LAMBDA NOTES

News for the Society of Reliability Engineers

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SRE President's Message

Henry Cook, Huntsville Chapter

The previous SRE President, Dr. Patrick C. Larter, has done much to strengthen the society with the updating of the constitution and by-laws and the chartering of new chapters.

I want to say that I believe the strength of the SRE lies in its strong local chapters. In the past year, the SRE has continued to prosper. Several of the local chapters have continued to experience growth. We need to continue to search for new ways to maintain contact and interface with our at-large members. We have been working with key at-large members to strengthen this as a virtual chapter. E-mail can go a long way in ensuring that information can be interchanged with members without encountering the delays and expense of mass mailings. I solicit any inputs on how to increase and maintain contact with all of our members.

I support the continued growth in our membership in our existing chapters as well as the establishment of new chapters. We continue to field inquiries about resurrecting some of the inactive chapters. The officers and board members continue to remain flexible in the re-establishment of chapters and the establishment of new chapters.

The subcommittees established in the past – Trends Committee, chaired by Dr. Patrick Hartman and the Reliability, Maintainability, Availability Standards Committee, chaired by Mr. Reid Willis continue to function. Each would welcome additional volunteer for the SRE membership. Mr. Robert Poltz is now the alternate for Mr. Reid on the Standards Committee. A new committee has been recently established to investigate the feasibility of SRE cosponsoring a Canadian Reliability/ Maintainability Symposium in 2003. This will be discussed at the Board of Director's meeting in January 2003.

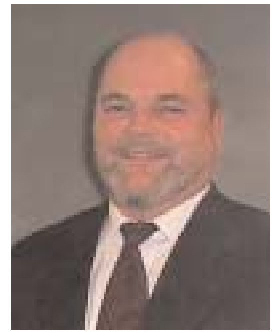
The SRE web site (www.sre.org) continues to remain a vital communications tool for our members and prospective members. I also solicit ideas for improvement of this valuable tool for communications within the SRE.

The SRE continues to be one of the proud sponsors of RAMS. I look forward to meeting some of you in Tampa, Florida in January 2003. Remember that your SRE membership entitles you to a $100.00 discount for RAMS. If you are presenting a paper at RAMS, you can compete for the society's Stan Ofstun award.

On behalf of the entire Board of Directors, I would like to wish you all a very happy holiday season and a prosperous New Year.

Volume 35, Issue 1
December 2002

Editor:
Richard Youngk
Washington Chapter



I would like to introduce a new look for *Lambda Notes*. Moving to a larger format allows us to extend our distribution by using three formats; color hard copies for our members and for RAMS attendees, an electronic copy will be included on the SRE CD, and a download copy will be available from our SRE.ORG website. Our goal is to broaden the distribution of *Lambda Notes* and to improve the quality of this very valuable forum.

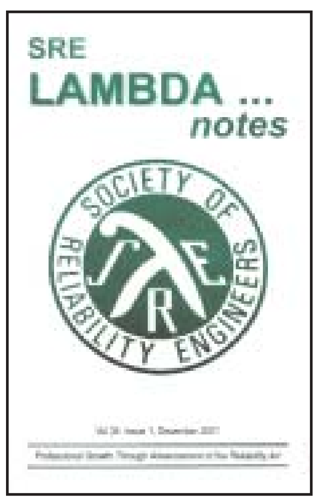
The responsibility of editing and publishing *Lambda Notes* has greatly broadened my horizons by requiring communication with many of the members among all of the chapters. One of the most rewarding parts of the editor's job is contacting each chapter to learn of their most recent contributions to SRE and the reliability profession.

This publication would not be possible without the contribution of our membership and contributing authors. This issue of *Lambda Notes* features articles provided from many of our SRE Chapters. Lambda Notes will continue to help us improve communication within and among our chapters. Thanks again to all who have made this issue possible. Thanks to Dave Dyrck and the Buffalo Chapter for writing another chapter on the history of the SRE. I would also like to thank our sponsors for their generous support.

I consider Lambda Notes as SRE's most important communication vehicle and plan to continuously improve both the content and the format. I welcome any input.

– Richard Youngk, Washington Chapter

Lambda Notes Gets A New Look



Before ...

... After

A Method for Achieving an Enhanced Mission Capability

- Larry H. Crow - IIT Research Institute - Huntsville

SUMMARY & CONCLUSIONS

When reliability requirements are set for a system, the intended purpose is generally to maintain a performance capability in an operational environment. The current parameter of choice for stating reliability requirements is Mean Time Between Failure (MTBF). Mission reliability MTBF requirements are typically established to give a high probability that a performance capability will be maintained, with no failures, for a specified period of time. However, the actual operational profile for a system may be larger than the stated mission time. This extension to the nominal mission duration, however, is typical of many realistic use environments for complex system, both military and commercial. This often results in a low probability of success for many systems, if no provisions are made for repair. This paper discusses a methodology that addresses the success probability of this enhanced mission time with selected repair actions and spares.

1. INTRODUCTION

Reliability requirements are often set based on a mission probability that a system will operate in a particular environment for a stated period of time with no failure. This notion of reliability is concerned with any unscheduled maintenance action affecting a defined mission objective. A corresponding mission mean time between failures (MTBF) that will yield the desired probability over a fixed length mission time is often set as the design reliability target for the system. In addition, a mean time to repair (MTTR) goal may be established in order to avoid extensive down times while a system is repaired due to failure. The two parameters, MTBF and MTTR, together allow for the calculation of the availability metric A = MTBF/(MTBF + MTTR). This metric is the long-term percentage of the time the system is not undergoing repair due to failure, i.e., is available for use. A design target may be established for A, allowing for tradeoffs between the MTBF and MTTR to meet this objective. The mission reliability addresses performance without failure over a fixed period of time, and availability addresses the percent uptime for a maintained system over a very long period of time.

In reality, for many systems the operational use scenario often lies between these two situations. That is, the system is deployed and operated for a calendar period of time longer than the nominal mission length, but not long enough for the availability metric to be relevant. Over this period of time part of the system may be very reliable and can usually be expected not to fail, while the remainder of the system will incur failures. If the system is to complete its total operating objective during this enhanced mission deployment period, then the failures must be repaired and the system returned to service.

In this paper we address a situation where the mission under consideration is not of short duration. Instead the mission is extended to calendar time T, with required operational uptime such that failures are likely. For success we must have the following: 1) the part of the system that is maintained with repairs and spares must operate for a specified total uptime U with no more than T-U total downtime, 2) the part of the system that is not maintained must operate for the entire period U without failure, and 3) the number of failures for a failure mode that is spared must not exceed the total number of spares allocated. All three of these conditions must be met; otherwise the system experiences a mission failure in calendar time T.

