



ALLEN-BRADLEY
A ROCKWELL INTERNATIONAL COMPANY

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Zero Defects: Cornerstone For Computer Integration

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Keeping Afloat on a Stormy Sea

The modern corporation is a ship on a stormy sea. It faces wave after wave of threats to its existence -- from global competitors, from takeovers, from fluctuations in world currencies. Business operations are thrown off keel so frequently that sometimes just keeping afloat can be a major accomplishment. In fact, today the energies of many companies have been sapped to the point where the top priority is no longer producing products. The top priority is survival.

For manufacturers, the key to survival in this fiercely competitive environment is Computer Integrated Manufacturing, or CIM. Despite its name, CIM is more than computers. It's an advanced business philosophy which integrates administration, engineering and manufacturing. A technological structure that unifies a company in purpose as well as production -- tying together every event that occurs in a business organization, from customer order to product delivery. A single closed-loop system unlike anything that came before it.

To some manufacturers, CIM is a plunge into the icy unknown. But they really have no choice. They don't have the cozy cocoon yesterday's industrial giants built for themselves.

Theirs was an exclusive club. They spoke their own language, wrote their own rules, and set their own standards. Competition was basically a sport among friends. And that stability let them concentrate their efforts on making products and getting them out the door.

Ultimately, some of these Goliaths grew complacent, inspiring a legion of industrial Davids to rise up and conquer them in the marketplace. The downfall of the Goliaths can be attributed to many factors, but a major one was quality. Their quality didn't get worse -- their competitors' just got better.

Poor quality has far reaching effects. Companies aren't the only ones who suffer. National economies do too. Poor quality nickels and dimes them to debt. By and large, that's what happened to the United States.

In America, Our Factories Are Full of Waste

In America, our factories are full of waste. One of every four American workers fixes things that weren't made right the first time. We could get away with that kind of inefficiency in the old days, when we competed against ourselves. But now, all of that's changed.

Today, we do business in a global marketplace. A marketplace with new competitive standards -- "world-class" standards of cost and quality. This market demands higher quality at a lower cost. And it expects products and services that live up to all of a manufacturer's promises...all of the time.

Customer satisfaction is today's driving force. And that's driving manufacturers out of business. Why? Because they've lost touch with their customers. Some insist their markets aren't concerned with quality. Others simply believe quality improvement programs cost more than they're worth.

Ignoring Quality Carries a Heavy Price

The truth is, the most expensive thing about quality is the price you pay for ignoring it. That price is a heavy one. It means falling market shares, reduced profit margins, higher material costs and increased warranty expenses.

Today's marketplace is teeming with aggressive competitors who have worked for a generation to streamline processes and boost productivity. All to make products more reliable -- and less expensive -- than yours.

Again, the most effective tool manufacturers have to meet this challenge is Computer Integrated Manufacturing. CIM is the marketing machine of the future. With it, a company can respond rapidly to changes in the marketplace, producing products in a wider variety, at faster rates, at lower costs.

But computer integration has a major prerequisite -- quality. You must have your quality under control before you integrate. If you don't, your state-of-the-art production system will produce scrap -- and it will do it faster, more efficiently than ever before.

Zero Defect Quality

That's why I say zero defect quality is the cornerstone for computer integration.

Notice, I didn't say zero defect manufacturing -- I said zero defect quality. Because you really can't limit the concept of zero defects to the production of a product. A zero defects philosophy must exist throughout a company before the company can succeed at computer integration. Zero defects must permeate a manufacturer's entire organization -- every nook and cranny of his business.

Why?

Because total quality depends on the total organization. It relies on every individual passing on quality parts, quality services and quality information to the next individual.

Our leading competitors recognize that. They have no intention of limiting their quest for quality to the factory floor. Their hidden agenda -- their real strategy -- is to spread zero defect thinking throughout their organizations -- doing everything they can to cut costs, boost productivity and eliminate defects.

