

Remarks to

Science & Technology Affordability Conference
Arlington, Virginia
October 1, 1998

Thanks, Lance, for those kind remarks. It's a pleasure to be here with all of you today.

I want to talk this morning about affordability -- in *any* environment, including science and technology. And I want to concentrate with you on the process discipline of Six Sigma -- not as a panacea, because it isn't -- but as a strong proven approach for making headway in the affordability challenge.

But before we bore in on *affordability*, we need to put the *technology* challenge on the table. And the starkest technology image that comes to mind is from a movie called, "The Final Countdown." Have you seen it?

It takes place aboard the *Nimitz*, a carrier, which goes through a time warp while steaming in the Pacific. The carrier goes back in time to December 7, 1941, just prior to the attack on Pearl Harbor.

The carrier's Hawkeye picks up the Japanese bombers and torpedo planes heading for Pearl, and the captain of the *Nimitz*, Kirk Douglas, launches his fighters to intercept. I won't ruin the ending for you. It's a great story.

But what struck me most was the stark *contrast in power and technology* between the two opposing air forces -- forces separated in time, after all, by *just decades*. Yet, in those intervening decades we have witnessed -- actually, we have helped *cause* -- a technological revolution in defense.

U.S. News & World Report sought to quantify this revolution.

- It reported that in the Civil War, the rate of data transfer was approximately *30 words per minute*. The transfer technology was the telegraph.
- By World War I, the data transfer rate was still 30 words per minute, via telegraph.
- By World War II, it had more than doubled to 66 words per minute, via teletype.
- But by the Gulf War, it had soared, according to the magazine, to almost 200,000 words per minute, via computer.

It's not just that *defense* technology is accelerating; *commercial* technology is accelerating as well, as we all know. Moore's Law has become almost a cliché, but there's clearly an inexorable dynamic of change going on here.

Further complicating the technology challenge is a post-Cold War world that requires us to prepare our forces to be the leaders in a world that is far *less predictable* -- with multiple *threats*, multiple *theaters*, and multiple *missions*, with new and emerging dangers.

The Joint Chiefs of Staff, in *Joint Vision 2010*, put it this way:

“Accelerating rates of change will make the future environment more unpredictable and less stable, presenting our Armed Forces with a wide range of plausible futures ...

“The American people,” they say, “will continue to expect us to win in any engagement, but they will also expect us to be more efficient in protecting lives and resources while accomplishing the mission successfully.”

And here’s the clincher: we need to fulfill the obligation inherent in *Joint Vision 2010* under the pressure of historically constrained defense budgets.

As we all painfully know, the defense procurement budget is off more than 60% from its peak of the buildup in the mid-‘80s. And, while RDT&E has taken less of a hit, it is still down significantly from its peak.

Now I could keep going with a discussion of the *technology* story. And I am very excited about the technology that all of us in this room are developing: acoustic fatigue, hyperspectral imaging, hypersonic airframes, multi-sensor fusion -- and just this morning in the *Wall Street Journal*, the University of Delaware, the Naval Research Laboratory, and Raytheon were talked about for mass producing tunnel diodes on silicon wafers.

We could even talk about the use of electro-optics to use night vision to make a child visible crossing the street at night. It will be available on Cadillacs in the year 2000. It just happens to have Raytheon technology on it.

But given the defense budgetary pressures on our industry, I wanted to focus with you on the *affordability* challenge instead.

Given all these pressures, how do we fulfill our commitment to our Armed Forces to maintain technological leadership, to field new technologies quickly, and to do all this *affordably*?

There is no monolithic solution.

Clearly there are many things we can do to control costs -- like accelerating the use of proven commercial inventory management techniques such as “*just in time*” deliveries and “*point of use*” inventories, and tapping into *COTS* (Commercial Off The Shelf) technology, but also acknowledging the challenges inherent in that; it is not a simple solution.

And then there is Six Sigma.

Six Sigma forces us to identify defects in any process -- from manufacturing, to engineering, to administration. It subjects every activity, even time itself, to thorough fact-based analysis.

It creates processes which are agile and lean -- all processes, even the process of innovation. It gets to root causes, and in a very interesting way, it brings people together -- people who wouldn’t normally consider themselves as sitting on the same bench.

It brings them together and requires them to think and operate in teams.

By using people trained in advanced statistical tools -- this stuff doesn’t come *naturally* -- and in techniques and the change management process, Six Sigma identifies problems, cuts down on waste, and reduces cycle time.

I hear Six Sigma is still controversial in some quarters. Frankly, it's hard for me to know why. And it means different things to different people. Let me start with the popularized metric for Six Sigma, which is 3.4 defects per million. Six Sigma quality is equivalent to 99.99966%.

Is that *excessive* and *obsessive*? I'd say "no" to the former and "fair enough" to the latter. Because we've *got* to be obsessive about cost and quality if we want to produce great technology that we all can afford, at a time when the United States is spending about the same on defense per GDP as it was in the isolationist years before Pearl Harbor.

