Improving the way organizations run through participative planning and management.
KARLEE
2000 Malcolm Baldrige National Quality Award Winner

Authors

Jo Ann Brumit, CEO and Chairman
David Briggs, Vice President
Rick Cherry, President
Jim Owens, Management Team Leader of Engineering
Shirley Putnam, Management Team Leader of Team Resources
Paul Springfield, Management Team Leader of Finance, KARLEE Corporation, Garland, Texas

Two dreams

Jo Ann Brumit, CEO and Chairman—KARLEE’s success began with the teaming of one man’s dream of building engines and my dream to build a company that would make our customers and our people successful. Lee Brumit, a machinist by trade with a passion for auto racing, founded the company in 1974 by borrowing $1,100 and setting up shop in a garage. When I joined the company in 1982, KARLEE was a thirteen-person machine shop making precision engine parts—and auto racing had taken a back seat to pursuing customer excellence. Today we are a vertically integrated contract manufacturer that provides a full range of manufacturing services, including:

• Advanced design engineering support;
• Prototype production
• Manufacture and assembly of precision machined and fabricated sheet metal products
• Product finishing
• Value-added assembly integration (cabling, power supply, and back plane installation, and electrical testing)

We serve the medical instrumentation, semiconductor manufacturing equipment, and telecommunications equipment markets. Our sales in the year 2000 totaled $80 million; we now have 550 team members.

A focus on customers and the Baldrige model

Our first strategy in our journey was to focus on a few customers and build very close relationships with them. We were a small company then, and we knew that by building partnerships we could use our customers’ resources to grow and deal with the challenges of building a business. By forming close relationships with our customers, we were able to expand our services from just machining to system integration by adding other processes and core competencies. We eventually added sheet-metal fabrication, painting, silk-screening, and assembly. We also learned how to do inventory management for our customers who wanted just-in-time inventory stocking.

Sometime in the mid-1980s, we decided that we needed a business model that
A focus on customers and the Baldrige model, continued

would instill excellence throughout all parts of the company. We discovered the Baldrige criteria, and we performed our first assessment. Like many companies, we thought we were wonderful, and we ranked ourselves very highly. As we got a little older, we got a little wiser, and our self-assessment became more realistic. We realized that we needed to look at all of our processes, not just our systems-integration process. We improved our manufacturing processes by applying lean production techniques to eliminate waste and improve productivity. We became excellent at managing change. Our customers’ needs fluctuate quickly, so we have had to grow quickly to meet their needs, sometimes at rates of 50% a year, while adding new processes within a few weeks.

Woman-owned and diverse

There are many unique things about KARLEE: one of them is that we are a woman-owned business. We are also socially and ethnically diverse. Only a very small percentage of our people have a college education, and only 61% have high school diplomas. Fifty-one percent of our people are Hispanic. We found that many of our employees don’t do well in a standard classroom, so we use other methods to teach basic math and English skills. The most important lesson we’ve learned is to leave the liability of diversity out of KARLEE, and concentrate on the asset of being diverse. We have become a largely self-taught organization that is continually learning.

Team members and leaders

We don’t like certain words at KARLEE. Employee is one; manager and supervisor are two others. Instead, we call the people who work for us team members, and we use the words leader and leadership.

Our leadership team consists of seven senior executives whose mission is to increase the value of KARLEE to all our stakeholders (Figure 1 on the following page). They are called the Senior Executive Leaders, or SELs. We believe that a leader must serve his or her constituents first. Our operational team leaders are there to serve our people and see that our operational objectives are met. Effective leaders create committed followers who achieve exemplary results. We aim to make it easy for our team members to remember our motto: “We strive not to look to the stars, but to be a star!”

A bold statement

Our company values are based on Christian ethics and are shown by:
- Team member growth and development
- Encouragement and recognition
- A clean and safe environment
- Mutual trust, honesty, and respect
- Social responsibilities

If you are going to lead, then you are going to have to make bold decisions. You have to be gutsy; you have to take chances. I am often told that by saying we are a Christian-based company I am making a very bold statement. Perhaps. But what
we try to do is truly care about one another; we don’t prescribe beliefs. We want to make a difference for our customers and for our people. Caring allows us to make a difference in people’s lives. We want each of our employees to learn English, to become a skilled tradesperson, a team leader, start a family—in short, be the best that he or she can be. Everyone experiences difficulties in their business and personal lives at some time. At KARLEE, we are here to support one another. Some companies sacrifice their employees for their customers or their shareholders, but we have chosen to strike a balance among them.

We are all leaders in our everyday lives: we lead within our families, organizations, and work environment. Moses was one of history’s greatest leaders because he convinced a group of people to follow him into the wilderness. When they were discouraged and despaired, he convinced them to continue to follow him.

Today there are leaders, such as Herb Kelleher of Southwest Airlines, whose dream is to build an airline different from other airlines. He knew that he would have to create a culture that was different, one in which people would be free to have fun and focus on their customers. Another great leader is Jack Welch.

Leaders are a bit like the pied piper of Hamelin: he could play a beautiful tune, and people would follow him to the ends of the earth. That skill set is the basis of leadership and the driving force behind every company.

Strategic Planning

David Briggs, Vice President—Our strategic planning process is the driving force of our leadership system (Figure 2 on the following page). Our goal is to achieve our mission to exceed our stakeholders’ expectations, without sacrificing our vision of continually improving our performance excellence.
Strategic planning drives leadership, continued

Figure 2. KARLEE Leadership Process.

We begin our strategic planning process in the early summer by assessing our planning and organizational structure. It is a good foundation for the plan because it forces us to plan our planning. Each member of the SEL team is given the following:

- Customer Satisfaction Survey results
- Team Member Opinion Survey results
- Supplier Performance and Satisfaction survey results
- KARLEE Steering Committee strategic planning questionnaire results
- Sales and Operations plans
- Industry market trends and economic forecasts

Strategic planning phase
CASE STUDY

KARLEE: 2000 Malcolm Baldrige National Quality Award Winner

Strategic planning phase, continued

- Environmental Impact data
- Performance to Corporate objectives
- Results of Hoshin projects

The SELs review the data and their own departments’ data to assess how well KARLEE’s mission, vision, values, and key business drivers define, communicate, and support management expectations. Our leadership structures are reviewed to make sure that the objectives of the SELs and steering committee are translated into clearly defined roles and responsibilities. During the first phase, we pull in all the data for our planning process and ask: “Is our planning system effective? Is it doing what we want it to do? Are we seeing any gains?”

Then we will assess our environment—our customers, team members, market, and technology. We analyze all the input that comes into our strategic planning process to update the company’s long-term business plan. Even if you are a small business, you don’t have to use a Ouija board to perform an economic analysis—there is a wealth of information available in your local library. We use trade publications such as the Wall Street Journal for research. The SELs perform a SWOT (strengths-weaknesses-opportunities-threats) analysis to establish key business drivers and specific measurable objectives. The SELs also evaluate customer requirements, past performance, and current resources to set the goals and targets for the coming year.

By performing an environmental scan, we are able to understand the many types of risk we face. Everyone knows that hindsight is 20/20; we try to take a more proactive approach to planning by evaluating risk in these areas.