Some of us are moving in that direction. We're implementing systems in various areas to increase productivity and boost efficiency -- creating islands of automation in the office, in engineering, in manufacturing.

But tying those islands together will be impractical without a zero defect philosophy. Anything less than zero defects -- in any one of those areas -- could drive a company to its knees. Production consultants may tell us to simplify, automate, and integrate. But the first step in that process is to become a zero defects organization.

A zero defects organization encourages its people to do their thinking up front -- to do things right the first time. Zero defects is an attitude that says scrap and rework is bad in any form. In a zero defects company, an improperly entered order is as great a sin as an improperly produced part.

Zero defect thinking is leading edge thinking. It's the winning strategy of the future. A strategy we can pursue with computer-based quality management systems. This is technology that exists today. It automates the acquisition, manipulation and display of quality data with tools that can help a manufacturer control his process, improve his quality and design defects out of his products.

Who's Responsible for Quality?

But let's back up for a moment and ask a fundamental question: Who's responsible for quality? Who's really responsible?

The worker on the assembly line? The manufacturing engineer? The quality control manager?

Some people say quality is everybody's business. Well, that's true. Quality is everybody's business -- but somebody's got to manage it.

And ultimately that's where the responsibility rests: Quality is management's problem. And it requires management solutions. New solutions.

Yesterday's inspection-based methods won't work because they can't eliminate waste, they just locate it. Besides, waste costs money, and the inspection to detect waste adds additional cost.

As for prevention-based methods, they were a step in the right direction, but, unfortunately, they didn't go far enough.

Management Must Lead

Today management must move in a new direction. It must take on new leadership and make a new quality commitment. A long-term commitment that won't be swayed by quarterly financial reports.

Management must dedicate itself to creating a zero defect company, one that does things right the first time.

A zero defect company approaches quality like preventive health care -- making sure every action promotes quality and prevents defects. If a defect slips into the system, these companies treat it like a disease -- tracking it down....isolating it...and correcting it, before it has a chance to mature.

Prevention-Oriented Quality Control

The first step on the road to zero defects is establishing a quality management system -- a prevention-oriented quality control program that encompasses the entire scope of a company's operations.

A quality management program must have management commitment and management participation. Its goal must be to weave zero defects into the fabric of everyday life of the corporation. It must monitor operations, correct problems and reward continual improvements.

That's just the kind of quality management system we worked to establish at Allen-Bradley. We developed ours when new product technology began giving our old inspection system some industrial-strength headaches.

A decade ago we began shifting our product line from electro-mechanical devices to solid-state products. Our human inspectors -- who had no trouble spotting cracks and flaws in mechanical devices -- couldn't see hidden problems in software, firmware and electronic circuitry.

As a result, thousands of defective products rolled off our assembly lines. The problem was, we didn't know they were defective until customers complained. And believe me, they complained!

Now this was a terrible, terrible crisis for a company with the word quality in its logo. It led us to do a lot of soul searching.

TQMS - Our Total Quality Management System

Since our old quality system wasn't working for our new solid-state products, we had to develop a new one. So, we studied the works of the great quality experts -- people like Dr. Deming and J.M. Juran, and developed our very own prevention-based, zero defect Total Quality Management System -- TQMS.

TQMS turned our whole company into one huge quality assurance machine, helping us control quality throughout a product's life cycle -- from design and engineering, through manufacturing, sales and service.

With TQMS we try to do things right the first time by bringing together all the functions that shape our products. So, from the start, our designers talk with our marketing people. Our engineers talk with manufacturing. And whenever possible, our products and processes are designed together.

TQMS made quality a strategic objective -- as important as financial performance -- and it gave us the means to measure quality as precisely as we measure financial performance.

One of those measurement tools is Statistical Process Control, or SPC. At Allen-Bradley, SPC helped us stabilize our manufacturing process. Today, it keeps it stable. Using SPC we established critical process parameters -- manufacturing

tolerances within which we produce our products. It's a range of control we continually tighten.

