The Pioneering of Reliability into the 21st Century Keynote Speech

Charles J. Latino

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17810 Comanche Trail

Los Gatos, California 95033

fmsreliability.com/publishing/

fms@fmsreliability.com

Charles J. Latino 1929 – 2007

"Experienced in all phases of work concerning the design, construction, and productive utilization of corporate facility assets. Have held positions from plant to corporate level; from foreman to manager; and in continuous and batch processes." from Charles' 1979 resume describing his experience.

In 1972 Charles founded the Allied Chemical Corporate R&D Reliability Center. In 1985 Charles retired and purchased the center from Allied Chemical thus founding the independent company: Reliability Center, Inc. (RCI). He remained the CEO of RCI till his passing in 2007.

"[...] founder of Reliability Center, Inc., [Charles] was a chemical engineer with a background in psychology and human factors engineering. He was a leader in the development of an integrated approach to achieving greater reliability in manufacturing and industrial systems and processes. He served as consultant to many companies in the United States and abroad. He is the author of Strive for Excellence... The Reliability Approach. He has left his Reliability legacy to his wife and five children who continue to spread his visionary Reliability Approach to companies throughout the world." – from his biography attached to articles/white-papers.

Charles career spanned roles as a Chemical Engineer Trainee (1951) to General Superintendent of Maintenance (1966) to Manager of Mechanical and Utilities (1968) with additional roles as Superintendent of Maintenance and Plant Engineer.

His experience and knowledge shows in the collected writings we have available today.

The Pioneering of Reliability into the 21st Century

PDVSA 3rd NATIONAL MAINTENANCE WORKSHOP

KEYNOTE SPEECH

Charles J. Latino, President, Reliability Center, Inc.

I am a Chemical Engineer but I am also a businessman. Next year it will be fifty years since I got my first job after graduating college. In the latter part of this span of time I have witnessed, as many of you have witnessed, the formation and growth of a global economy. Along the way I learned that if companies want to compete globally they must focus on two issues. They must continuously increase their productivity and they must grow.

Increasing productivity is important because it produces more goods, of the same or improved quality, with the same number of workers. This provides several benefits. For example, companies can then increase worker wages without increasing inflation in their respective economies. This, in turn, puts more money into circulation which, in turn, is used by people to buy goods, invest or save. All of these outcomes boost society's self-confidence, and their standard of living.

Growth is necessary because it puts more people to work. In the earlier days of my career in the United States many workers felt that feather bedding and slowdowns were the way to job security. Feather bedding is the implementation of inefficient work rules while slowdowns are the dragging out of the production process. These strategies simply could not sustain themselves because they reduced productivity, drove up the price of goods and decreased profit margins. So we are left with essentially one strategy that works for everyone, that is, the manufacturer, the worker and society. That strategy is growth.

It is important to note that both are required. Productivity without growth results in fewer jobs, which can drain an economy that is forced to sustain families without jobs. Likewise, growth without productivity is recklessness in a highly competitive global economy because it tends to inflate prices and does not allow salaries and wages to progress. These are the issues that I learned and pondered as I moved forward in age and experience.

To project ourselves into the future of maintenance and reliability we must examine the past. In this way, we discover the patterns of evolution that allow us to predict the future.

When I started my career as a Chemical Engineer in 1951, I was assigned as a maintenance supervisor of a central shop facility in a small chemical plant in Pennsylvania. I quickly found out what breakdown maintenance was because that was the only kind of maintenance that was done. Planning of maintenance work was non-existent and scheduling was done by the boss's secretary, as she handed us the work orders for the day. Fortunately, I only stayed in this job for 2-1/2 years because I joined the Army in 1954 toward the end of the Korean War. In the Army I was exposed to organizational structure, really excellent training and a lot of responsibility for a young man.

Shortly after I left the Army I joined a new venture, in Hopewell, Virginia, that made Nylon monomer that would eventually be polymerized and spun into nylon fiber for rugs, tires and a host of industrial uses such as belting and slings. Within a year I was made the head of maintenance.

This was the mid-1950's when the interest in rocketry was rising in our nation. I was intrigued by the possibilities and wondered how we would ever find the reliability to venture into space. I found out that there was no body of knowledge titled "Reliability". I found that all references to reliability resided in Quality Control literature. I did not know at the time that I was preparing for my life's work.