For a particular design, repair, and sparing option, we present a model that gives the probability that all three of the success conditions are met. Such a model can be used as both a design tool and a logistics tool. As a design tool, the model can be used in the design phase to assist in making design, reliability, and logistics trade-offs that will enhance the mission capability time for the system. In addition, the model would allow a greater trade space than designing to the usual reliability and availability MTBF, MTTR parameters. As a logistics tool, the model may be used to develop a sparing and support strategy to increase the probability that a maintained system can operate for an enhanced period of time. Examples for sparing military and commercial systems are presented.

Notation

T	Total mission calendar time
U	Total System uptime in time T
x = T-U	Total Downtime due to repair
MTBF	Maintained system mean time between Failures
MTTR	Maintained system mean time to repair
λ	1/ MTBF
μ	1/MTTR
$I_1(\cdot)$	The Bessel function of order 1 for the imaginary argument
s	Number of available spares
LRU	Lowest Replaceable Unit

2. BACKGROUND

Suppose the mission time is over a calendar period T (in hours, say) over which we will operate a system. The system consists of two parts — a non-maintained part, and a repaired or maintained part. For the maintained part of the system, we assume that times to failure follow the exponential distribution with MTBF = $1/\lambda$. The item that is replaced is often called a Lowest Replaceable Unit (LRU). These are the items that comprise the total maintained system and are replaced at failure. Let the failure times for each LRU follow an exponential distribution. We assume that the times to repair at the system level follows an exponential distribution with MTTR = $1/\mu$. Also, we denote by R(U) the probability that the non-maintained part of the system operates for time U without failure.

During the calendar time period T, we want the maintained part of the system to operate for at least U hours. That is, for success the total downtime due to repairs cannot exceed T-U hours. Let F(x) be the probability that the total repair time T-U is less than x. This probability is given in Ref.1, page 80, as

$$F(x) := \exp\left[-\lambda\cdot(T-x)\right]\cdot\left[1+\sqrt{\lambda\cdot\mu\cdot(T-x)}\cdot A(x)\right] \tag{1}$$

where

$$A(x) := \int_0^x \exp(-\mu\cdot y)\cdot y^{-.5}\cdot I1\left[2\cdot\sqrt{\lambda_1\cdot\mu\cdot(T-x)\cdot y}\right]dy$$

For example, let T=1000 hours, and for the maintained part of the system, MTBF = 50 hours (λ=1/50), and MTTR= 1 hour (μ=1). Suppose we want the maintained part of the system to have a total operational mission uptime of at least 970 hours out of the total mission length of 1000 hours. That is, we want the total downtime not to exceed 30 hours. What is the probability this will happen? This probability is given by F(30)=.944. Equivalently, there is a .056 probability that the total repair time will be greater than 30 hours. This would constitute a mission failure.

The calculation performed by F(x) assumes spares are available for all repairs. In order to address the sparing aspect of mission success we rewrite F(x) to reflect the sparing factor. It can be shown that F(x) in Eq. 1 can be rewritten as

$$F(x) := \sum_{n=1}^{\infty}\left[e^{-\left[\lambda\cdot(T-x)\right]}\right]\cdot\left[\frac{\left[\lambda\cdot(T-x)\right]^n}{n!}\right]\cdot D(x) + e^{-\left[\lambda\cdot(T-x)\right]} \tag{2}$$

where

$$D(x) := \int_0^x \left[e^{-\mu\cdot(z)}\right]\cdot\mu\cdot\frac{\left[\mu\cdot(z)\right]^{(n-1)}}{(n-1)!}\,dz$$

For each value of n in this expression, the term in the summation give the probability that the number of failures is equal to n, and the total downtime due to repair of these n failures is less than x. Let s be the total number of spares. We observe that the sum of these terms for n = 0 to n = s give the probability that two conditions necessary for mission success are satisfied, namely the spares required is no greater than s, and the total repair time due to failures is less than x. We express this probability by G(x,s), where

$$G(x,s) := \sum_{n=1}^{s}\left[e^{-\left[\lambda\cdot(T-x)\right]}\right]\cdot\left[\frac{\left[\lambda\cdot(T-x)\right]^n}{n!}\right]\cdot D(x) + e^{-\left[\lambda\cdot(T-x)\right]}$$

(3)

Now suppose we only have s = 20 spares and we want the combined probability that U=970 hours uptime is achieved, and the 20 spares are not exhausted, during the mission time T =1000 hours. This is given by G(30,20) = 0.61. If we increase the spares to 27, the probability of success increases to 0.92. Recall that F(30) = 0.944 is the maximum probability of success, with unlimited spares. From a practical point of view this is actually attained with 33 spares, as seem from G(30,33) = 0.944.

Total mission success is defined as 1) the non-repairable part of the system operates for time U without failure, 2) the maintained part with MTBF 1/λ, MTTR 1/μ, successfully completes U uptime, i. e. no more than T-U downtime for repairs and 3) the s spares are not exhausted. This probability is give by the product [R(U)][G(T-U,s)]. Suppose that R(970) = 0.975. Then, in our example, we have [R(970)][G(30,27)] = 0.975 x 0.92 = 0.897.

Now note that this example assumes that whatever fails will have a spare, up to 27 failures. In practice a system is made up of many failure modes, which would require a spare for replacement if a failure occurs. Therefore, the 27 spares in the example actually represents enough spared LRUs so that 27 failures would always have the appropriate spare part or LRU. Consequently knowing that spares or LRUs are required for up to 27 failures does not at this point tell us how many of the LRUs for the maintained system need to be spared. We next address the issue of determining the number of specific LRUs to be spared.

3. APPLICATION METHODOLOGY

Equation 3 gives the probability that the total downtime does not exceed x=T-U and the number of spares required does not exceed s. Let the maintained part of the system consists of K distinct LRUs. These are the candidate items to be spared. We next develop a methodology to aid in determining how many of each LRU must be spared.

Under the exponential model for system time to failure, the probability that the s spares will not be exhausted in operating time U is given by

We can also show that G(x,s), Eq. 3, has the lower bound

$$G(x,s) \geq [F(x)][SP(U,s,\lambda)]. \tag{5}$$

Now, G(30,25) = 0.89 and F(30) = 0.944. By Eq. 4, the probability that spares would not exceed 25 is given by SP(970, 25, 1/50) = 0.91. The lower bound on G(30,25) (Eq. 5) is [0.944][0.91]= 0.86. Also, for s = 27 spares, the lower bound is 0.91.

If we spare in such a way as to achieve the lower bound approximation (Eq.5), then the actual probability of mission success for the maintained part of the system is greater, if the system consists of one LRU. We extend this to more than one LRU.

To illustrate the general methodology, let the maintained part of the system consist of two LRUs with respective MTBFs and MTTRs: $MTBF_1 = 1/\alpha_1$, $MTTR_1 = 1/\mu_1$ $MTBF_2 = 1/\alpha_2$, $MTTR_2 = 1/\mu_2$.