Our existing primary customers and their markets are evaluated to ensure alignment with our goals and targets. Because 95% of our sales come from long-term partnerships, we address three primary areas:

- Exceeding customer expectations
- Responding to changing customer demands
- Evaluating existing and prospective customers

We determine improvement projects, opportunities for advancement, and areas for benchmarking by assessing the following:

- Current and projected customer requirements
- Plant and equipment capacity usage
- New manufacturing processes and technology improvements
- Cycle time and labor cost reductions through more efficient equipment and systems

We evaluate how we stand compared to our competition:

- Are we the preferred supplier?
- Can our response times and cycle times be reduced?
- Do we have enough process capacity and capability?
- Do we have the distribution capability?
- Is our onsite support adequate?

Every business has to evaluate risk. But there is a risk there, too—“analysis
Strategic planning phase, continued

The solution is balance. Our biggest exposure to risk is in our financial, market, and technical areas. We look at debt ratios, profit trends, capital expenditures, and plant utilization for financial risk. Customer growth and industry market strength are evaluated for risk. Process capabilities and growth capacity are also evaluated for technical risks. Social risk is minimal, but it is evaluated before we implement a new process. We look at turnover ratios, team survey results, and exit interviews; current and future staffing requirements; skill availability; customer satisfaction; and company performance data. The SEL and steering committees review supplier quality and delivery performance, identify changes in the supplier base, and identify improvements to our supplier performance management.

The five-year plan provides a framework within which to develop short-term objectives, goals, and plans. Finally, the SELs identify one or more Hoshin Plans for the year. Our Hoshin for 2001 is to implement lean manufacturing concepts throughout the company.

Deployment phase

Communicating and deploying the plan is the responsibility of each SEL and management team leader on the KARLEE steering committee. The purpose of the deployment phase is to communicate our goals and plans and establish team performance objectives. The strategic planning results are assessed and refined by the steering committee, and consensus is reached with the SEL team.

Each department then negotiates their targets based on their past experience, current capabilities, and available resources. Once targets are established, the management team identifies work projects and Hoshin projects for the next fiscal year. The SEL team then establishes the review schedule for the company. Each Hoshin is assigned an SEL or management team owner for direction and support.

Project management phase

During the project management phase, the steering committee deploys the objectives, targets, and projects to their teams. Then the teams develop and execute detailed action plans.

Accountability phase

As we say in Texas, “If you are riding at the head of the herd, it’s a good idea to look back once in a while to make sure the herd is still there.” We use measures to make sure the “herd” is still there. Measures are reviewed in the accountability phase: the SEL team and management team monitor the progress of projects and results during review meetings.

Evaluation and recognition phases

Evaluation of the performance is done during the steering committee’s weekly meetings and cell team visits. Plans are refined, and resources are allocated as needed; new projects may be introduced each quarter.

Recognition is given to the management team during their presentations to the steering committee. Cell and department teams are recognized during the team visits and on the bulletin board evaluation form.
Customer and Market Focus

Rick Cherry, President—KARLEE has a slightly different view of the customer-supplier relationship than most companies. We think that a relationship with a customer is a little like a marriage. Marriages are no longer arranged—people choose their spouses. We think that the relationship between a customer and a supplier ought to be mutually agreed upon, too. We pursue relationships with customers who share our values, want a long-term relationship, and are global leaders in their industry. We try to create a win-win situation with them. Of course, there may be individuals within the customer’s organization who are difficult, but we look at the values of the leadership to see whether or not we are compatible. We’ve had customers in the past who have expected us to ask “How high?” when they say “Jump.” We feel that there is enough business out there that we don’t have to accept a relationship in which we are browbeaten. Then we try to build partnerships by providing solutions.

The most important thing we do when we meet with customers is to try to understand what is important to them. We use weekly customer status reports that are prepared by all account managers to let us know whether they are experiencing any quality problems, or if they have any engineering projects on the horizon. We also use customer surveys to track satisfaction, and we use internal and external measures to improve performance in areas that are important to our customers. This practice has spotlighted some areas that weren’t obvious to us previously. For instance, many of our customers supply us with an approved vendor list. It was a surprise when we found out that they still expect us to audit those suppliers even though they specified them.

We also use a problem history report, or PI sheet (problem and information) to document problems and record Statistical Process Control information and the efforts made to improve the product.

Figure 3, on the following page, shows how we evaluate prospective clients to determine whether our strengths fit their needs. Once we’ve agreed to do business, we then develop the relationship, as shown on the right side of the figure. We use our strategic planning process to show us how and where we should grow. But, occasionally an opportunity will jump at us. For that reason, we review our strategic plans quarterly, so that they can be readjusted as needed. We assess our customer satisfaction and relationships; we talk to their other suppliers to find out how to best relate to them. In the Estimating and Engineering step, we look to see what kind of product mix the customer wants, and whether they will have a small, medium, or high volume, or even a mix of product volumes. We also look at how many industry segments they are in. A telecommunications customer, for example, may be in several different market segments of their own, and often one of those segments may be in different phases of the business cycle. By knowing this, we can adjust our customer base so that we can optimize our capacity.
We look at our customers’ manufacturing requirements in the Implement Any New Technology phase. Here we address whether or not we need to put new processes in place. For example, we recently added powder-coating to augment our wet-painting processes at the request of our customers.

At the next step (Implement Customer Service) we start to involve the team in the planning process. We also look at how mature our customers’ products are—if they are well into their product life cycle or not. We look for opportunities to help our customers lower the cost of manufacturing. One customer told us in a survey that they wanted us to add product development to our service offerings because we weren’t turning around the prototypes quickly enough. We established a separate process so that there would be enough dedicated design capacity. When we consider changes to our production process, we place priority on innovations that will benefit all of our customers. Before we implement new services for a single customer, we make sure that they are cost effective and fit within our strategic plan.

The SELs and steering committee evaluate the effectiveness of our “Listening and Learning” system during our annual strategic planning reviews. We look at the type, frequency, and effectiveness of the information we gain. We also try to find other ways to obtain and analyze information about our customer requirements, expectations, and preferences.

Our customers’ satisfaction is largely determined by how well we maintain contact with them and how well we determine their needs. Timely communication about schedules and deliveries for production orders and deliveries is critical. Each of our primary customers is assigned a two-person Customer Service team, which acts
Customer satisfaction

as the main point of contact for day-to-day production issues. One member of the team is an estimator who provides quotes for competitive bids for new components and annual contracts, and costing information for potential products. The second member of the team is a Customer Service representative who acts as the liaison, communicating scheduling, delivery, order entry, and other requested information. The teams for three of our primary customers are onsite at their locations from two days a week to full time. Each team is on call twenty-four hours a day and uses mobile phones, e-mail, voice mail, and radio communications to ensure rapid communication. Each week they prepare a customer status summary report that documents any concerns or problems. The SELs and steering committee review the reports during their weekly meetings. If someone else within our company is contacted by the customer, then that team member takes action to resolve the customer’s concern directly or contacts a management team leader to intervene.