I found that maintenance had progressed since I left the Pennsylvania plant and now included planned shutdowns. This meant that on a periodic base, never more than a year in those days, large important machines and processes were shutdown and overhauled. All bearings and seals, as well as worn parts, were replaced and oil was refreshed on rotating and reciprocating machines. Heat exchangers were opened and pressure tested. And we would crawl in to inspect columns and vessels. The machines were then closed up and the processes restarted.

The only problem posed by these planned shutdowns was that a significant number of equipment items had to be taken down and inspected and/or repaired between overhauls. These were unnecessary failures that were usually caused by the mistakes of the workers performing the maintenance and/or the conditions prevailing during the overhauls. These breakdowns were subsequently named Infant Mortality failures. Nevertheless, planned overhauls did progress us up the productivity ladder, although it was a small movement.

In the Army I was in the Medical Service Corp. I learned that medicine was moving in the direction of non-invasive examinations of internal body organs, that is, gauging the health of internals parts without opening the body surgically. After all isn't that what the doctors were doing when he or she listened to our hearts and lungs with a stethoscope, took our temperature or analyzed our body fluids. By association I felt that it made sense that we should be able to examine machines without opening them up.

Accordingly, I purchased my first IRD vibration analyzer in the mid 1950s. It was a large box of electronics that was awkward to move around but, by God, it worked. I managed to identify problems such as resonance, "softfoot" alignment and balance. Thoughtfully applied this would be a giant leap in productivity. We were making progress. Our failure rates, at my plant started going down but not as fast as I hoped and I wondered what was missing.

In the beginning of the 60's I was transferred to my company's largest plant, still in Virginia with over 3000 employees. This was the plant that used the monomer that I helped produce. I became the head of Maintenance, Engineering, Utilities and the manufacture of dies to extrude the polymers into nylon fibers.

I quickly established my nondestructive testing (NDT) tools. I began to prove that we could indeed apply non-invasive techniques to machines. I started by having every piece of rotating equipment vibration checked every week. I had instant coverage of all rotating equipment. The technicians recorded the vibration readings and then submitted them to an engineer for analysis.

Within a short period of time, approximately six months as I recall, we were able to determine the proper inspection frequencies and adjust the program. Today many companies go into very long and arduous studies to set inspection frequencies. I still believe that it is best to get coverage as soon as possible.

Of course, thickness testing of pipe, boiler tubes and some process tubing followed. Infrared Thermography entered during this period and we were able to measure and analyze insulation breakdowns, pluggages and process flows with this new tool. Other tools followed and the better run plants put them to good use. We found that we not only were able to monitor the health of equipment while it was running but that we could do it with a great deal of precision.

What was the benefit? We were able to identify component failures and take equipment off line in time to prevent more catastrophic machine failures. This provided more running time for the processes and more product for the same amount of labor. So productivity profoundly improved. Because our market was developing we expanded our facilities. So we were also growing.

To most facilities that were progressing along this path, benefit was measured in millions of 1970 U.S. dollars. We were able to lengthen turnaround – cycles to two years and continued lengthening them, as inspection equipment improved, to the point that many facilities go down in five years intervals today.

The benefit of lengthening the time between turnarounds was also in the millions of dollars.

Interestingly, in the seventies, and perhaps before then, we were able to continuously monitor the bearings of our largest, high-speed turbines and compressors. It naturally followed that if we could monitor these bearings continuously then we should automatically take the equipment off line if the signals indicated trouble ahead. But, this did not work in the United States, because of a human factor. Some equipment came off line when it was still operational and managers were hard pressed to explain to their bosses why they allowed an expensive shutdown and subsequent startup to occur. Until voting logic was available and managerial fears were calmed, the compressors were not afforded automatic shutdowns in many U.S. facilities. As many of you are aware, a loss of a thrust bearing can wreck a high-speed machine before people have a chance to react manually.

But I still needed to understand why we would fix problems that we detected and they would reappear. I concluded that we really did not understand our failures. First, I discovered that even though we were preventing catastrophic failures by our non-destructive tools, we were still experiencing failure of machine components. After all isn't that what our non-invasive testing tools were finding?

I directed my reliability engineering staff to study the failures to find their root causes. First we confirmed our earlier premise. Even though we had the technology to predict a large number of machine failures, we still weren't preventing them.

Now, man has a natural tendency to want to know why he cannot control his environment. All of us have a innate desire to solve problems that affect us. In the fifties and the early sixties we would muse about such things. We learned to read the surfaces of failed components and took measures to prevent those failures.

