

**The Electronics Quality/Reliability Center:
Lessons Learned From Partnering With Industry**

Theodore A. Dellin
National Center for Ultra-Reliability Engineering
Sandia National Laboratories, Albuquerque, NM 87185

Introduction

The government electronics community faces the exciting challenge of entering into new types of partnerships with the commercial electronics industry. Past interactions have been based primarily on the needs of government. Future interactions will be based more on the needs of industry, particularly its need to be competitive in commercial products. The most successful groups will be those most adept at forming this new type of "win-win" partnership.

Fortunately, both government and industry want to make these new partnerships successful. The government is driven by the necessity of establishing a common government/commercial manufacturing base and the desire to support U.S. competitiveness. Industry is driven by the need to partner with government to remain competitive.

Unfortunately, there are no detailed guides available to help government electronics groups and their sponsors in the Administration and Congress cross this uncharted terrain. The purpose of this paper is to share some "lessons learned" from the experiences of a government electronics group that has been active in establishing these new types of partnerships with industry. It is our hope that by sharing these lessons we will make it easier for other government groups to work with the commercial industry.

It needs to be stated up front that "lessons learned" papers are inherently subjective. To make the paper more readable, we have avoided constantly using leading phrases such as "In our opinion..." or "We have observed..." However, the reader should remember that these are opinions, not gospel, and they are based on a relevant, but limited, set of interactions with the commercial industry.

Electronics Quality Reliability Center (EQRC)

The EQRC represents several groups at Sandia that meet the Department of Energy's need for very high reliability electronics for nuclear weapons and other applications. The EQRC's activities span the whole product cycle from R&D on how devices fail to a SWAT team for resolving production and field reliability problems. The EQRC is a world leader in new reliability and failure analysis techniques, software, and benchmarking.

All papers must include the following statement:

This work performed at Sandia National Laboratories is supported by the U.S. Department of Energy under contract DE-AC04-76DP00789.

The EQRC's Industrial Partners

The EQRC produced Sandia's first Cooperative Research and Development Agreement (CRADA) in June 1991. Since then, the EQRC has added 7 more CRADAs. CRADA partners include Philips Semiconductors, National Semiconductor, LSI Logic, Schlumberger, Analog Devices, Hewlett Packard, Advanced Micro Devices, and General Motors. The EQRC won a 1992 Federal Laboratory Consortium Award for Excellence in Technology Transfer. CRADAs represent only one way that the EQRC is partnering with industry.

These CRADAs involve a variety of activities. We are doing cooperative R&D with industry to better understand oxide and stress voiding failures. In addition, almost every manufacturer we have worked with has used the EQRC to characterize and benchmark the reliability of their current and future technologies. They also have transferred from the EQRC new techniques for doing failure analysis, as well as advanced test structures for monitoring manufacturing. In the software arena, the EQRC jointly developed a wafer level reliability software package with Hewlett Packard (Slide 6) and is jointly developing a failure analysis expert system with Schlumberger. Another common feature of these partnerships is the ability to use the unique capabilities of the EQRC as part of a SWAT team to resolve reliability problems.

Lessons Learned

A detailed list of lessons learned is presented in Table I. Commented copies some slides we use with industry are also attached (the slides are in the order we usually present them). Space limitations allow commenting on only a few of lessons learned.

Sell Benefits, Not Capabilities

The most important lesson learned is that industry chooses projects based on the benefit they perceive they will gain. They do not choose projects based on the capabilities of a potential government partner. Capabilities are relevant, but only in the context of how they contribute to adding value to the industrial customer. It is a big mistake to assume that your industrial partner will immediately recognize the profit potential in your capabilities (Slide 5).

The benefit is determined solely by the industrial partner. Sometimes it may be something very transparent and logical such as increasing profits. Other times, it may be the need to satisfy a government regulation. However, it could also just be a gut feeling that this need is important.

In addition, at any one time, industry works on only a small fraction of the potentially beneficial projects. First, almost all potentially beneficial projects involve an investment of time and money, resources that are becoming increasingly scarce in industry. Second, industry has been burned by potentially beneficial projects whose benefits have not been realized in practice, or even worse, which have caused serious problems. In industry "no change is a small change." For example, if your idea involves any change in a manufacturing process you may be surprised to find that being twice as good is not good enough, and that you would have to be ten times better before the industry will pay attention.