TQMS uses SPC and other tools to monitor design, engineering and manufacturing operations. It helps us track progress, correct problems and design out defects. In a nutshell, that's how our quality system works.

Management Sets Improvement Goals

The reason it works is because it has the full participation of company management. What does management do? For one thing, it sets quality improvement goals for each major business group. And it requires each division to routinely report progress with prevention, appraisal, scrap, rework, warranty returns, supplier quality and customer satisfaction.

Management makes TQMS an important part of management performance reviews, with quality objectives incorporated into job descriptions and quality improvements tied directly to compensation packages.

Management also requires every Allen-Bradley facility and every Allen-Bradley acquisition to operate to TQMS standards -- with each business unit undergoing regular certification. This management commitment gives our people the backing they need to focus the entire organization's efforts on the pursuit of zero defects.

Has TQMS been successful? Yes it has. In many ways.

The TQMS Payoff

The program has paid off handsomely. In its first five years we estimate it saved Allen-Bradley \$82 million in quality costs -- money we were able to plow back into areas like research and development.

TQMS lowered the total cost of quality for our leading product line -- programmable controllers -- by nearly two-thirds. From 13 percent of sales to less than five percent.

TQMS helped us improve product reliability. It took our programmable controllers from hundreds of hours of failure-free operation to hundreds of thousands of hours. As a matter of fact, each new PLC product has started life at a higher rate of reliability than its predecessor.

TQMS also helped trim our warranty returns and warranty costs, reducing them by nearly 25 percent over a three year period. This was also a period of increasing sales. So as more and more products were shipped, fewer and fewer were returned.

That's not all. Our quality program delivered other rewards. Customers noticed improvements and purchased more products, helping us more than double our programmable controller market share!

What did TQMS cost? I'll answer that by telling you about the program's phenomenal return on investment. On a cumulative basis, we estimate that for every dollar we invested, we got 13 in return.

The best benefit of all is that TQMS generates a wealth of data that is leading us closer and closer to becoming a zero defect organization.

Zero Defect Quality Requires CIM

Now, in manufacturing, the problem is, once you achieve zero defects, there's no way to maintain that level of quality using clipboards and meter readers. There's just too much information to track. To maintain zero defects you need computers and computer integration. You need CIM.

What I'm saying is, just as CIM depends on zero defects, zero defects depends on CIM.

Let's look at it in practical terms. In the world of manufacturing, knowledge is power. Information is power. The right production information gives you the power to correct problems, to improve conditions. Without that information, you don't know what's wrong, so you don't know what to fix. You're just guessing.

Our engineers express it another way. They say, "Without data, you're just another person with an opinion."

CIM Automates Information

The computer controlled machinery in an automated system generates a mountain of data. A CIM system offers tools to capture data, automate information, package it into useful form and distribute it throughout the factory -- providing the facts, figures and trends manufacturers need to keep their processes under control.

There's a wide range of tools available. From minicomputer-based systems which perform real-time statistical process control on 35,000 variables per scan to hand-held microprocessor-based systems that gather data from individual machines.

These devices can make quality information available to anyone with a hand in the process -- getting it to the right people in the right format at the right time. Most important, they can deliver quality information to the person who needs it immediately -- the person who exercises modern quality control: the plant floor operator.

A Plant Floor Operator is Like an Archer

Today, the plant floor operator plays a key role in any quality improvement effort. A good operator is like an archer. He tries to hit the bull's eye every time. He knows that's statistically impossible, but that's his goal whenever he draws his bow. With each shot, he tries for the inner circle. He shoots, evaluates his performance, tightens his control, and shoots again.

Now, imagine an archer who's blindfolded. There's no way for him to know if he's hitting his target. No way to gauge his

effort. That's exactly what you have in most manufacturing operations. Plant floor operators have no real-time information on the process.