Recognize that this was always done under pressure to get the equipment repaired and running. So, at best, our efforts were hit and miss. In the late sixties we began to add discipline1 to our efforts by employing logic trees introduced to us by fault tree analysis. Now fault tree analysis is an excellent prospective tool but since we already had failures and data, we could be even more definitive.

We employed logic tree analyses to solve our most catastrophic failures. We found stress risers, misalignment, balance, resonance, poor metallurgy, speed, and equipment sizing to be typical causes of machine breakdowns. As we solved problems, we found ourselves apparently adding to the benefit pool. But a strange thing happened; many of the failures that we solved later began to reappear.

So we thought that if stress risers, misalignment, balance, resonance, poor metallurgy, speed and equipment sizing were typical causes shouldn't we logically wonder how they happened. So we extended ourselves to define the point of human intervention that caused these things to happen. But we fell into a trap. It seems that we humans do not find closure to problems unless we associate a human with incidents that befall us. Once identified as a source of a loss, punishment was dispensed. Solved failures disappeared for a time, but then most of them returned. We still had work to do.

Some time in the 70's a researcher described to me the path of error. He pointed out that all things that go amiss are caused by a multiplicity of errors, that our environment was therefore very forgiving. Think about this in terms of man's existence on this earth. If only one error could cause an accident or a catastrophe we would not have survived the tens of thousands of years we have occupied this earth.

I later found that 11 to 13 errors generally occur prior to the one that obviously causes major problems to occur. Now this put a new dimension on solving problems. When we discipline an employee for causing a mishap, we effectively cut off the lines of communication that could lead us to the other contributing errors.

We now know that although the paradigm that has existed for many years, that "punishing people for errors prevents them from committing the error again" is true, its effects are destructive. When workers see another worker disciplined, they are not likely to supply information on the string of errors that lead up the incident. The information that is withheld is vital to analyzing all causes and finding preventive solutions.

In the 1980's we added a new dimension to failure analysis. We drove the logic tree further down into an area of latent causes. Interestingly, this was the area that management exercised the most control. Now when we analyzed why errors were made we found that employees make errors because they are poorly prepared for their tasks, procedures are flawed or do not exist, they have too little time to perform with precision, engineering errors make assembly and operating errors easy, or poor communication exists. All of these base line causes occur because of poor, or lacking management systems.

Let me give you an example or two. When a piece of equipment fails and shuts down the productive capacity of a facility, often the plant or mill manager will only ask when will it be ready to run again. If he or she does this often enough they will instill a paradigm in the workforce that says that management is not interested in the quality of repairs, only in getting the process running again. Management has now laid the seed for poor quality work and they don't even know it.

One steel mill was having catastrophic, but chronic, failures that were physically caused by misalignment, lack of bolt torquing and lack of cleanliness during assemblies. Their latent issues were improper training and lack of procedures. Because the physical causes were easily overcome the latent causes were not addressed. Were they surprised when the failure occurred again? This time they took care of the latent issues and the failures disappeared.

Shift mechanics in an East Coast chemical plant all carried a section of chain and chain links in their toolboxes because they knew that a feeder under a rotating horizontal dryer would either have the drive chain break or it would fall off. This was one of the invisible failures. It happened once or twice a shift. The mechanics were experts at reinstalling the chain in about 1/2 hour.

Consider that this facility was losing more than 6% of their production because of these failures. In today's dollars, this would amount to about $175,000 US per year. Think about how many of these sleepers exist in a plant. Incidentally, when the new young Superintendent of Maintenance perused a year of shift notes he noticed this failure and several others. He performed failure analysis on the chain problem and found that the original Design Engineer had misplaced a decimal point in his design calculations causing the feeder to operate 10 times faster than it should have been doing. A simple sprocket change was made and the problem disappeared.

Now we had a very powerful tool that would increase productivity as failures were eliminated. The plant that I was in was expanding again so we were able to maintain the plant census. As things further improved we assigned mechanics to construction work so growth was maintaining employment. Wages were also steadily improving but our productivity meant that we were not a contributor to inflation.

We concluded the 1980's with smaller boxes to do vibration analysis, more sophisticated and smaller equipment to do infrared scans, better means and equipment for acoustical studies and a host of new ways to gather information. Unfortunately, although we had improved our design technology we were still lagging in our ability to help employees to motivate themselves, to transfer knowledge from the training room to the field and support proactive activities such as Root Cause Analysis.