A service the EQRC offers is the ability to do a very detailed analysis and benchmarking of the reliability of a new technology. We assumed that industry would see a large benefit in being able to identify and fix problems before they started production. To our surprise, we found that for many of our customers the really big benefit was that this extra reliability work had a very positive impact on the auditors. Customers use auditors to evaluate potential suppliers and their recommendations are, therefore, critical to our partners. We have subsequently modified our marketing material to make sure customers understood how the EQRC could help when they are audited by their customers.

So how do you determine the maximum potential benefit you could provide to a commercial electronics company? Talk to as many people in the industry as possible. One good way to find out what is really important at a company is to ask what is the most important factor considered when their customers make a buying decision or what things will determine their boss's annual bonus. Things that are important to customers, important to their upper management, or solve a crisis are good candidates to be 'hot buttons.'

A Sustainable Differentiating Strength

You need to possess a unique, cost effective, ability to add value to your customers' products. This is not easy to achieve. You will do more business with industry if you are uniquely strong in one critical area, than if you are good, but average, across the board.

The industry typically wants to use, but not pay to develop or sustain, differentiating strengths. Thus, this role falls to government. Unfortunately, it appears

that one of the hardest things for government agencies to do is to identify those areas where they have a realistic opportunity to develop a sustainable differentiating strength.

The more glamorous areas of technology are crowded. For sustainable, affordable, differentiating strengths look at the less glamorous, but equally critical areas, such as manufacturing or reliability.

Draw Out The Objections

We were surprised to discover the depth and intensity of the concerns that industry has about working with government. Some common concerns are that government electronics groups:

- Do not know how to work with industry
- Are not dependable
- Only want to do leading-edge R&D
- Are more trouble than they are worth

We found that it is vital to draw out these concerns very early in interactions with a potential industrial partner. At the beginning of our presentations we bring up these objections and then address them (see Slide 1). You must work hard to draw out these objections.

Cash: It's Hard, But It's Worth It

We were surprised to find that it is generally much harder to get industry to make a smaller cash contribution to a joint project than to get them to make a much larger in-kind contribution. (In-kind contributions include things such as the salaries of the industry staff working on the project and any materials or equipment supplied.) It seems that in-kind contributions can be approved at a lower management level than cash contributions. Furthermore, in-kind contributions may be viewed by some companies as "free" since they may represent costs that would have been incurred even without the CRADA.

Nonetheless, it is our strong recommendation that projects that involve cash are much better for both the industry and the government. If the industry provides cash you know that you are doing something that is very valuable. Furthermore, the commitment of industry to the project is much greater. If industry does not want to pay even a fraction of the cash required, is the project really valuable?

Acknowledgements

The whole staff of the EQRC has contributed to our successes in working with industry and these lessons learned, especially Rich Anderson, Ann Campbell, Ed Cole, Bill Filter, Chris Henderson, Paul McWhorter, Bill Miller, Don Pierce, and Eric Snyder.

Table I: Lessons Learned From Partnering With Industry

Market the Benefit

Sell the benefit to the industrial partner, not your capabilities.

The benefit is whatever the industrial partner thinks it is.

Industries only do a small fraction of the "good" things that they could. You have to find a "hot button" benefit.

Many people in manufacturing believe that "no change is a small change." The benefits of a change often have to be overwhelming (or mandated by law) before they will risk a change.

Differentiating Strengths

You need to have an affordable, sustainable, differentiating strength that provides you with a unique way to benefit industry.

There are lots of competitors in the glamorous areas of technology. It is much easier to establish and sustain differentiating strengths in critical, but less glamorous areas of technology such as reliability.

Being smart or having worked on similar problems in the past is generally not a differentiating strength.

Industry will want to use your differentiating strength, but will not generally be very interested in paying for you to develop or sustain a differentiating strength.

True dual-use technologies are the most sustainable. To be truly dual-use the technology must be equally valuable today to both commercial and defense customers.

Effective Communicating

The message is more important than the medium. A simple black and white brochure that clearly communicates your unique ability to benefit your industrial partner will be more effective than a glossy color brochure describing capabilities.

Prepare a press release. It is easy to get widespread, free publicity in the trade press.

Never let a potential customer leave empty handed. Always hand out hard copies of your slides

and give a brochure.

A picture is worth a thousand words. A site visit is worth a thousand pictures. Capabilities never seem as "real" to a potential customer as when the see them in person.

Importance of Cash

It is easier to obtain an in-kind than a cash contribution from industry.

Projects with cash contributions are much better. It is the clearest indication that you are adding value.

Dealing with Objections

Industrial people can have strong objections and prejudices about the value of working with the government. You must draw out and resolve those objections early in your interactions with a company.