The system MTBF is $1/\lambda$, where $\lambda = \alpha_1 + \alpha_2$, and MTTR = $1/\mu$, where

$$MTTR = [\,(\alpha_1/\lambda)\,MTTR_1 + (\alpha_2/\lambda)\,MTTR_2\,]$$

Let $MTBF_1$ = 65 hours, $MTTR_1$ =1.2 hours and $MTBF_2$ = 218 hours, $MTTR_2$ = 0.3 hours. This gives system MTBF =50 hours, and system MTTR=1 hour, so that again F(30) = 0.944.

If we want spares so that the probability of mission success for the maintained part of the system is 0.86, as in the previous illustration, then from Eq. 5 we can approximate this by

[F(x)]•[Prob(spares are not exhausted)].

Let SP = Prob(spares are not exhausted). As noted above, this is a lower bound with only one LRU to spare. For more than one LRU our methodology spares the separate LRUs so as to achieve the same probability SP. Since 0.86 = (0.944)· (.91), the target for the probability (Eq. 5) of not exhausting the spares is SP= .91. This is set as the product of the spares probabilities SP1 and SP2, the probability of not exhausting the allocated spares for LRU1 and LRU2, respectively. In determining the spares allocation for this example, we give equal weight to the probabilities for LRU1 and LRU2. This establishes the target values for SP1 and SP2 equal to $\sqrt{.91}$ or .954. That is, using the Poisson distribution we find the number of spares S1 and S_2 such that

$$SP1 := \sum_{n=0}^{S_1} \left[\left[e^{-\left[\alpha_1 \cdot (T-x)\right]} \right] \cdot \left[\frac{\left[\alpha_1 \cdot (T-x)\right]^n}{n!} \right] \right]$$

$$SP2 := \sum_{n=0}^{S_2} \left[\left[e^{-\left[\alpha_2 \cdot (T-x)\right]} \right] \cdot \left[\frac{\left[\alpha_2 \cdot (T-x)\right]^n}{n!} \right] \right] \qquad (6)$$

both equal approximately 0.954, or the product target of SP = 0.91. A solution is to allocate 21 spares for LRU1 and 8 spares to LRU2. This gives SP = 0.913, SP1 = 0.949, and SP2 = 0.962, with a total of 29 spared LRUs.

With this allocation there is approximately a .86 total probability that the maintained part of the system will have repair time less than 30 hours, and the 28 spares are not exhausted. That is, mission success.

These methods are easily extended to any number of LRUs as illustrated in the following examples.

4. EXAMPLES

Example 1

Navy aircraft and associated support equipment will perform a special deployment to a regional hot spot for the next six months. Very limited repair capability will be available at the deployment site with sparing being the primary method of support. The total calendar time for this deployment is 4320 hours. Six pieces of portable Automated Test Equipment (ATE) will support the repair of these aircraft. The ATE is used for diagnostics and retest after repairs. This particular ATE is older technology, but is crucial to the success of this mission. Under this field deployment environment the ATE also requires maintenance. The mission profile will be that this ATE is expected to operate, if necessary, for 2880 hours, with no more than 1440 hours of downtime due to repair. It is desired to initially deploy each ATE with sufficient spares in order that it will have a .90 probability of successfully completing 2880 hours of operation. The measure of success for this ATE will be if 1) the non-repairable part of the system operates for time 2880 without failure, 2) the total repair time for the maintained part does not exceed 1440 hours, and 3) spares for repairs to the ATE are available when needed.

Data show that under the expected field conditions the ATE has a mean time between failures (MTBF) of approximately 19.35 hours. However, most of this system failure rate is due to 10 specific Shop Replaceable Assemblies (SRAs), which will need to be spared. (SRA is Navy terminology equivalent to LRU.) The remaining part of the ATE is very reliable and for this mission duration of 2880 hours the non-spared parts of the ATE are estimated from data to have a reliability of .99.

For the maintained part of the ATE the MTBF and operational MTTR, including administrative wait times, diagnostics, removal, repair, calibration, and test-out, are given in Table 1, below, for each SRA. The MTBF and MTTR for the total maintained part of the system are also given.

SRA	MTBF	MTTR
1	100	3.5
2	300	5.5
3	500	4
4	1000	4.5
5	50	14.5
6	100	3.5
7	500	4.5
8	750	5.5
9	1000	12.5
10	1000	5.5
Overall Repairable System	19.35	8.23

Table 1. SRA and ATE MTBFs, MTTRs

Applying Eq. 1 for λ_1 = 1/19.35, μ_1 = 1/8.23, T= 4320, x = 1440, we have that the probability is 0.931 that the repairable part of the ATE will have no more than 1440 hours of downtime in mission calendar time of 4320 hours, with unlimited spares. With unlimited spares, the overall probability that the ATE will be able to operate for a total of 2880 hours in the six-month period is (0.99)(0.931), or 0.92. It is desirable to determine the spares allocation so that the overall system probability with spares is lowered to 0.90, from the maximum of 0.92. Because the non-repairable part of the system has a reliability of 0.99, the target of 0.90 means that the repairable part of the system has a target reliability of 0.909 with spares (0.90=(0.99)(0.909)). The .909 with spares is lowered from the 0.931 with unlimited spares. We next use the lower bound in Eq. 5 and set this equal to 0.909. In Eq. 5, the .909 target consists of two parts, which are 0.931, the probability that the repairable time does not exceed 1440 hours, and 0.976 =0.909/0.931, the probability that spares are available when needed.

There are 10 SRAs that will need to be spared. The sparing probability target for all ten is set at 0.976. The sparing probability for each SRA is set at the 10^{th} root of 0.976 or 0.997. Using the Poisson distribution (Eq. 6), we find the following number of spares for each SRA for this six-month mission. These are listed in Table 2.

SRA	Target Prob.	No. of Spares	Actual Prob.
1	0.997	45	0.9981
2	0.997	19	0.9978
3	0.997	13	0.9975
4	0.997	9	0.9992
5	0.997	80	0.9979
6	0.997	45	0.9981
7	0.997	13	0.9975
8	0.997	10	0.9979
9	0.997	8	0.9971
10	0.997	8	0.9971
Overall Repairable System	0.976	250	0.978

Table 2. Results of SRAs Sparing Solution For ATE

Example 2

Total storage volume is often a consideration. Suppose the volume allocation, in cubic feet, for each of the SRAs in *Example 1* are: SRA1, 1.25; SRA2, 1.50; SRA3, 0.75; SRA4, 1.25; SRA5, 1.00; SRA6, 1.00; SRA7, 1.50; SRA8, 2.00; SRA9, 3.00; SRA10, 2.00. The total volume required with the solution of *Example 1* is 310.25 cubic feet. Suppose it is desired to lower this storage volume. This situation can be addressed in the design phase for a system. For example, increasing the MTBF for SRA 5 from 50 hours to 55 hours would change the sparing solution, and reduce the required total sparing volume to 283.5 cubic feet. Similarly, reducing the MTTR for SRA 5 from 14.5 to 10 lowers the required total sparing volume to 284.5 cubic feet.