So our challenge for the nineties was to educate management that it is possible to establish a culture where proaction leads and reaction lags. But we ran into awesome obstacles. Hammer and Champy ushered in the concept of Re-engineering the work place. It caught on in the United States and a $4.7 billion dollar business emerged. However, many of these applications eventually failed. When questioned about these failures by a Wall Street Journal reporter in 1996 Hammer said, " I wasn't smart enough about that. I was reflecting my engineering background and was insufficiently appreciative of the human dimensions." I hope you see the obstacles. Reengineering has propelled us forward but at a cost. We lost a lot of company expertise. We suffered a loss of morale, at least for a time, and we increased anxiety in the work place.

However, Re-engineering was a proactive step forward. It reduced excessive resources and made many processes more efficient. Proactive moves will increase anxiety. In fact, if there is no anxiety, then expect that there is no culture change to support the new way of operating. The problem with Re-engineering, in my opinion was its intensity and lack of precision concerning the human element. Because of it, in the

United States, we lost loyalty to many of our companies. Now people work for the benefits and the pay, few work for the joy.

In an effort to link Maintenance and Reliability, people like John Moubray brought Reliability Centered Maintenance out of the aircraft industry and offered it to the continuous process industries through his book "Reliability Centered Maintenance" published in 1992. RCM, as it is usually called, is a through audit of equipment and process functionality with the end result being a program of non-destructive testing and usually some procedure changes to avoid catastrophic failure. There is no harm to equipment or processes by using RCM, but I personally believe that it is a long and arduous way of developing an effective non-destructive testing plan.

I was amazed at the following that this method got in the continuous processing industry in the United States. The United States aircraft industry is proud of the fact that they can keep some of their airplanes in the air for 30 hours. This is herald as a remarkable feat. In contrast, in the continuous process industry, equipment runs for years without shutting down. They do this 24 hours a day without the redundancy that exists on those airplanes. I often wondered who should have been teaching whom.

In the 90's 6 sigma was also introduced. This is a very expensive training exercise in statistical approaches to achieving excellent operational performance. Here again I have no quarrel with people that want to use their financial assets in this manner. I personally know that the results can be greater and achieved in less time by other means.

In 1993 Noel M. Tichy quoted Jack Welsh, the then Chairmen of General Electric Corporation, as saying, "I made my share of mistakes – plenty of them — – but my biggest mistake by far was not moving faster." No one challenges General Electric's performance during the Jack Welsh tenure. I am certainly impressed. However, 6 Sigma, which was used by General Electric, is not simple or fast although it can get results. I believe there are simpler, faster and more powerful means available.

To appreciate this fascinating appreciation of fads, we have to understand that it is restraining paradigms that are preventing us from achieving much grander production and much higher profits.

For example, most businesses employ people to deal with problems. In fact, when one considers that anything that is repetitive can be automated we begin to realize that most of the people that we employ are there to solve problems. In deed, in most cases, the problems that they encounter are the same problems that they encountered yesterday, last week or last month. Many, if not most, of these problems are so commonplace they tend to be invisible. Stock deficiencies, misaligned machinery, unbalanced rotating machinery components, misplaced x-rays in a hospital and dispensing medicines to the wrong patients are examples.

My point is that most of us will put up with enormous chronic losses without finding the root causes of our problems and resolving them for good. In contrast, if we have a large loss such as a fire, explosion, babies switched in a hospital, large accounts that default in a bank, we will do our best to find the roots of the problem. In economic terms these issues happen so infrequently their costs can usually be amortized over several years. I am not making a case for ignoring these large outlays but I will submit to you that the losses that you are incurring from chronic problems are much, much greater. So why do we put up with these drains upon our businesses?

Because of paradigms that can be stated as follows:

Large losses raise the attention of top management so they must be studied down to their root causes.

Chronic problems are small and of no interest to top management.

Management wants to see us getting things back to normal instead of spending our time in long investigations.

Finding and eliminating the causes of problems can reduce my job security.

I have discussed the past and tried to bring it up to the present. Now, I want to discuss the future in terms of this past evolution. When I started working professionally in the1950s we did breakdown maintenance. When a machine broke we fixed it. In the fifties we also began performing Preventive Maintenance, which meant, in those days, that we took our critical equipment down, usually once a year, cleaned it, replaced worn parts and always replaced bearings and seals. Of course, as you know these actions encouraged infant mortality failures.

In the late fifties, early sixties, we introduced Predictive Maintenance. We used newly emerging non-destructive testing tools to determine when machinery components were starting to fail so we could take action to prevent more catastrophic machine failures. We were looking for primary component failures to prevent more expensive secondary equipment failures. Throughout the ensuing years we used new developing technologies to perfect these approaches.