99.99966%. Wouldn't just 99.9% be good enough? Well, that would translate to 20,000 wrong drug prescriptions a year, over 25,000 newborn babies accidentally dropped each year, or almost 500 incorrect surgical operations each week.

We've got to aim higher than that.

Let me identify some of the principles that go under the – let's call it the Six Sigma "umbrella."

There's quality improvement technology. That includes design of experiments, mistake proofing, design to cost, design for manufacturability, statistical process control, process mapping and more.

And there's leadership direction, customer satisfaction surveying, organizational structure initiatives, metrics and tools, including the Process Capability Analysis Toolset, or PCAT, which was developed by one of our legacy companies.

Let me give you a few quick examples of how some of these Six Sigma principles come together for the common good.

Let's start with General Electric. GE, per their 1997 Annual Report, delivered more than \$300 million to their operating income in 1997, and they have projected several hundred million dollars more for 1998 because of their efforts in Six Sigma. They have documented savings across their entire businesses, from a 10X increase in the life of CT scanner X-ray tubes, to cutting defects in their Loan Workout process by 96%. The use of Six Sigma principles has allowed GE Capital to offer borrowers quicker solutions while reducing claim payments by \$8 million.

Allied Signal has achieved similar results. The company embraced Six Sigma in late 1994, and for 1995 the company reported savings of \$175 million in bottom line improvements -- that's net of the costs to launch the initiatives -- \$350 million in 1996, \$400 million in 1997, and the company has said it expects even greater improvement in 1998.

Allied Signal reported a Six Sigma project at the company's Pendleton, South Carolina laminates plant that showed a 50% hike in capacity, a 50% reduction in cycle time, a 50% reduction in inventory, and an increase in on-time delivery from 90% to almost 100%.

These are a few examples from outside the defense industry. We have also documented results at Raytheon. And we have just gotten started at this.

A circuit card assembly shop using Six Sigma techniques reduced defects from 40,000 per month to 3,000 per month. The value to the operation over a two-year period was in excess of \$13 million.

In one engineering development program, Six Sigma tolerancing techniques were used to design a product which met the customer's requirements and avoided an investment for us of approximately \$4 million in Jig-Bore machines. This same program has also achieved a 27% reduction in the average unit production price with other Six Sigma activities.

Another example comes from one experience with BAT, the Brilliant Anti-tank Munition. The team used a Design for Manufacturing and Assembly workshop to reduce parts count and to improve the assembly process on the BAT altimeter. This workshop sought to involve all of the people associated with the design, manufacture, assembly, service and, ultimately, end use of the device.

The proposed re-design was evaluated using our Process Capability Analysis Toolset, which provides a quantitative assessment of quality, cost and cycle time before ever starting the job.

The PCAT model for the BAT altimeter showed:

- An 85% reduction in defects per unit;
- A 97% reduction in total cycle time;
- A 73% reduction in defects per million opportunities;
- And an increase in Sigma from 3.4 to 4.0.

We're making the altimeter now. We believe we will achieve the PCAT level reductions. And we're working to squeeze additional cost out of the BAT program.

This is all tough sloggng, but the battle for quality and affordability is fought, and won, in the trenches, day by day -- by teams well trained in these statistical tools.

The key is deploying highly trained people to get in and do root canals on process. Not in a high-minded way, but as leaders, experts -- "Black Belts" is the increasing term of currency in the industry.

I believe that by using this powerful tool of Six Sigma, along with other methods of attack, we will improve our efficiency and be able to meet this affordability challenge, and strengthen the defense industrial base.

Now, look, there are other actions that need to be taken. We all know that.

We've just heard about the importance of acquisition reform. We clearly have come a long way, faster than a lot of us felt possible. And clearly we need to continue down that road with all due haste. We also need to draw on infrastructure and management technologies to achieve affordability.

But if I could leave you with one thought today, I'd like you to consider the importance of Six Sigma -- as a focused, disciplined way of getting to the root causes of cost and time.

I started with a reference to a movie. Let me conclude with one -- just to sort of step back here at the end.

Have you seen "Saving Private Ryan"? I think those who have seen it will agree that the first 20 minutes of that film are about as intense and realistic as movies get. It shows D-Day from the perspective of GIs spilling out from amphibious vehicles into a spray of gunfire on the beaches of Normandy.

Now, Ike had no choice but to throw those boys on the beach. His assignment was to *re-take* a heavily fortified *continent* occupied by the enemy. The kids who did it, who swallowed their fear, are now parents and grandparents.

We *owe* them -- in a big way.

Our responsibility *today*, all of us working *together* -- in industry and in government -- is to make sure that we keep our country and our allies so strong that we never, *ever* have to play "catch-up" again. The price is too high.

And, if we *do* need to fight, we must make sure that we have equipped our country and its allies with the tools to decisively defeat our aggressor without ever having to contemplate a D-Day style assault again.

To me, that's really what we're talking about today: how to get that job done.

On behalf of the 115,000 folks of Raytheon, we deeply *appreciate* and take pride in the support of our Armed Forces -- and we will work with you to do everything within our power to provide you with the *best* systems, and *affordable* systems. And that is not a goal: it is a *commitment*. Thank you.