Example 3

There are many civilian applications where high reliability and availability are required for finite operating times. One such application is the use of agricultural machinery to harvest grain, known as "combines". As with military missions harvesting grain often has a very limited operating time. This window of operation is often determined by random factors such as weather and crop conditions. Consequently, there is a need for high reliability during the harvesting "mission" with a minimum amount of downtime. In order to maintain mission readiness and minimize downtime there must be an ample supply of key service parts to replace any components that fail during the harvest.

Suppose a fleet of 5 combines are owned by a custom harvesting company. These 5 machines will be harvesting grain for approximately 20 weeks, beginning in the Southwest US in May and ending at the Canadian border in September. However, a given window of operation may only last 3 weeks before weather or crop conditions close it. Within this window each combine is expected to run an average of 12 hours per day. Thus, the maximum operating time, T, for each machine is 21 days times 12 hours per day or 252 hours. To keep on schedule the fleet must maintain a percent uptime of at least 90%. Therefore, total downtime can not exceed 25 hours per machine.

Data from previous harvest seasons shows that each combine has a MTBF of approximately 74.5 hours. Records indicate that downtime failures occurred on 8 key service parts or LRUs (lowest replaceable units). The remainder of the machine was extremely reliable over the typical operating time of 252 hours, demonstrating a reliability of 0.98. For the repairable part of each combine the MTBF and MTTR for each LRU are given below. The overall MTBF and MTTR for the repairable system are also shown.

LRU	MTBF (hours)	MTTR (hours)
1	4000	1.5
2	2500	2.0
3	250	3.0
4	1250	6.0
5	1500	3.9
6	800	4.3
7	1270	3.2
8	190	3
Overall Repairable System	74.5	3.3

Table 3-Harvester MTBF and MTTR

Applying Eq. 1, the probability is 0.94 that the repairable part of the system will have no more than 25 hours of downtime in total harvest time of 252 hours, with unlimited spares. The overall success probability (0.94 times 0.98) with unlimited spares is 0.92. To address the limited number of spares that can be carried in the supporting field parts truck we reduce this probability from 0.92 to 0.90. Following the previous example, the sparing probability target for all eight LRUs is set at 0.976 and the sparing probability for each LRU is the 8th root of 0.976 or 0.9969, rounded to 0.997. The number of spares required for each LRU for the 12-week harvest is given in Table 4.

LRU	Target Prob.	No. of Spares	Actual Prob.
1	0.997	1	0.998
2	0.997	1	0.996
3	0.997	4	0.998
4	0.997	2	0.999
5	0.997	2	0.999
6	0.997	2	0.997
7	0.997	2	0.999
8	0.997	5	0.999
Overall Repairable System	0.976	19	0.985

Table 4. Results of LRU sparing solution for Harvester subsystem

These spares are sufficient to achieve the desired 90% uptime of 227 hours of harvest without stocking an excessive number of spare parts in the parts truck. In this manner the customer is satisfied with the fleet performance without having to purchase too many spare parts.

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I would like to thank Robert Seman of General Dynamics Advanced Technology Systems, for the many discussions on this subject and his insight into this problem. I would also like to acknowledge Kevin Oshaughnessy at the Reliability Analysis

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BIOGRAPHY

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Larry H. Crow is VP, Reliability& Sustainment Programs, at IIT Research Institute, Huntsville, AL. Previously, Dr. Crow was Director, Reliability, at General Dynamics ATS (formally Bell Labs ATS). From 1971-1985, Dr. Crow was chief of the Reliability Methodology Office at the US Army Materiel Systems Analysis Activity (AMSAA). He developed the Crow (AMSAA) reliability growth model, which has been incorporated into US DoD handbooks, and national & international standards. He chaired the committee to develop Mil-Hdbk-189, *Reliability Growth Management* and is the principal author of that document. He is the principal author of the IEC International Standard 1164, *Reliability Growth-Statistical Tests and Estimation Methods*. Dr. Crow is a Fellow of the American Statistical Association, the Institute of Environmental Sciences and Technology, and the recipient of The Florida State University "Grad Made Good" Award for the Year 2000, the highest honor given to a graduate by Florida State University.

STAN OFSTHUN AWARD

The late Stan Ofsthun of Sierra Research, was the first president of the SRE in 1971 and 1972. As a member of the Buffalo Chapter from its earliest beginnings, he was responsible for initially leading SRE beyond its beginnings in Buffalo to the present organization with more than twenty chapters worldwide.

This award recognizes the best technical paper by an SRE member accepted for presentation at the Annual RAMS.

The award consists of a certificate of recognition and $1,000 CASH. The "Call for Papers" appears early each year. Abstracts must be submitted to RAMS and to the SRE by April. The criteria for the Stan Ofsthun Award are (1) being an active member of SRE, (2) having the paper approved for presentation at the annual Reliability and Maintainability Symposium (RAMS), and (3) being selected by the SRE Paper Awards Committee. SRE members can submit their papers destined to RAMS, through their local chapter president, to the SRE paper Awards Committee. The Chairman is:

SRE Paper Awards Committee
C/O Dr. J. A. Nachlas
250 New Engineering Bldg.
Virginia Tech
Blacksburg, Va. 24061-0118

Lambda Notes will reprint award winning papers in future issues with the permission of RAMS and IEEE.

Virginia Tech engineering professor voted USLIA men's coach of the year

(by Liz Crumbley, PR Coordinator, Virginia Tech College of Engineering)

"There's enough time in life to do the things you really want to do—if you don't waste your time," Joel Nachlas says when asked how he manages the equivalent of two full-time jobs, as an associate professor in Virginia Tech's Grado Department of Industrial and Systems Engineering (ISE) and as head coach of the university's men's lacrosse team.

In May 2001, Nachlas was named Coach of the Year by both the Southeastern Lacrosse Conference (SELC) and the U.S. Lacrosse Intercollegiate Associates (USLIA). In addition, Virginia Tech placed first in the SELC, defenseman Ernie Lemmert was named SELC Defensive Player of the Year, and Lemmert and four of his teammates—Andrew Randall, Aaron Connelly, Drew Enstice and Ben Gogol—were chosen for the SELC All-Conference 1st Team.

The success of this team, however, is not a typical Hokie sports story. Men's lacrosse at Virginia Tech is a club sport, not a varsity sport supported by the university's Athletic Association. Lacrosse team members receive no sports scholarships. In fact, Nachlas explains, each of the 35-40 students on the team pay a $1,000 per year membership fee to support the bulk of the team's expenses. Virginia Tech contributes another $6,000-$7,000 each year from student activity fees, which helps pay for equipment.