We always had failure analysis because it is man's nature to determine causes. Unfortunately, as we honed this technique we were able to find individuals that we could blame for the failures. When we punished these individuals we rationalized it by believing that:

When a person is disciplined for making a mistake we are preventing future failures because that individual will never make that mistake again and his colleagues will observe his or her punishment and not make the same mistake.

As I pointed out earlier, in our research over the years we found that when a deviation occurs, whether a failure of a machine or process or administering the wrong medicine to a patient there are always multiple causes. When we examine the deviation and find the human error we make a grave mistake when we discipline an individual for committing the error. This is because the error represents only the last error before the deviation occurred. Disciplining has the effect of closing off communications that help us identify the other eleven to thirteen errors. This is the reason why we were not successful in eliminating chronic problems.

Our research has also revealed that new initiatives cannot take hold if management is not willing to actively support them. What can management do? First they must realize that any change that they want to instill into the culture will usually be resisted. So they must appoint people to drive the change remembering that any change can ultimately be absorbed into the culture if it does not violate the deep-seated values of the people that they are trying to change. I have found that in today's working environment it is best to also appoint champions. A champion is a member of management that can support and mentor the drivers.

Beyond this, the introduction of a new initiative requires that management set up management support systems. For example, if we train employees to perform problem analysis they will need some way to access experts. Since problems are resolved after the fact, that is, they are solved after an incident takes place; the urgency to make changes passes. Our newly trained analysts need to have systems that will assure that their recommendation will be considered akin to when the urgency existed. I think you get the idea. Currently, some forward-looking companies are provided these needed supports. In the near future many others will come on board.

During the last term of the Eisenhower presidency in the United States, we had 35% of our work force engaged in manufacturing activities. Today we have 18%. Yet, we are producing three times more products. So we are progressing. We are all becoming more and more competitive. But much more can be done.

Using the evolutionary past as the basis for my predictions, I believe that in the future we will strive to eliminate the need for predictive maintenance. We can do this by performing with much greater precision. To be proactive in the future will mean to be more precise. We will machine to exact dimensions not to tolerances. We will assemble our machinery in clean room environments. We will automate bearing assemblies. We will find new ways to fill prescriptions and dispense medicines and we will conduct meetings that get results.

Some of you will think that what I am predicting will not happen because eventually everything will fail. This is true, but let me give you an example of what is possible. Early in the 1990's Mobil Oil Company placed a BMW 325i on a test stand. They filled the engine with their synthetic lubricants and filled the gas tank with their fuel. They followed the manufacturer's instructions on maintenance and changed oil every 7500 miles. They ran this automobile at speeds of 50 to 85 miles per hour. After 1 million miles they disassembled the engine and measured every part. Every part was still within manufacturer's tolerances. Since the average car runs about 15,000 miles a year, a million miles is the equivalent of 66 years of ordinary driving.

The point of this BMW story is to demonstrate what is possible when we add precision to manufacturing, to maintenance, to fuels and additives and to our operations.

To get there we will need to recognize that our biggest impediment is our thinking, and our pride. We will employ new approaches to identify restraining paradigms, which will help us to understand existing cultures. We will develop the techniques that will induce urgency for change, a prerequisite to shifting a culture. Finally we will develop the necessary strategies to move people's thinking.

Eventually our emphasis will shift from improving manufacturing to improving services. This means that we will bring order and precision into our human endeavors. For example, physicians will communicate prescriptions to pharmacies by computers that will check a patient's health record and current medicines to assure compatibility. Prescription drug orders in pharmacies will be filled by robotic designs.

True expert systems will be developed to analyze machine problems down to their physical roots. It will still require humans to delve into the human and management system causes. We are building the data bases to collect this information in industry right now.

To collect information for the expert systems of the future will require open sharing of information.

As this develops, we will bring into sharper focus deviations that disturb our societies. For example, eventually situations like the current tread separations on tires will be caught much earlier so that fixes can be applied before we injure and kill people and before companies suffer massive financial losses.

Reliability Center, Inc. believes that by understanding human motivations we will be able to guide our clients to the full use of the newest technologies available. This is our focus and it is our dedication.

I wish I could be around for the next fifty years because I believe it will be very exciting. I wish you courage to do the things that seem impossible, empathy and understanding of the human heart and the perseverance to stay the course.

Thank you for the opportunity to share with you my experiences and my vision of the future.