Our annual customer satisfaction surveys are divided into the major categories of our key process groups that directly impact customer satisfaction:

- Customer Service
- Engineering Support
- Quality Assurance
- Shipping and Delivery
- Accounts Receivable
- Receptionist

All of our customers’ personnel who have contact with KARLEE, such as buyers, planners, quality personnel, engineers, and managers, participate in the survey. We have conducted verbal (in person and over the phone) satisfaction surveys for the past four years. We monitor the percentage of quotes accepted as an indicator of customer satisfaction trends. And we look at the number of reorders and our market share with each customer.

Problem resolution

Figure 4 on the following page shows our problem resolution and return management process. Our attitude is that if the customer says a product isn’t right, it isn’t right, and we’ll fix it. Customers are always kept informed of the status and resolution throughout the process. If the product is at the customer’s site, the Customer Service Specialist visits the site immediately. Depending on the situation, either the issue is resolved there, or arrangements are made to return the product to KARLEE. Defect information is then entered into a database for teams to use to identify process problems and to create improvements.

A “can-do” attitude

Our strategic position in our marketplace depends on building long-term relationships with our customers. We ensure customer loyalty by providing a full range of manufacturing, engineering, and customer support services. We try to understand our customers’ own business challenges and meet their rapidly changing requirements with a “can-do” attitude.
Problem resolution, continued

A framework to track organizational performance

**Figure 4. Problem Resolution Process.**

![Diagram of Problem Resolution Process]

**Information and Analysis**

*Paul Springfield, Management Team Leader of Finance*—Information management is a framework to measure and provide comparative data to track organizational performance. Our information system asks four questions: What? How? Where? Who?

We focus on our key business drivers: they are what we need to concentrate on to be successful. Key business drivers are usually set by the optimists of the company. Our key business drivers are Customer Satisfaction, Team Member Satisfaction, Financial Performance, Operational Performance, and Community Service. (I used to argue that Financial Performance should be first, but Jo Ann Brumit convinced me that by putting Customer Satisfaction first, then financial performance will follow.) We also focus on measures—the goals and the progress that we make. This is where the accountants get involved because they are usually the pessimists of the company. They can bring in mounds of data to prove why the key business drivers won’t work.

Once our key drivers are identified, we select goals and measures. These include quality, delivery, performance, team satisfaction, safety, training, ROI, sales growth, productivity, costs, hours, and funds donated. The goals are agreed upon by the SELs, management team, and team members. The measures for daily operations are selected based on the following factors:

- Links to key business drivers
- Supports process improvement
- Links to goal or project
- Prevention oriented
- Verifiable
- Supports daily operation
A framework to track organizational performance, continued

For example, a key measure of the Customer Satisfaction driver is delivery. Delivery is measured at the company, department, and manufacturing cell levels: Is the product delivered on time to the customer? Is the product on time in your area? These measures are customer-oriented because if it’s late to a cell, then team members know that it will be late to the customer, and they can notify them as soon as possible. We have found that what works for one work group may not work for another. For example, we use two different methods to measure delivery at the cell level: one group uses throughput, and another uses a true on-time measure. Both sets of data give us the information we need to know. For example, the accounting department’s customer satisfaction rating is measured by the accuracy of paychecks.

Data should be verifiable. One of the Baldrige examiners’ favorite questions is “How do you know that the information you are using is correct?” Our answer is that we use comparable data supplied from comparable areas to audit our system to the best of our ability. For example, we would use our customer’s delivery rating or quality rating and compare it to our delivery or quality rates.

Strategic road maps

Once all the key drivers and goals for the company have been established, we create a strategic road map. We began developing these road maps so that projects and goals don’t fall through the cracks. These maps define the following:

- Key business driver
- Goal or projects
- Data owner
- Data measure
- Improvement target
- Data review schedule

Our steering committee reviews the road map quarterly. The information comes from our e-manufacturing integrated software system. We developed this system in 1996 when we realized that our existing business application was inadequate. The e-manufacturing system brings all of our quoting, purchasing, production, sales, team resources, inventory, and financial information into one main system, from which we can extract and structure data any way we need. This system gives us the capability we need to analyze our business. For example, although we have only five major customers, these customers may have six or more product groups in different markets. The information is used by our customers, suppliers, senior executives, the steering committee, departments, teams, and team members. Figure 5 on the following page shows the type of information distributed.

There is no point in collecting data if you don’t analyze it. Figure 6 on the following page shows the level of team training relative to the percentage of scrap and rework. It shows that by addressing one of our key business drivers, team member satisfaction, operational performance improves. Correlations exist; you just have to find them.
Strategic road maps, continued

Figure 5. Types of Data Distributed.

- Customer Satisfaction
  - Quality
    - Delivery
      - Performance Rating
        - Team Member Training
          - Team Member Satisfaction
            - Safety
              - Training

- Corrective Action Database
- Problem History Reports
- Nonconforming Process Reports
- Internal Quality Audits
- Production Process Cycle Time
- Quote Response Time
- On-Time Work Center Performance
- Bimonthly Customer Surveys
- Annual Customer Surveys
- Customer Status Summaries
- Customer Competitive Ratings
- Annual Team Member Satisfaction
- Annual Benefits Survey
- Annual Performance Reviews
- Turnover/Exit Interviews
- Accident Reports
- Insurance Reports
- OSHA, EPA, ADA Report
- Team Member Training Completed
- Team Leader Training Completed
- Tuition Reimbursement and ESL
- Quality Certifications/Job Type
- Annual Team Member Satisfaction
- Annual Benefits Survey
- Annual Performance Reviews
- Turnover/Exit Interviews
- Accident Reports
- Insurance Reports
- OSHA, EPA, ADA Report
- Team Member Training Completed
- Team Leader Training Completed
- Tuition Reimbursement and ESL
- Quality Certifications/Job Type

Figure 6. Team Member Training and Waste Reduction.

FY2000 Goals: 30 Hours of Training and 0.1% Scrap and Rework of Sales
Quality weighting and cellular manufacturing

KARLEE adopted work cells as part of its lean manufacturing initiative. We tried several approaches over the last four years to develop quality ratings for the cell teams. We settled on the following weightings:

- Customer returns: 50%
- Internal defects: 10%
- Corrective actions: 10%
- Self-audits: 10%
- Statistical process control: 10%
- Logs complete and accurate: 5%
- Information boards up to date: 5%

Company-level data analysis

At the company level, we look at information in various ways. We compare our financial performance to our goals, and we look for a correlation between sales and customer satisfaction, productivity and capacity to forecasts, and savings from improvements and team member satisfaction and turnover. For example, for the Customer Satisfaction driver, at the company level, quality is measured as the number of returns divided by the number of sales. At the department level, process capacity, scrap, and rework are measured. At the manufacturing cell level, the quality rating is measured by the amount of returns plus the amount of defects.

Measurement system integrity and improvement

We make sure our measurement systems are evaluated throughout the year. Are the measures current? Are our measures creating the desired results? We found that three or four months after we implemented our metrics, the situation took on a whole new shape; measuring one area reveals other areas to measure. The objective should be to create the best measurement system. Also, we make sure to audit data; when people’s bonuses and perks are based on the information they provide to the system, they can become creative. Unfortunately, when something is hidden in one area, it usually surfaces in another.