And unlike varsity coaches, Nachlas does double-time, making the team's travel plans, booking hotels at modest prices and chartering buses for games that are long distances from Blacksburg. But despite the financial drawbacks, this *pro bono* coach has become a great believer in the sports club system.

Nachlas began his lacrosse career at the age of seven while growing up in Baltimore, Maryland. When he later played lacrosse as an undergraduate at Johns Hopkins University, his team won the national lacrosse championship.

In 1974, Nachlas came to Virginia Tech as an assistant professor and Kim Flint of the university's ROTC program was the men's lacrosse coach. Nachlas signed on as assistant coach and became head coach when Flint left the university in 1975.

At that time, the NCAA had oversight of lacrosse and club teams were associate members. "The goal of NCAA was to let club teams make the transition into varsity teams," Nachlas says. From the early 1970s until 1994, the Virginia Tech team competed with NCAA varsity teams. "We did well against the varsity teams and usually had a winning record," he notes.

Then the NCAA began pushing the club teams away and the USLIA evolved to provide a league for the club teams. Virginia Tech is one of 130 member teams in the association, and the SELC is one of eight conferences.

Although Nachlas hoped during the 1970s that men's lacrosse would become a varsity sport at Virginia Tech, he has since decided that the students are better served as members of a club team under the umbrella of the USLIA.

"The students on our lacrosse team put academics first," he says. "A club sport provides something worthwhile that I'd like to preserve. The students learn how to balance the aspirations they have for both academics and sports."

However, one thing does bother the coach. "These students shouldn't have to pay so much in order to play lacrosse," he remarks.

The team practices three afternoons a week the first half of fall semester, then every afternoon until the season starts in

February. The season ends with a national tournament in May. Virginia Tech has reached the tournament almost every year since joining the USLIA, and came in fifth in the nation in 1998 and 2001.

About half of the team members are engineering students, Nachlas notes. For the USLIA 2001 season, eight of the Virginia Tech players were selected as lacrosse All Americans and four were named academic All Americans.

"For a student who is well-organized, competing in club sports is not a hardship," he comments. "The enjoyable thing about coaching and teaching at Virginia Tech is that the students are smart, capable people."

Editors note: Virginia Tech's mens lacrosse team participated in the 2002 USLIA National Championship and was highly ranked. To learn more about the Virginia Tech men's lacrosse team, visit their website: http://www.GroupLoop.com/VTLax/index.asp?Action=Old

SRE Information CD Contains Useful Reliability Test Plan Program & More – by Duane Cook, Belvoir Chapter

How much would you expect to pay for a CD containing a useful Reliability Test Plan program, which would enable you to design and modify test plans, and assess the associated confidence and risks? Wait, there's more! This CD also contains a selection of Reliability related Government specifications and standards. And, if that wasn't enough, there are also templates of many of the SRE documents in Word format ready for your use. Would you guess this CD would cost $29.99? $19.99? How about FREE!

Presented by the Belvoir SRE Chapter, this disk contains the latest version of the Reliability Test Planner (RTP) software. This program was developed by Gary Pryor, a Belvoir Chapter member, and a long standing Reliability Engineer working for the U.S. Army. (See Gary's article below for details of the program). Mr. Pryor's program has been (and still is) available for download from the Reliability Utilities section of the SRE Website (http://www.sre.org). Belvoir Chapter President Anh Ma, and past Executive President Duane Cook had discussed with Mr. Pryor about making the program available on CD, to be distributed to the Chapters and also given out at the SRE Booth at the RAM Symposium. Mr. Pryor was very receptive to the idea, so Ms. Ma and Mr. Cook began looking to see what else might be beneficial to include on the CD. The SRE Website contains a selection of Government reliability specifications and standards. Working with Clarence Meese, SRE Web Master and Belvoir Chapter member, these standards, along with templates of the SRE documents were incorporated into the CD. Ms. Ma, Mr. Meese, and Mr. Cook went into production; copying the CD, printing and applying the labels, and packaging them for distribution. The CDs debuted at the 2002 RAM Symposium in Seattle, WA and were a big hit! Since that time, the RTP software has been updated (is any software ever truly finished?). The newest version will be available on the CD to be distributed at the 2003 RAM Symposium in Tampa, FL. The CD offers an easy way to get all of this information out to the chapters, and helps us out in attracting people to the SRE booth. If you can't wait until the Symposium, all of the information contained on the CD (including the latest version of RTP) is available for download on the SRE website.

Anh Ma, Clarence Meese, Duane Cook work together to develop the SRE CD.

Reliability Test Planner – by Gary Pryor, Belvoir Chapter

The *Reliability Test Planner* is a software utility that simplifies the development of statistical reliability test plans for the exponential and binomial distributions. After choosing a MIL-HDBK-781 test plan, or specifying test parameters (length, failures, consumers and producers risks), the Operating Characteristic (OC) Curves and risks can be quickly calculated and displayed, as well as compared to multiple similar test plans. The test plans (either fixed length or probability ratio sequential test plans) may then be modified and tailored to meet your needs, and printed in multiple formats.

RTP was written in Visual Basic 6.0 and versions are available for Windows 95/98/ME and Windows NT/2000/XP. (Previous versions for DOS and Windows 3.1 are also available upon request).

Features:

- Use MIL-HDBK-781 standard test plans, or develop original plans for exponential or binomial distributions
- Plot multiple OC Curves for plan comparison
- Manual or automatic marking of risks or other points on OC Curves
- Multiple options for printing test plans, OC Curves, plan info in color
- Run Monte Carlo simulations of your test plans for varying reliabilities, and plot results
- Simulate Weibull or Normal distributions against exponential test plans
- Automatic generation of families of related test plans

Gary is a member of the Belvoir Chapter of SRE. His contact information is available in the program under "Help/About".

Note: RTP is copyrighted by and is property of the US Army and may be distributed and used freely where permitted by law.

Gary Pryor is an ASQC certified reliability engineer who has been working for the US Army for the past 19 years. He has been working at the US Army Engineer School, Fort Leonard Wood, MO as a member of the TRADOC Combat Developments Engineering Division for the past 12 years. He obtained his Masters degree in Computer Science from the University of Missouri, Rolla in 1995 and is the author of several reliability oriented computer software applications.

A Short History of the SRE — Part 4 — Growth in the Late 1970's

by David D. Dyrck, SRE Buffalo Chapter

This is the fourth in a series of articles tracing events in the history of the SRE. Parts 1 and 2 chronicled the founding of the SRE and the formation of an international organization. Part 3 chronicled the activities and expansion of the SRE in the mid-'70's. Part 4 continues with the activities and growth in the late '70's.