Make sure your customer knows the differences between working with the government and industry. In particular, make sure that they understand that you cannot guarantee results at a fixed price.

The Contract With Industry

Read and understand the contract you are asking your customers to sign.

Write a very specific statement of work that clearly states the obligations of both parties, the exact deliverables, the schedule, and the costs. Consider adding one flexible task to cover contingencies, but make it clear that both parties have to agree to the details of this task, in writing, before it is activated.

Our Government Customers

The government group that provides your support is also your customer.

Understand all the steps in approving the contract. If possible, talk in advance to the people who will review the contract to find out what is really important and where problems may occur.

Do not consider the emphasis on U.S. preference as an impediment to get around. Work hard to justify an investment by U.S. taxpayers.

Typical Industry Concerns About Gov't Do Not Apply to the EQRC



- The EQRC is part of the "industry"
- Decade of "Real World" experience
- Supports the whole product cycle: R&D to manuf. to end-user
- Large, near term Return-On-Investment
- Many projects payback in months
- Capability exists and runs 24 hours a day
- 8 Industry Partners



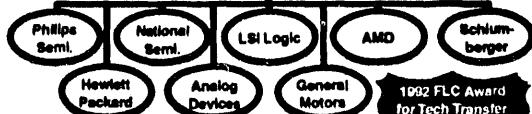
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A Growing Number of Companies are Working with the Electronics Quality/Reliability Center

DOE Need for Ultra-Reliable Systems

Electronics Quality/Reliability Center

- R&D on how devices fail
- Develop new reliability & failure analysis techniques
- Characterization and Benchmarking Test Bed
- "SWAT" Team for fixing production & field problems



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Slide 1. Raises and tries to answer common industry objections to partnering with the government.

Slide 2. Establishes credibility by mentioning industry partners. Also provides an overview of the DOE to industry connection and the common interests.

The EQRC has Unique and State-of-the-Art Capabilities and Expertise



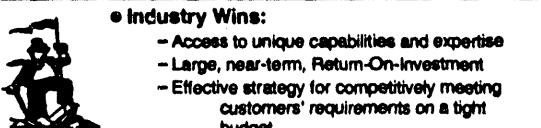
- Complete, state-of-the-art, industry-standard equipment set:
 - Wafer level & long term reliability
 - Failure Analysis
- Unique and world-class sets of test structures, software, expert systems, and techniques
- Staff with in-depth, "real world" expertise
 - "SWAT" Team to fix production and field problems
- Rapidly reduce R&D to practice and transfer the technology

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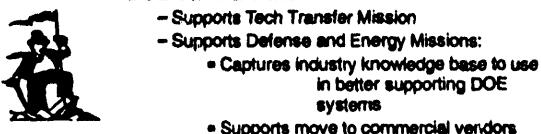
Slide 3. Attempts to establish the depth and breadth of the capabilities, the differentiating strengths, and the "industry-like" nature of the EQRC.

A Win-Win DOE-Industry Partnership In Microelectronics Quality/Reliability

• Industry Wins:



• DOE/Sandia Wins:



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Slide 4. Emphasizes how both industry and DOE/Sandia jointly benefit. Also features return-on-investment benefit.

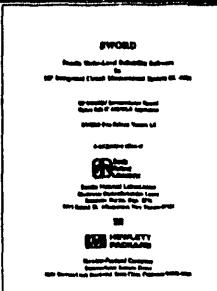
8 Ways for U.S. Manufacturers to Profit from the EQRC This Year

1. Improve technologies before they enter production through detailed characterization and analysis.
2. Improve customer audits by benchmarking your technology against the industry.
- Obtain unique test structures for improved reliability
 - 3. Wafer level reliability and test-lab-on-a-chip
 - 4. Stress voiding test chip
 - 5. Assembly test chip
- Save time and money with new Failure Analysis tools:
 - 6. RCI - See metal breaks under opaque Overlays
 - 7. CIVA - Rapidly identify site of metal breaks
8. Fix reliability problems faster with our SWAT team

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Hewlett Packard and the EQRC Brought a New Software Product to Market in 6 Months!

- Combined Sandia's Reliability and HP's Software Quality Expertise
- Developed a commercial version of Sandia's wafer level process control and reliability assessment software
- HP delivered product 6 months after signing of CRADA!
- HP will pay Sandia royalties



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Slide 5. Focuses on 8 specific ways that the industry can profit from the EQRC this year. The key words are "profit" and "this year."

Slide 6. One of a series of slides explaining specific benefits in more detail. This slide demonstrates fast responsiveness, a typical industry concern.

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