Benchmarking

We are a privately held company, as are most of our competitors, so financial information for benchmarking is hard to come by. So we benchmarked our processes. We benchmarked our European competitors for robotics, several California companies for laser cutting, credit unions for customer service, and a local company for training. We’ve also extensively benchmarked semiconductor manufacturers for their lean manufacturing techniques. It makes sense to look outside our industry. We pick companies that are the best in their industry to benchmark; sometimes smaller companies have really good, creative solutions.

Process Management

Jim Owens, Management Team Leader, Engineering—There are four steps to process management at KARLEE: Process Design, Produce, Measure, Improve. This is really
just another way or saying Plan, Do, Check, Act, as shown in Figure 7.

Figure 7. Key Manufacturing Processes.

Let's look at an example of Process Design at KARLEE, as shown in Figure 8.

Figure 8. The Process Design Phase.

In the Process Design for new components, we begin by discovering what our customer's requirements are. Knowing our customer is a great help, so we make an effort to learn more about them. We place employees at our customers' sites and ensure that there are clear communication links between the customers' purchasing, quality, and engineering people and KARLEE. Partnering with customers and suppliers helps us to improve quality by improving our understanding of their needs and their understanding of our capabilities and processes.

We've recently added design assistance to our processes, which allows us to create a component design that meets the customer's needs and fits our equipment and processes. This step in the process allows us to pull all of the production aspects together. Often this allows us to reduce the number of product components for the
Process design phase, continued
customer and reduce our retooling and equipment purchases. The quality of our products is improved, too. Our designers are now able to give better guidance to the production people about key design features, the limitations of the design, and what the end result should be. We used to ship paper documents back and forth; now we try to keep the design review as paperless as possible. For the design review, we set up a web site on the intranet that displays the drawings, tooling, and a three-dimensional model of what we will build.

The second step is equipment and capacity requirements; here we compare our current state against what we’ll need. If we don’t have the technology available, we’ll benchmark companies that do. For example, we looked at the robotics used by a Finnish company to better understand how to add this capability to our processes.

The third step is cell design; this step determines how the workspace is laid out. There is a lot of hardware, process steps, and materials involved in the manufacturing that we do. An efficient workflow reduces cycle time and waste. Materials are delivered straight to the work cell to reduce the amount of time and effort it takes to move the material.

In the fourth step we try to understand our suppliers’ requirements, with the aim to reduce waste. Supplier management is distributed among process owners throughout the company so that decisions are made at the most knowledgeable level. The purchasing team establishes partnerships with suppliers, evaluates their performance, and gives them feedback.

From there, we begin to build the prototype. We invite the purchasing group, the assemblers, and the designers to discuss all the issues. Once everything is out on the table, we build the prototype in a product development cell.

Produce phase

Figure 9 on the following page shows the steps in the produce phase of our process management. The customer will evaluate the design and start a discussion with us about dimensions and tolerances before we start production. Then we will produce a quote and send prices down to purchasing. Once the customer’s purchase order is in hand, we purchase the raw materials, having made sure that the bill of materials is correct. The assembly is transferred from the product development cell to a production cell, along with the work instructions and documentation. We train the people in the production cell how to manufacture the new product. Then we begin to build. The shipping and receiving team packages the product to the customer’s specifications and completes the required paperwork. Our goal is to reduce the amount of packing material and labor required in shipping. We offer a replenishment cart system to our customers. Carts are designed to hold a family of parts that our customer uses to make their final assembly, and they are on a kanban system. Then we invoice the customer.

Measure phase

In the measure phase, Figure 10, we use a non-conforming process report to document problem areas in the process. When a product doesn’t meet customer
Produce phase, continued

expectations, we send a team out to see whether or not it needs to be reworked, or rebuilt, and identify what went wrong in the process. For example, there may be something wrong with the tooling or equipment, or the team may need more training.

We use statistical process control to gather data on our error rates, and this information is used to calculate our process capability, $C_{pk}$ (Figure 11). This data allows us to identify areas for improvement, in man or machine.

The critical key features of the product are listed on the back of the “traveler” on the product information sheet. This helps everyone understand what is happening on a project—what to look for, what to check, what problems have happened in the past. Team members sign off to indicate that they’ve read it.

Process audits are performed by the cell team and by the process auditors. These audits help us make sure that everyone follows all the processes. We measure the cycle time of each process to evaluate training requirements, tooling, and equipment. Problem reports are addressed immediately by a supervisor to make sure everything is under control in that area. We also use team boards to display information on the cell team’s quality ratings, equipment utilization charts, on-time performance, and events and organization charts. We also display the company goals and objectives on the boards.

Measure phase, continued

Figure 9. The Produce Phase.

Figure 10. Measure.

- Nonconforming Process Report
- Statistical Process Control
- Process Capability
- Critical Key Features
- Process Audits
- Cycle Time
- Problem Reports
Measure phase, continued

Figure 11. Capability Ratio.
(Goal $C_{pk} > 2.0$)

In the improve phase, Figure 12, we use all of our weighted quality ratings, problem history reports, and the actual vs. standard information to identify weaknesses in our processes. Cell teams follow the PDCA cycle to make improvements. They use fishbone diagrams and the other quality tools to identify the root cause of the problems, define improvements, set goals, verify that the change meets requirements, and report lessons learned. We’ve made a number of production line improvements. For example, we use metrics on machine utilization and cycle time to measure performance improvement.

Improve phase

Figure 12. Cell Team Improvements.
- Weighted Quality Ratings
  —Customer Returns
  —Internal Defects
  —Team Performance Measures
- Problem History Report
- Actual vs. Standard Performance

Lean production techniques improve processes

Lea production techniques are being adopted throughout KARLEE. We’ve implemented these methods by sending a team out to work with the cell teams to make the changes. By implementing a visual management system in our card-cage assembly cell, we achieved an 80% reduction in rework, a 50% reduction in floor space, and a 28% reduction in work in progress. We measure these areas continually to make sure that the changes are effective and that we are continually improving.
A team culture

Human Resources

David Briggs and Shirley Putnam, Management Team Leader, Team Resources—Team culture, family values, and high performance expectations are the basis of KARLEE’s approach to managing people. A team structure promotes cooperation and collaboration. We’ve found that if we allow people to work in teams, together they will make better decisions than one person alone.

Our core production and delivery processes are designed around manufacturing cell teams. These teams monitor their own performance using Statistical Process Control and performance measurements. Cross-training and job rotation help team members broaden their skills and allow us to respond to peak loads in various work areas. Teams are empowered and encouraged to take ownership of the processes within their work area. Leaders and team members receive formal coaching sessions every year to discuss their individual goals, performance, action plans, and training requirements.

Recognition and rewards

Everyone likes to be recognized for a job well done. At KARLEE we recognize our people’s contributions in a number of ways: Jo Ann sends thank-you notes on a regular basis for outstanding efforts and achievements. The leadership recognizes, among others, the High-Performance Team of the Month, the Team Member of the Month, and the Quality Person of the Month. Their names are listed on our Wall of Honor on a brass plaque, and they receive various other rewards.