Much of the content is taken *verbatim* from the early documents of the founding chapter, and thus takes on a Buffalo Chapter perspective. The prime information sources are minutes of meetings, newsletters, reports, correspondences, notes, membership directories, and consultations with some of those involve during that time. Among those contributing were Ed Banaszak, Jim Bilz, Paul Couvutsakis, Vince Daniels, Mike Hufnagel, Zig Gilchowski, Chet Orlowski, and Norm Zobel. I'd like to acknowledge the assistance of Gary Cohen for his recollections, Bob Nowacki for having the foresight to compile documents more than 25 years ago, and Jack Baker for storing the bulk of the documents and making them available to me.

Editor's Notes: This publication is intended to inform the members of the SRE and to stimulate discussion of reliability engineering topics and issues. Comments, suggestions, and contributions are encouraged.

Background: By mid 1975, The SRE had grown to about 400 members, its treasury was about $500. Chapters were holding regular technical meetings, educational programs, seminars, and some were publishing chapter newsletters. At the international level, discussion and activity continued on the issues of improving communications, establishing a member-at-large category, developing a certification, and expanding membership and chapters. An international newsletter was being published quarterly.

The following is a continuation of the chronology of some of the events in the history of the SRE.

17 April 1975

The SRE is included in the coordination of all reliability documents for which RADC is the preparing activity.

15 June 1975

The SRE Newsletter International Edition (Volume 10, No. 1) is published. Bob Tillotson (Buffalo) replaces Neville Jacobs as editor.

16 July 1975

SRE Constitutional amendment is approved to require that the SRE Executive Chairman and the Secretary/Treasurer be elected from and by the SRE Executive Board of Directors comprised of immediate past chapter chairmen and the past SRE Executive Chairman. The amendment also established an "at-large" membership class, administered by an "at-large" chairman, having no voting rights. SRE membership dues are raised to $6.00 per year.

15 September 1975

Tucson Chapter grows to 32 members. Huntsville Chapter reports that it has held a series of technical meetings by the U.S. Army Missile Command (MICOM). Among the lessons learned at MICOM was "Don't fall into the too early / too late trap. (Too early for testing – parts are going to change; too late for testing – design is frozen); window between 'too early' and 'too late' is 4 micro-seconds."

2 December 1975

Buffalo Chapter states its policy that its membership list "…shall be distributed only to SRE Buffalo Chapter members in good standing and other SRE officers. Copies will not be distributed to area companies or other commercial interests. Control will be by mailing list…"

Buffalo Chapter is asked to embark upon a certification training program, perhaps in conjunction with ASQC, after its recent survey yielded a preference for the Reliability Engineer Certification administered by ASQC.

1966 – SRE Formed

1971 – SRE becomes international

1979 – RAMS Sponsor

27 January 1976

Buffalo Chapter drafts chapter committee operating guidelines for its education, membership, program, publications, and publicity committees

Buffalo Chapter issues its first "Membership Directory". It contains 100 entries.

6 April 76

Buffalo Chapter acquires videotapes on "Engineering Reliability" from University of Arizona (Dr. Kececioglu) as its chapter education program and for showing at its upcoming seminar

15 April 1976

SRE completed review and comments on its first government document, MIL-HDBK-217B, Notice 1.

The Philadelphia Chapter Newsletter is now into its third year and is being issued monthly. Membership enrollment is 24 members from Boeing-Vertol with two members at-large.

27 April 1976

Ottawa Chapter (Bruce MacMillan) writes SRE Chairman Bob Nowacki that "It has become apparent…that there is a definite lack of communication between the International Executive Board of the SRE and the Ottawa Chapter. …Cooperation…will be judged as a positive indication that communications plays an important role in the success and survival of the SRE…"

May 76

After Buffalo Chapter invites Toronto area SRE members to its technical meeting in Hamilton, Ont., R. S. J. Voytek, SRE member from Litton Systems, expresses an interest in forming an SRE chapter in Toronto. Bob Tillotson provides information.

5 June 1976

Ottawa Chapter holds its 1976 Canadian Reliability Symposium, SRE-76. 95 attend.

7 June 1976

Buffalo Chapter donates $25 to Canisius College for the Dr. Sigmund P. Zobel Memorial Book Fund. " Sig had been instrumental in the founding of our society and had supported our activities…for over ten years."

15 July 1976

SRE newsletter editor (Bob Tillotson) offers prizes for members' submission of newsworthy items. The prizes are a circular slide rule incorporating conversion factors, a copy of Suggestions for Designers of Electronic Equipment, a metric slide rule, and an Alvin T-41 pocket-size stencil. (Five months later he reports that "Your editor's attempts to 'wheedle' some news out of the general membership was a flop…")

23 September 1976

SRE co-sponsors the Third Annual Reliability Engineering Conference for the Electrical Power Industry in Montreal, Quebec.

10 November 1976

The Tucson Chapter meeting featured "SRE –Past, Present, and Future" by Bob Tillotson (Buffalo).

"Bob traced the history of the SRE from its first informal meeting in April 1966 in Buffalo…Current Society membership is over 500 with new chapters in the process of forming. The SRE is a loose confederation of chapters bound by a single constitution…He noted that lack of communication between the Executive Board and the chapters and lack of a sound financial base are problems facing the International. As to the future - …it's up to the members to decide…he did point out that 'when participation in the SRE and chapter activities ceases to be fun, the SRE will no longer be a viable organization'."

18 January 1977

The SRE Executive Board discusses continuity and the need for two-year, staggered terms for officers. The Board rejects creating a Chapter-at-Large.

18-20 January 1977

SRE exhibits at the 1977 Reliability and Maintainability Symposium. SRE's first technical publication, Poisson Confidence Table (SRE-1201276), by Ken Eagle is available for sale.

February 1977

Terry Brady (Philadelphia) suggests an amendment to the SRE Constitution replacing the title 'Chairman' with 'President'. The amendment was approved by the membership shortly thereafter.

1986 – SRE grows to 15 Chapters, 751 members

1989 – Stan Ofsthun Award established

1997 – SRE web page (www.sre.org)

Bob Nowacki (Buffalo) calls for an exchange of chapter publications such as proceeding of local SRE seminars. He distributes the proceedings of the 1976 Buffalo joint SRE/ASQC seminar.

2 March 1977

After surveying interest of potential SRE members in the Toronto area, Al Ling forms the Toronto Chapter. (17 members)

11 March 1977

Roy Hunt (Philadelphia) replaces Bob Tillotson as SRE newsletter editor.

Huntsville Chapter's technical program topics include "Systems Effectiveness", a tour of Wylie Lab, "Electro-optics", "Standards", "Air Pollution Controls", "Space Environment Testing Chamber", and wine tasting.

26 April 1977

Montreal (Jack Marriott) holds an inaugural meeting.

10 June 1977

The new society-wide mailing address was changed to SRE, P. O. Box 131, Crum Lynne, PA, 19022.

The SRE has endorsed U. S. President Carter's bill to establish a single agency for consumer protection.