They're blindfolded. They fire away eight hours a day with no idea how they're doing. But they're not the only ones in the dark. Managers are too. They can't evaluate their plant performance until the next day -- or the next week. By that time a lot of arrows have been fired, and a lot of defective products produced.

How can manufacturers give archers the information they need to hit their targets? Let's look at some uses of automated information.

Allen-Bradley's Industrial Computer and Communication Group produces solid state devices such as industrial computers and programmable controllers. The integrity of these products depends on printed circuit boards. Everything in the product lives off the board. And every board -- right down to the smallest electronic component -- must be defect free.

QIS - Automating Quality Information

That's why our people developed QIS -- a Quality Information System that captures defect data and monitors quality levels. QIS automates and organizes quality information for problem solving purposes.

It's an on-line real-time data collection and measuring system -- a huge database of component, process and workmanship information generated by incoming inspection, on-line testing and field repair centers. If need be, QIS can tell us which component from which vendor was put on which board in which location.

QIS helps us identify problems, redesign products, and beat down reject rates part-by-part and component-by-component. It also helps us select component vendors more carefully -- choosing them for the best quality, instead of the best price.

CIM at Allen-Bradley

Automated quality information systems -- like QIS -- and zero defect thinking are making Computer Integrated Manufacturing a reality at Allen-Bradley.

Twinsburg Printed Circuit Board Assembly

Case in point: Our Twinsburg, Ohio printed circuit board assembly cell. This facility combines surface mount and thru-hole insertion technology in a step-by-step implementation of CIM. Ultimately, it will link all three of the factory's information flows -- uniting the office, engineering and manufacturing.

The cell works on a just-in-time basis, with no incoming inspection of components from certified vendors. That's why we need zero defects. An average board produced on this line uses some 300 components, and each must be a good part.

In this facility, our completely automated lines assemble boards using robotic assembly, thru-hole insertion and wave soldering. Each product is carefully profiled, its recipe stored in the cell controller.

Twenty-five different boards are currently being produced, with many more under design. And soon engineering will be able to download designs and modifications directly into the cell controller using CAD stations.

On the assembly line, a multitude of sensors gathers and feeds information to the controller, which performs statistical process measurements. Production is halted automatically if all functions are not within specifications.

How well is this integration working? Initial statistics indicate that this facility is producing products with a 98 percent first pass yield. That's world-class quality! And improvements are being made daily.

Milwaukee Small Parts Manufacturing

Back in Milwaukee, we're assembling motor contactor products in a small parts CIM manufacturing operation called the World Contactor Facility. It too operates on a zero-defect just-in-time basis, producing world-class motor contactors to international standards.

The World Contactor Facility uses automatic order/entry, automated molding and fabrication and automated assembly. The assembly line itself has 26 machines and 3,500 automated inspections. It can produce more than 725 different varieties of world-class contactors -- one after another -- in lot sizes as small as one. And, it can build to order and ship product within 24 hours.

We designed the World Contactor Facility to produce to specification 100 percent of the time. But as a back-up measure, the systems tell us if tolerances slip -- even a little.

Sophisticated computer-based technology gives us a real-time look at the process as it's operating. For example, our cell controller generates color graphic views of the facility, letting us look at the entire plant or at any individual machine. This controller tracks machine cycles and alerts us to perform scheduled maintenance. It also generates a daily one-page trouble sheet that summarizes every problem within the facility.

On the plant floor, another Allen-Bradley product performs on-line statistical process control and identifies other problems for our engineering staff. This system divides the 725 products produced in this facility into 10 families. It tells us which families are experiencing problems...and the reasons behind problems. It also generates X-bar and R charts to tell us whether individual processes are staying within control limits.

These computer-based quality management systems help us produce superior products by tightening process control in key areas. For instance, on one solder point operation, we've tightened the control limits so the process operates within a narrow 15 percent range.