We also recognize each other as peers. We have the Gold-Star award, which is a trophy that is passed from one manager to another to show appreciation for any reason. Included with the trophy is a note describing why it’s been a positive experience to work with that person. The Rising Star Program is a simple thank-you note written on a paper star, which anyone can put up for any reason. And after a month, they are taken down. Like most companies, KARLEE has service awards that recognize and reward years on the job.

We recently benchmarked several other comparable companies in the area and realigned and increased our pay scale to remain competitive. Our benefit package also includes a profit sharing program and a matching contribution to team members’ 401(k) accounts.

Communication

Ensuring good communication is especially important in a culturally diverse workplace. We publish critical internal documents in English, Spanish, and Vietnamese. We have interpreters at meetings when needed, as well as a bilingual Team Resources member.

We make extensive use of Team Performance bulletin boards in the work cells; posted on the boards is information about product quality, performance, improvement storyboards, and team information. Teams are evaluated on how well they keep their boards current and whether they know the information. We also have a corporate bulletin board, which displays our corporate measures and performance data.
Training

Training and career development is an important part of our team culture; it helps us build an atmosphere of high expectations and empowerment. A lot of people think of empowerment as a buzzword—but it’s not to us. Jo Ann Brumit and I teach KARLEE’s leadership class, which is given to new leaders, new team members, new managers, and aspiring leaders. In it we review several books, including *Zap, the Human Lightning of Empowerment* and *Heroes: Empower Yourself, Your Coworkers, Your Team*. Both are excellent. The concepts in each book have helped us encourage and empower our team members and set high expectations. We have also used *The Servant as Leader*, by Robert Greenleaf, which discusses the concept that the leader’s job is to serve our team members.

New employee training begins with a half-day orientation that covers our mission, vision, and values; safety; and product information. We have a buddy system; new team members are assigned a buddy who shows them the really important things—such as where the lunchroom and restrooms are.

We receive requests for new training classes from the leadership teams, our survey on training needs, the Operational Team Leaders, cross-functional teams working on new processes, and team members. Individual training needs are identified at annual performance reviews. In 2001, each team member averaged twenty-five hours of training; leaders averaged forty hours. The effectiveness of our training program is evaluated during the annual strategic planning sessions and quarterly reviews. Tuition and book reimbursement and flexible work schedules allow team members to attend off-site continuing education classes and degree programs.

Safety

Quality isn’t first at KARLEE; safety is. We are a manufacturing company, and the potential for personal injury is always present. Safety is everyone’s responsibility. People are trained in safety precautions and are expected to follow procedure. The management team and/or safety committee investigates and documents all incidents and takes corrective action. We have a program for the early detection of ergonomics-related problems.

KARLEE cares

KARLEE cares for the spirit of our employees, too. We recruit for a fit in values, and we have made many efforts to build a culture where caring for people is central. Of these efforts, our KARLEE Cares is the most special. This program was initiated by our people after the sudden deaths, within the span of a month, of two well-liked employees, Michael and Irving. Michael’s family didn’t have the money to bury him; Irving’s family was very new to the area. Our team members collected money—some sold their vacation days—and with the owners’ matching gift we raised $13,000 to help pay for Michael’s funeral expenses and provide for his family. Irving’s family’s needs were different: they needed consolation and emotional support. Our team members called, visited, and held out a hand to them.

We realized at that time that if both families had needed financial support, we wouldn’t have been able to help. So we created the KARLEE Cares program, which
KARLEE cares, continued

is funded through payroll deductions. This program provides financial assistance to KARLEE team members who are in need.

KARLEE looks outward to our community, too. We support the local elementary school; our team members volunteer as English and math tutors, give out awards, and sponsor field trips. We sponsor blood drives and Walk America.

We also give people a “second chance”; we try to give people who may have a checkered past but share our values a chance to succeed at KARLEE. The results have been tremendous. Although not all of the hires have worked out, it has proven to be one of our better ways to hire good, loyal team members.

Quality Journey and Lessons Learned

Rick Cherry, President—KARLEE began with Lee Brumit’s passion for car racing, entrepreneurial spirit, and creative spelling. Our journey took a turn in 1985. Business was really slow, and a new customer had a large number of jobs that required sheet metal work that we couldn’t do. We got tired of turning the business away, so we added a punch, a brake, and a shear and went into the sheet metal business.

By 1990, Jo Ann and Lee started to feel the stress of being the only decision-makers most of the time. They had always had a vision, but it wasn’t one that was often shared with others besides themselves. At one point, Lee thought that he wanted to sell the company, but Jo Ann wanted to train and empower the people to run the business. Happily for us, they chose the latter course.

The Baldrige Criteria, which Jo Ann brought to the company, set the platform for KARLEE and the direction in which we were going. We also started the steering committee at that time, and I was given the opportunity to lead this committee. Our first step was to learn how to conduct ourselves as a team. Early on, Jo Ann said to me, “Rick, I’m always dominating the conversation, so you need to tell me to shut up sometimes and let other people talk.” Obviously, I found a more tactful way than saying “shut up” to my boss. And thus, KARLEE came to embrace teamwork.

By 1996 we no longer had employees, we had team members. We had standard meeting times: weekly, monthly, or quarterly. And everyone understood their function within the team, whether it was as a facilitator, chair, or participant. We’d also added welding, plating, silk screening, and mechanical assembly to our competencies.

In 1997 we won our first contract manufacturing job, which required us to deliver fully tested, integrated assemblies, ready for the field. We began just-in-time programs with our suppliers and customers. At that time, we were also making the transition from a small to a medium-sized company. I was the general manager and had all the different departments reporting directly to me. We were limited by this structure because the management team was not getting the experience they needed to grow. So we created our team of SELs.

We won the Texas Quality Award in 1999, after receiving a site visit in 1998. During this time we became TL9000 Certified, and we are UL certified. At first, we
KARLEE’s journey, continued

thought our performance was great. As we became more involved, however, we became more realistic about ourselves. The feedback report that we received is really the reason that we won in 2000. We won the National Malcolm Baldrige Award on our first try, although we did have to register twice. When we found out that we had won a site visit, we had to re-register as a large company because we had grown to over 500 people. If we’d realized we’d have to re-register, I think we’d have just worked more overtime!

Results

We measure customer satisfaction in a number of different ways. Our account managers and representatives interact with our customers daily; I and the other senior officers meet with our customers at least once a month. Figure 13 shows our customer satisfaction survey results. You will notice that our ratings went down in 2000; that was the year in which we changed the questions and the scale on the survey. We felt that the previous questions were becoming redundant. We weren’t getting the kind of feedback we needed, and everyone was just sleepwalking through it. This change didn’t happen without some serious discussion because we knew the numbers would drop. In the end we went through with the change because the feedback was more important than the numbers. This figure shows the aggregate of all our customers. We also break the responses down by industry, departments, and position, so that we know exactly what to improve.

Figure 13. Overall Customer Satisfaction Ratings.
(Scale 1–5, 1.0 = Excellent)

Figure 14, on the next page, shows our revenue and productivity growth. We experienced 25% growth in 1995–99 and 100% growth in the year 2000, averaging a 39% increase over the last six years. We haven’t just added to the head count as sales have increased. Productivity has kept pace as we’ve added robotics and implemented lean manufacturing techniques.