Ottawa Chapter's technical meetings covered semiconductor reliability, reverse engineering, and software reliability. The chapter education program, "Management of Reliability Programs" and "Maintenance and Maintainability", was completed. Another SRE Canadian Symposium is being planned.

16 June 1977

Montreal and Toronto Chapters are chartered by SRE. The charter states, in part, "…the…Chapter is entitled to affiliation. We do hereby invest the officers with full power to establish a Chapter of the Society of Reliability Engineers with the objectives to foster the Philosophy and Principles of Reliability and to promote Professionalism among its members."

July 1977

SRE Awards Committee Chairman Ken Eagle nominates Dimitri Kececioglu to receive the SRE Certificate of Excellence. Shortly thereafter (in 1978) Dr. Kececioglu receives the award for his "personal contributions made toward the advancement of the philosophy and principles of reliability engineering".

1 October 1977

Milwaukee Chapter is formed. Its first President is Dev Raheja.

13-14 October 1977

Ottawa Chapter hosts the 1977 Canadian Reliability Symposium. 175 attend.

22 October 1977

Buffalo Chapter holds its 10th Annual SRE/ASQC Seminar in Niagara Falls, NY. The format includes keynotes, technical presentations, exhibits, and films.

9 December 1977

After having been a participating organization for the required two years, attending RAMS meetings, serving on committees, and presenting papers, SRE is invited to seek RAMS co-sponsorship status. SRE (Ken Eagle, President) formally requests this change to "co-sponsor". The RAMS Board of Directors later approved SRE co-sponsorship starting with 1979 RAMS.
10 December 1977

SRE President Ken Eagle appoints Joan Vivaldi (Philadelphia) as International SRE Librarian and Custodian. "She will file…[just about everything] …and…keep the newsletter morgue".

Tucson Chapter's technical program includes "The Mysteries of Reliability Failures and their Resolution" and "Product Liability – Landmark Cases and Product Planning".

Toronto Chapter's program includes "Nuclear Reactor Safety", Software Reliability", and "Flight Safety".

Milwaukee Chapter's first technical meeting was entitled " The GIDEP System" by Edwin Richards.

10 June 1978

SRE President Ken Eagle reported that SRE Certificates of Recognition have been awarded to Bruce MacMillan, Jack Marriott, Al Ling, and Phil Thompson for their efforts, which resulted in the formation of the Montreal and Toronto chapters.
31 July 1978

Los Angeles Chapter is formed. Its first President is John Ingram-Cotton.

16 September 1978

California (Los Angeles) and Portland chapters are chartered. Portland's first President is Om Gupta

Jack Baker (Buffalo) and Mike Bolar (Montreal) are elected as SRE President and Secretary/Treasurer respectively.

Roy Hunt (Philadelphia), Dev Raheja (Milwaukee), and Hugh Shadenfroh (Buffalo) were elected for the SRE Certificate of Recognition for their contribution to the establishment and/or advancement of the SRE. Hans Rieche (Ottawa) was nominated to receive the SRE Certificate of Excellence.

January 1979

SRE membership was about 600 members in ten chartered chapters, and another 60-

100 members at-large, world-wide, including Japan, Greece, U. K., and Sweden.

19 January 1979

Mike Bolar (Montreal) reported that the feeling in Toronto and Montreal is that the fee of $6 is unrealistic when compared to IEEE dues of $42 and ASQC dues of $30. He suggested that SRE dues be raised from $6 to $10 or $15. "The $6.00 does not provide sufficient funds for any sort of activity." He also reported that "There is a feeling here that a chapter to cover Eastern Canada (Toronto, Ottawa, Montreal) is desirable."

28 July 1979

SRE Certificates of Recognition are awarded to Bob Nowacki and Bob Tillotson, both from Buffalo Chapter.

SRE Chapter Presidents 1966-1980:

Year	Buffalo	Ottawa	Huntsville	Philadelphia	Tucson
66-67	Gerry Cohen	—-	—-	—-	—-
67-68	Bob Nowacki	—-	—-	—-	—-
68-69	Neville Jacobs	Neville Lewis	—-	—-	—-
69-70	Bill Atkins	Blair Clerke	Joe Caffrey	—-	—-
70-71	Stan Ofsthun	Hans Reiche	Wayne Straight	—-	—-
71-72	Bill Kean	Nick Balke	Oscar Williamson	—-	—-
72-73	Bill Yurkowsky	John Ingram-Cotton	Scott Hosom	—-	—-
73-74	Don Clark	Jim Arsenault	Dennis Malik	Ken Eagle	—-
74-75	Bob Nowacki	Diju Raha	Steve Parker	Kirk Rummel	Dimitri Kececioglu
75-76	Hugh Schadenfroh	Bruce Mac Millan	George Stewart	S. Steigelfest/T. Brady	Dimitri Kececioglu
76-77	Jack Baker	Phil Thompson	Dick Anderson	T. Brady/ J. Dougherty	Dimitri Kececioglu
77-78	Vince Daniels	Al Harris	Dick Anderson	Bob Hazlett	Robert Mielke
78-79	Mike Pilarsky	Al Harris	Len Steinburg	Steve Blewitt	Robert Mielke
79-80	Wayne Harper	Dave Honkanen	Len Steinburg	Dave Sesso	Robert Mielke

Year	Montreal	Toronto	Milwaukee	Los Angeles	Portland
76-77	Jack Marriott	Peter Chai-Seong	—-	—-	—-
77-78	Jack Marriott	Peter Chai-Seong	Dev Raheja	John Ingram-Cotton	
78-79	Peter Cheeseman	Peter Chai-Seong	Dave Marciniak	John Ingram-Cotton	Om Gupta
79-80	Peter Cheeseman	Ian McRae	Robert Herman	John Ingram-Cotton	Warren Collier

SRE Executive Officers 1971-1981:

Year	President	Chapter Affiliation	Secretary/Treasurer	Chapter Affiliation
71-72	Stan Ofsthun	Buffalo	Hans Reiche	Ottawa
72-73	Nick Balke	Ottawa	Oscar Williamson	Huntsville
73-74	Scott Hosom	Huntsville	Bill Yurkowsky	Buffalo
74-75	Jim Arsenault	Ottawa	Dennis Malik	Huntsville
75-76	Bob Nowacki	Buffalo	Steve Parker	Huntsville
76-77	Terence Brady	Philadelphia	Hugh Schadenfroh	Buffalo
77-78	Ken Eagle	Philadelphia	Al Ling	Toronto
78-79	Jack Baker	Buffalo	Mike Bolar	Montreal
79-80	Hans Reiche	Ottawa	Ken Eagle	Philadelphia
80-81	Wayne Harper	Buffalo	Bob Lebeau/ Vern Keller	Montreal/Portland

Working With Delayed Failures and Delayed Distributions

By David M. Brender, SRE At-Large Chapter

For the purposes of product characterization and product improvement, it is often necessary to convert a collection of data on failures and survivors into a failure distribution. From this form we can provide a proper measure of future reliability over the working life of the product and so judge the adequacy of product design and build.