Like our Twinsburg cell, this CIM facility has been very successful for Allen-Bradley. It made us a low-cost high-quality leader in world contactor products. In fact, we believe our manufacturing costs can't be beaten anywhere in the world -- even where labor costs less than a dollar an hour.

This facility has lowered our cost of quality as a percentage of sales. It's four times lower than Allen-Bradley's traditional contactor manufacturing. And six times lower than our overall cost of quality.

The computer integration here also helped to reduce the learning curve for quality improvements. In a very short time -- just two years -- we've achieved levels of quality and service that took decades to reach with conventional manufacturing.

These examples provide graphic proof that a zero defect mentality leads to successful computer integration...and computer integration can maintain those zero defect standards.

Now I'd like to share some rules of thumb we've learned in our continuing quest to achieve both.

Rules for Quality Management

One: A customer burned may never return. In today's brutally competitive arena, you may not get a second chance to make a good first impression. My advice is, find a way to give your customers high quality at a lower cost **now** -- before someone around the corner does.

Two: Without data, you're just another person with an opinion. To know what's going on in your factory you have to have the right information -- specific facts and figures culled from the sea of data that computer controls generate. There's not enough time to pull that information from reams of print-outs. You must get it instantly, electronically, using automated quality management systems, which deliver it in real-time.

Three: Make zero defects and a lot size of one your goal. If that sounds like an impossible mission for your company, consider this: A modern jetliner, one of the most complex pieces of machinery built by man -- contains more than 4.5 million parts. If you produced that jetliner at a one percent defect rate -- in other words, with 99 percent good quality -- you'd get 45,000 defective parts. Obviously aerospace manufacturers need higher quality than that. That's why they have to shoot for nothing less than zero defects. If they can do it with their product, you can do it with yours.

Four: Little problems can grow into monsters.

King Kong may have started life as a baby, but when he grew up he was nothing to monkey around with. The same is true in manufacturing. Some experts estimate that as you progress from one assembly step to another, the cost of a defect grows by a magnitude of 10 or more. That means a defect that costs pennies to fix in a subassembly, could cost you thousands of dollars to fix in the field.

Five: Try to improve everything and you'll end up improving nothing. Don't try to solve every problem in one fell swoop. Analyze your cost factors. Prioritize them as to which add the most cost and the least value to the product. Then go down the list, attacking them one by one.

Six: Your product is only as good as your vendors'.

Your product is built on your vendors' foundations, so their products have to be the best. Make your vendors partners, not just subcontractors. Open a dialogue with them and share your concerns and strategic objectives. A united effort will benefit both of you.

Seven: Make your system great, then automate. Automating a system before it's under control will only result in automated confusion. After all, you wouldn't put your company's ledger system under computer control if the books couldn't be balanced by hand.

Manufacturers Need Zero Defect Thinking

Manufacturers need more than integrated computers to compete in today's global economy. They need zero defect thinking -- and not just in manufacturing. Zero defect thinking must rule the entire organization.

The road to zero defects starts with a solid commitment from management. No organization charges into something as aggressive as a zero defect program without management's commitment and participation. After all, people perform to the standards of their leaders, and if the generals aren't committed to a goal, the troops won't be motivated to achieve it.

So the quest for zero defects must begin with top management. Corporate executives must recognize that zero defect thinking is essential to computer integration. Then, they must set in motion programs that weave it into the corporate lifestyle, spreading it to every level of the organization.

**Zero Defects:
Cornerstone for
Computer Integration**

A zero defect philosophy is the cornerstone of Computer Integrated Manufacturing. There's no way to achieve CIM without it. You must be a zero defect company with a zero defect mentality to enjoy the full benefits of CIM. Then, once you achieve integration, the two go hand-in-hand: CIM relies on zero defect quality -- and zero defect quality relies on CIM.

One final word on quality. A quality improvement program is one of the best investments a manufacturer can make. You've

We're reshaping the way industry thinks.
And works.



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