Raw metal delivery is an intricate part of our business; we have been able to reduce the delivery time from between two to five days to under two hours. We
Results, continued

accomplished this through customer-supplier symposiums, in which we invite our suppliers and customers to come together to develop a better understanding of our needs. Now our suppliers realize that they have to support us.

For a long time our waste and scrap rates remained stagnant. We finally began to reduce the amount of scrap and rework as a percentage of sales by motivating the different departments to do it. Once they started establishing scrap and rework reduction as annual goals along with our corporate goal, the numbers started to drop. We’ve been able to sustain that drop through our engineering efforts to improve product design and training to make it easier for team members to assemble the product the first time.

Team member satisfaction ratings (Figure 15) also show a drop in the year 2000. Again, we changed the questions on the survey, to receive better feedback. We
Results, continued

also have other ways to measure team member satisfaction. We have an open-door policy, which allows team members to come in and talk to Jo Ann. We also have “KARLEE Talks.” People who don’t feel comfortable openly asking a question can write it down on a piece of paper and put it in a mailbox. The forms are available in both English and Spanish. Our Human Resource manager distributes them to the people who can best answer them. The answers are posted on the corporate bulletin board. Our turnover rate for the year 2000 was 3.7%, an increase of 1.7% from the year before; our goal was 3%. This higher rate was because of the large number of new hires that year. Team members have been accountable for their work for years, and we have certification programs to make sure that their skills are current.

The journey continues for everyone at KARLEE; we’ve by no means reached a plateau. As always, we strive not to look at the stars, but to be a star.

Author information

Jo Ann Brumit, CEO and Chairman. Ms. Brumit’s vision has been to create a manufacturing organization focused on customer service, producing precision, custom products through the best processes available. Her efforts have resulted in KARLEE’s receiving many awards. Some recent ones are: 2000 Texas Business of the Year, 2000 Athena Award, and the 1999 Texas Quality Award.

David Briggs, Vice President. Mr. Briggs is directly responsible for Quality Assurance, Human Resources, Training, and Document Control. He wrote the application and prepared the company for the Texas Award for Performance Excellence and the Malcolm Baldrige National Quality Award.

Rick Cherry, President. Mr. Cherry joined KARLEE in 1984 as a machinist and programmer, and progressed to team leader, quality manager, machine shop manager, general manager, and vice president. In 2000, he was promoted to president.

Jim Owens, Management Team Leader of Engineering. Mr. Owens has twenty-two years of sheet metal fabrication experience and has expertise in many product design software programs, such as AutoCAD, I-Deas, ProE, and Solidworks. He provides the KARLEE team with leadership in all phases of product development.

Shirley Putnam, Management Team Leader of Team Resources. Ms. Putnam has provided KARLEE with the enthusiasm and leadership necessary to maintain a family and team environment. Karlee employs a very diversified workforce, and Ms. Putnam is responsible for all strategic aspects of team resource development and administration.

Paul Springfield, Management Team Leader of Finance. Mr. Springfield has implemented KARLEE’s fixed assets program and coordinated the development of their e-manufacturing capabilities. He has also offered leadership in the area of process flow management.

Editorial assistance for this article was provided by Carolyn Field.
From a Culture of Safety to a Culture of Excellence

Quality Science, Human Factors, and the Future of Healthcare Quality

Authors

Martin D. Merry, M.D., C.M., Consultant, Senior Medical Advisor to New Hampshire Hospital Association, and Associate Professor of Health Management, University of New Hampshire, Exeter, NH

Jeffrey P. Brown, M. Ed., Principal, System Safety Group, Peterborough, NH

Could this happen in your community?

Martin D. Merry—Consider the following case study from a front-page story of a local newspaper: Parents bring their nineteen-year-old daughter to a hospital emergency room. Findings include a rapid pulse, severely low blood pressure, and an abnormal electrocardiogram. After five hours, her condition stabilizes and she is discharged, with instructions to see her family physician the next day, which she does. The family physician sees her and orders an echocardiogram for the next day, assuring the family that she will call them with the results. The echo is done the next day. When they do not hear from the family physician, the parents assume that all is well. However, the echo is not actually seen by a physician until the next afternoon (a Saturday, three days after the ER visit). The cardiologist reads the echo as “severely abnormal” and recommends a follow-up. But he doesn’t notify anyone; instead, he dictates a report (which finally reaches the family physician five days later). The day after the cardiologist dictates his report (Sunday), the mother finds her daughter dead in bed. The autopsy report indicates multiple pulmonary emboli (i.e., blood clots that have traveled to the lungs) as the cause of death.

The U.S. healthcare system’s dark side is revealed

The National Academy of Science Institute of Medicine’s (IOM) dramatic November 1999 release of To Err Is Human simultaneously signaled the end of medicine’s 2000-year-old tradition as a virtually pure craft endeavor and announced the beginning of health care’s concurrent industrial, information, and consumer revolutions. This IOM report made it starkly clear that the case study above is not an aberrant fluke that might be written off as an extremely rare tragedy in an otherwise exemplary healthcare system—arguably “the best in the world.”

Rather, in a direct and effective challenge to this idyllic myth, To Err Is Human revealed that medical error causing injury, and even death, was a common, daily occurrence throughout the U.S. healthcare system. Americans were suddenly jolted into a stark new realization: A system remarkable for its technological achievements is inextricably linked with what we now realize as a parallel dark side. It is now public knowledge that modern health care is indeed miraculous in its technological capability, but also potentially dangerous—even lethal—in its execution.
The root cause of health care’s current dilemma: Its craft model basis

To Err Is Human clarified that the root cause of such preventable tragedies as the case study above is rarely attributable purely to incompetent or careless caregivers. Indeed, all three physicians involved in this unfortunate young woman’s care were fully qualified members on the medical staff of an excellent community hospital. While the individual decisions of any of these physicians might be subject to question, the IOM report makes clear that the deeper issues of causation in such cases are embedded in the environment in which physicians practice. The root cause of the vast majority of such tragic cases is this: The healthcare (non)system on which we rely in our most vulnerable moments has in recent decades simply grown (1) far too large and complex for the craft model on which it was built and (2) far more dangerous than anyone, until recently, has realized.

Health care’s “sigma gap”

Some comparisons allow perspective on health care’s current dilemma. Systemic-error or defect rates are expressed in terms of sigma units, with a high sigma value correlating with low defect rates (see Figure 1 below). World-class manufacturing competitiveness dictates that firms unable to generate defect rates in the five- to six-sigma range are likely to fail. In fact, the airlines are now achieving 0.43 deaths per million passengers, well above the near-perfection of six sigma for this key safety indicator. In stark contrast, healthcare measures generally fall into the two- to four-sigma range. For example, a recent New England Journal of Medicine article found that 2% to 8% of the patients who visit hospital emergency rooms with heart attacks are misdiagnosed as having something else. This percentage of missed diagnoses, not unlike the fatal example of our case study, translates to 20,000 to 80,000 errors per million heart attack patients who visit hospital ERs.