It is often assumed that the fitted failure distribution should start from time zero simply because the product was tested from time zero. This assumption can lead to serious errors in reliability projections and engineering decisions. It is unfortunate that a good deal of the reliability literature and software is based on the casual assumption of zero start times.

Consider a component. It may not be possible for the principal failures to occur until a considerable time after it is put into service. Damage leading to failure may take some minimum time to accumulate to serious levels. Examples are dielectric fatigue and metal fatigue.

If you observe a considerable failure free interval proceeding a cluster of failures, you may well have encountered a naturally occurring delayed distribution. Delayed data and delayed distributions can arise from several causes, including the physical nature of the failure mechanism and certain types of Accelerated Life Tests.

In a delayed distribution the real start point of the distribution occurs sometime after zero. This delay alters both the analysis of failure data, and the prediction of future reliability of components and systems.

First consider data analysis. In practice, for example, one should not routinely accept large estimates of the Weibull shape parameter. If your data shows a considerable initial interval without failure, it is essential to try fitting a three parameter Weibull. Here, the third parameter represents the delayed start time of the failure distribution.

In one application (to ALT data) with just a two parameter Weibull, the shape parameter estimate BETA = 3.66 (RMS Error = 0.276). The same data with a three parameter Weibull gives a nonzero start time and a very different BETA = 1.72 (a better RMS error = 0.113) and, of course, a far better looking fit to the data. Note that the data says that the reliability is unity before the start time. The estimated start time is less the first failure time.

Now consider reliability prediction, in a fairly simple case. With delayed failures, even components with an exponential distribution behave in surprising ways. That is because, basically, a delayed exponential distribution is not an exponential distribution. A delayed exponential can not be analyzed or applied like a regular, pure exponential distribution. The whole conceptualization is different. But reliability applications of the delayed exponential distribution are straightforward and definitely advantageous.

a) Even though they have the same MTTF, components governed by a delayed exponential are far more reliable initially than components governed by the pure exponential. This is critical — it translates into far fewer early system failures.

b) Components governed by a delayed exponential exhibit an aging effect — older components are worse than newer ones — unlike pure exponential components.

c) In a delayed exponential, the MTTF is not the reciprocal of the failure rate, and the failure rate is not the reciprocal of the MTTF.

d) The MTTF alone can not be used to calculate the component's reliability. Similarly, the failure rate alone can not be used to calculate component reliability.

e) With a delayed exponential, one can not obtain the system reliability by simply adding together failure rates — direct reliability calculations are necessary and advantageous. Proper, higher system reliability values result.

f) With a delayed exponential, the simple decrease in test time with increased numbers on test does not hold.

g) Test planning requires modified planning formulas.

Interestingly, I have seen occasions when a two parameter (delayed) exponential distribution can give a better fit to data than can a (non-delayed) two parameter Weibull distribution.

Note: This material covers 3 items out of 36 items from my paper: "What Not To Do in Accelerated Life Testing and Reliability." A complimentary copy of the paper is available on request. David Brender, has thirty years of industrial experience — IBM, Xerox, Harris — applying systems engineering and operations research techniques to every sort of reliability, service, and quality based engineering problem. He is a Magna Cum Laude graduate in Electrical Engineering at NYU. (BrenderBrender@IEEE.Org)

SRE Ottawa Chapter Organizes 2003 Canadian Reliability, Maintainability Symposium (CRMS)

– by Dean Scrofano, Ottowa Chapter

New technologies for design engineering, manufacturing and test are rapidly developing, changing and expanding. Manufactured products must meet all customer expectations for the manufacturer and distributor to penetrate the market, retain current or increase current market share. As a result, cost effective techniques and innovations to assure high quality product that is reliable and maintainable are more essential

SRE Ottawa executives: seated left to right, Vern Robertson, Jonathan Patterson, Dr. Tony Wild; Back Row, Colin Chabot, Jim Arsenault, Dean Scrofano; Absent, Aaron Dinovitzer, Dave Pedly.

than ever. Just meeting basic engineering and manufacturing requirements does not provide the competitive edge needed today. To survive, managers and engineers must sharpen their competitive edge through cost effective application of reliability and maintainability techniques.

Early this year, several members of the Ottawa Chapter of the SRE got together to discuss the current state of R&M in light of the economic climate and the doldrums in the high tech sector. Discussion revolved around the rapidly expanding need and role of reliability and maintainability in order to meet increasing public and industry demand for reliable products and services. The enormity of the topic matter soon became apparent. Discussions revolved around learning about new technologies, tools, methodologies, who was doing what and how etc. The idea of a northern R&M symposium was advanced and agreed upon, a Planning Committee was formed and planning activities quickly followed. The 2003 Canadian Reliability, Maintainability Symposium (CRMS) was born.
The two (2) day symposium will be hosted October 16-17, 2003 at the Lord Elgin Hotel in beautiful downtown Ottawa Canada. The 2003 CRMS theme is "Reliability & Maintainability – The Productivity Engine for this Century". It is intended for the CRMS to provide a forum to share in the experiences of, and to network with, leading R&M practitioners, colleagues, industry leaders and academia. . Further, the CRMS planning committee is pleased to announce that the "founding" sponsors are the American Society of Quality (ASQ), IEEE, Ottawa Chapter of the SRE and the International SRE.

Planning activities are well under way with the initial Call for Papers issued in November 2002. The Call for Papers solicits contributing articles in eight different themes. In addition to the paper presentations, the symposium offers a parallel stream of exceptional tutorials with the theme, "Achieving Reliability and Maintainability: Best Practices from the Electronics Sector". Call for Papers and tutorial content descriptions are available at the symposium WEB site at: http://www.crms2003.ca/

The program will be finalized in the spring of 2003 following response to the Call for Papers and tutorials.

For R&M practitioners, the 2003 CRMS is an excellent and cost effective opportunity to sharpen or update their skills and meet professional colleagues. For non-practitioners, it offers an excellent opportunity to meet R&M experts, attend educational tutorials and gather insights into the critical aspects of R&M.

For more information, please visit our WEB site at http://www.crms2003.ca/

Society of Reliability Engineers Application for Membership

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Daytime Phone: ______________________________

Evening Phone: ______________________________

Fax: ______________________________

E-mail: ______________________________

Area of Professional Interest: ______________________________

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Signature: ___________________ **Date**: ________________

Please include a check/money order for $10.00 (US funds) made out to:

Society of Reliability Engineers

Mail this application along with your check to the Chapter with which you wish to affiliate. If you want to join as an At-Large member send your application to the address shown on the At-Large Chapter page on SRE.org. Please indicate your desired address for postal mail.

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