops A La Carte is looking for Senior Reliability Consultants *around the world* to join our team of consultants and work on some of the most exciting and challenging projects in the industry. Whether you have an existing consulting practice or are interested in developing one, please contact us.

If interested, please email hr@opsalacarte.com or call (408) 472-3889.

Ops A La Carte's newsletter goes out to over 12,000 subscribers. If you would like to put a job opening in next quarter's "Reliability News", email us at jobopenings@opsalacarte.com or call at (408) 472-3889.

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