It is important to withhold emotionally based judgment regarding the enormous “sigma gap” that currently exists between health care’s current state and that which it needs to achieve in the future. As noted above, health care’s current sigma state is directly attributable to its craft-model basis, which is now seriously inadequate for its complexity.

The underlying assumptions of health care’s craft model

Because this craft model is so fundamental to health care’s current dilemma, it warrants brief exploration. The craft model of healthcare system development was founded on a number of assumptions that were once arguably valid but no longer apply. These assumptions are as follows:

<table>
<thead>
<tr>
<th>Sigma Level</th>
<th>Defects per Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>690,000</td>
</tr>
<tr>
<td>2</td>
<td>308,000</td>
</tr>
<tr>
<td>3</td>
<td>66,800</td>
</tr>
<tr>
<td>4</td>
<td>6,210</td>
</tr>
<tr>
<td>5</td>
<td>230</td>
</tr>
<tr>
<td>6</td>
<td>3.4</td>
</tr>
</tbody>
</table>
The underlying assumptions of health care’s craft model, continued

1. Diagnosis and treatment of disease are complex tasks that require very specialized knowledge and experience.

2. In general, these tasks are beyond the knowledge of the vast majority of potential patients.

3. Physicians are the only professionals qualified to master the diagnosis and treatment processes.

4. Physicians acquire this mastery via a long period of book learning, hands-on experience, and mentoring by senior masters; hence, they are actually “master craftspersons.”

5. Given the Hippocratic dictum of “First, do no harm,” it is best to build health systems around these physicians and other healthcare professionals with confidence that “If it’s good for the caregivers, it must be good for the patients.”

Prior to the latter decades of the twentieth century, these assumptions appeared to well serve caregivers and patients alike. Given the relative simplicity of the medical encounter, and the relatively few effective treatments available during that earlier era, the potential problems inherent in these assumptions never came to light. But the exponentially expanding complexity of healthcare technology and delivery of recent decades has rendered these assumptions not only obsolete, but also dangerous.

Why is this so? How can it be that a set of assumptions at the core of the world’s most effective healthcare system can suddenly become obsolete, even dangerous? Because a highly complex, inherently high-risk system cannot be built on a craft model. Such complex systems require sophisticated design elements to prevent the multiplication of human error indigenous to highly labor-intensive, complicated endeavors such as health care. Most important, such systems must not be built around how individual caregivers—including physicians—practice; rather, they must be built around how those served by the system flow through it.

Why haven’t healthcare professionals created safer systems? Again, the answer to this question can be traced back to the craft model and two fatal defects that only recently have come to light.

1. It relies on humans checking humans as its basic safety mechanism, thus actually compounding the likelihood of total process error in complex, multiple-caregiver settings.

2. It is essentially “blind” to the systemic complexities of modern health care—especially today’s de facto high-risk environments that, via their complexity, actually increase the likelihood of human error.

To mitigate the harm-generating effects of inevitable human error, complex high-risk environments require careful design and extensive testing. This concept is wholly incorporated into such high-risk endeavors as aviation, where autopilot systems do all the “heavy lifting” of flying a complex modern jet and thus preempt...
“Human-error-proofing” systems are nonexistent, continued

the inevitable errors of human pilots and their potential adverse consequences.

In contrast, health care (with rare exceptions, such as anesthesiology) has never built into its core processes such “human-error-proofing” systems as the autopilot. Health care still relies almost totally on the knowledge and skills of caregivers—essentially denying the reality that no matter how knowledgeable, skilled, or “caring/careful” these people might be, they will still make errors at an irreducible minimum human rate—probably around four sigma. And some of these errors will generate harm—a certain percentage of which will be fatal to patients, as in the case study outlined earlier.

Managing safety in high-risk systems: Health care’s craft tradition vs. those of other modern high-risk endeavors

Jeffrey P. Brown—As discussed by Dr. Merry, the release of To Err Is Human (IOM 1999) fundamentally altered our perspective on the reliability of healthcare systems in the United States. This report estimated that preventable medical error causes up to 98,000 deaths each year—a staggering number, and a public safety concern of the highest order. At its core, this untenable rate of preventable death is a function of the widening gap between health care’s social and technical complexity and its pre-industrial managerial capability. Fortunately, other high-risk industries have pioneered approaches to proactively managing safety that can narrow this gap.

James T. Reason (1997) discussed administrative control in systems where outcome reliability is dependent on a blend of rule-based and knowledge-based problem solving, such as health care. He concluded that such systems require a balanced type of administrative control, which he characterized as “feed-forward” and “feedback.” Feed-forward administrative control is an approach to managing organizational processes wherein decisions flow from the “top” to the “bottom” of the organization (see Figure 2 on the next page). Healthcare systems predominantly conform to a feed-forward administrative control model. The lack of familiarity of feedback administrative control (i.e., bottom-to-top checks and balances) in health care presents an experiential and structural barrier to the adoption of balanced, proactive system approaches to safety.

Reason cites two ways in which decisions and actions contribute to adverse events in organizations. The most obvious is direct operational errors of action, inaction, or decision making (“active failures”) occurring at the delivery level of the organization. Active failures may include violations, which constitute deviation from policy or procedure. Less obvious are “latent conditions” for failure. These are conditions that can provoke operational error under certain circumstances, or present hazards of their own accord (see Figure 3 on the next page).

Latent conditions for failure include inadequate training, unworkable procedures, and poor or inadequate technology (Reason 1997). Undue time pressure,
Feed-forward vs. feedback control systems, continued

Active failures and latent failure conditions contribute to adverse events, continued

understaffing, and fatigue are also latent conditions for failure. Weick (1990) identified four processes that can emerge under stress that are an inherent source of vulnerability in human systems, including “interruption of important routines, regression to more habituated ways of responding, breakdown of coordinated action, and misunderstandings in speech-exchange systems.” Fragmentation of effort in clinical environments is both a manifestation and a source of stress. High workloads, fatigue, emergent crises, time pressure, over-tasking, and understaffing are common

Adapted from Managing the Risk of Organizational Accidents, J. Reason, 1997.
Active failures and latent failure conditions contribute to adverse events, continued

stresses acting on delivery-level personnel in the U.S. healthcare system (IOM 2001). Escalating political and financial pressures on the healthcare system are exacerbating these and other problems.

Latent conditions for failure frequently arise from high-level decisions and actions and are often deeply rooted in organizational culture (Carthey et al. 2000; Helmreich and Merritt 1998; Maurino et al. 1995; Schein 1996; Patankar and Taylor 1999). Examples of latent organizational conditions for failure include the strategic decisions and actions of the organization’s managers (e.g., budgeting, planning, and resource allocation) and of government and industry regulatory entities. Latent failure conditions in the clinical space, such as undue time pressure, understaffing, inadequate tools, and managerial deficiencies, are typically made visible in healthcare systems only after they precipitate unsafe acts and/or adverse outcomes. Feedback loops designed for the proactive identification and correction of latent failure conditions are virtually nonexistent in healthcare systems (IOM 1999, 2001).

The term error-tolerant is not intended to convey that it is “okay” to have systems that provoke a high rate of error, injury, and death. In the parlance of human-factors science, the term is intended to convey the need to accept that errors will occur in any system, no matter how well managed, and that early identification and analysis of errors can provide an opportunity for the proactive correction of conditions that are unsafe.

As discussed above, research in high-risk domains has revealed that preventable errors are predominantly a consequence of workplace conditions that provoke error and that originate in organizational processes. Complex productive systems continually generate these error-provoking (i.e., latent failure) conditions, which often trigger a “near-miss” prior to inducing an injury or death. The occurrence of a near-miss indicates not only the presence of a new or recurrent threat to safety but also the opportunity to proactively identify and correct the root causes of the condition(s) that induced it. In addition, near-misses enable the identification and reinforcement of the behavioral and/or technological safeguards that might have prevented the near-miss from becoming an adverse event.

These are the principal reasons for the development of proactive risk management strategies designed to “flag” near-misses. Such management systems are commonly referred to as error-tolerant because they treat error and near-misses as inevitable and as a manifestation of system vulnerability, not individual deficiency or fault (Reason 1997).

Among the key requirements for establishing an error-tolerant management system are the means and methods for making error visible; that is, recognizing and reporting near-misses so that root causes can be identified and corrected. To manage the risk of active failure and to correct latent conditions, a methodology is required that both (1) actively prevents, traps, and mitigates error in clinical space (Helmreich 2000; Helmreich and Foushee 1993; Mudge 1998; Uhlig et al. 2001)
The need for “error-tolerant” management systems, continued

(2) generates proactive feedback (Figure 4) on near-misses and unsafe conditions to enable root-cause analysis and correction of latent-failure states that have arisen as a function of fallible, “upstream” management decisions (Reason 1990, 1997).

![Figure 4. A Mixed Process-Control Model: Reactive vs. Proactive Feedback Loops.](image)

Adapted from Managing the Risk of Organizational Accidents, J. Reason, 1997.

Managing the risk of active failure: Team-based approaches to actively limiting error in clinical space

There is considerable evidence that teams accomplish most safety-critical tasks better than individuals (Ginnett 1997). Multiple research findings reveal that groups perform better than individuals under stress (Suchman 1987; Weick 1990; Weick and Roberts 1993). Several authors have emphasized the need to redesign healthcare systems to support interdisciplinary teamwork from a safety and efficiency perspective (Nolan 2000; Reason 2000; Helmreich 2000; IOM 1999, 2001; Uhlig et al. 2001). Recent studies in aviation have outlined the fundamental elements of team-based approaches to safety.

Team-based methods for managing the potential for active failure in high-risk operational environments are commonly referred to as Error Management or Crew Resource Management (Helmreich 1996; Mudge 1998; Reason 1997). Klinect and Helmreich (2000) conducted an analysis of 4000 Line Observation Safety Audits (LOSAs) of airline crews throughout the world. Their findings identified the following key behavioral countermeasures and safeguards against active failure that are exercised by flight crews:

- Team building: leadership and communication environment.
- Planning: briefing, statement of plans, workload assignment, and contingency planning.
- Execution: monitor and cross-check, workload management, vigilance, and automation management.
- Review and modification: evaluation of plans, inquiry, and assertiveness.
Teams often perform better than individuals, continued

These countermeasures and safeguards are being increasingly incorporated, or further developed, as foundation elements in the error-management training programs of major airlines in the United States and other nations (Brown 2001; Gunther et al. 2001). These countermeasures and safeguards have also been adapted and piloted in health care with promising results (Uhlig et al. 2001).

The LOSA findings of Klinect and Helmreich (2000) are consistent with the findings of Taylor and Patankar (2000), who have characterized the behavioral countermeasures and safeguards against threat and error in terms of “structured communication,” where structured refers to the requirement for personnel with interdependent roles to communicate, and communication refers to the required use of a standardized communication process for collective judgment and decision making (Mudge 1998; Weick 1995, 2001). Structured communication, as an approach to actively limiting error in high-risk operational settings, establishes the essential behaviors of collective practice, or sensemaking. Sensemaking, per Weick (1995), can be viewed as an approach to assessing a situation as a primary function of judgment and decision making under uncertain circumstances.

While structured communication methodologies are effective in limiting the risk of active failure at the delivery level of a system, they are not sufficient as a lone strategy to mitigate the risk of adverse events in complex organizations. Establishing a system for continual identification and correction of conditions that provoke error, or otherwise create a hazard, is critical to sustaining a proactive organizational approach to managing safety (Reason 1997; Vincent and Adams 1999; Wiegmann et al. 2000).

Managing latent failure conditions: Feedback loops and data classification needs for early warning and proactive correction of latent failure states

In addition to providing teams with a means of avoiding, trapping, and mitigating error at the “delivery end” of high-risk systems, structured communication error-management methods can provide teams with practical approaches to providing early warning of latent failure conditions that have arisen through organizational processes. Teams can operate proactive safety-feedback organizational-learning loops by bringing error-provoking and otherwise unsafe conditions to light as a function of debriefing. In aviation, flight crew debriefing is ordinarily conducted at the conclusion of a flight (or mission). In health care, debriefing can be conducted at the conclusion of a shift, preferably at the overlap between shifts, to convey critical information to the team coming on duty.

To be useful for organizational approaches to safety, information garnered through debriefing must be described and classified in a manner that enables identification of performance factors beyond the local realm of individual, team,
task, and technical performance. Data that guides the identification and analysis of “upstream” organizational factors in near-misses or suboptimal/unsafe outcomes must be captured as well.

Approaches to classifying and analyzing human and organizational factors in error-provoking/unsafe conditions have been validated for incident analysis and safety intervention in aviation and are being studied in health care (Sarter 2000; Vincent and Adams 1999; Wiegmann et al. 2000). These methods of identifying, analyzing, and intervening in conditions that adversely influence human performance are aimed at identifying and correcting failed or absent defenses or safeguards against active failure (Reason 1990, 1997; Vincent and Adams 1999; Wiegmann et al. 2000). These failed or absent defenses and safeguards are, effectively, latent organizational and workplace conditions that induce active failure.

The most effective of these investigation, classification, and analysis methods embrace five primary perspectives on human error, revealed in recent reviews of literature on human error and error analysis (Wiegmann et al. 2000, 2001). These perspectives, or models, and their key emphases, are as follows:

**Cognitive.** This perspective on error examines such factors as attention allocation, pattern recognition, and decision making. According to Wiegmann and Shappell (2001) and other researchers, cognitive frameworks—while useful in determining judgment, procedural, and response-execution errors—have not typically addressed contextual or task-related factors in error, individual physiological issues, or organizational factors (Rasmussen 1982; Wickens and Flach 1988).

**Ergonomics and systems designs.** These models examine the interdependencies of individuals, tools, machines, and the workplace, highlighting human/machine interface issues and anthropometric requirements of tasks. They do not provide in-depth examination of cognitive, social, and organizational factors (Heinrich et al. 1980; Wiegmann and Shappell 2001).

**Medical.** Medical models focus on an understanding of physiological factors in human performance. Under such models, the physiological condition of delivery-level personnel can be viewed as a “resident pathogen” (Reason 1997) in human/machine systems that, when triggered by workplace conditions, manifest as error. While these approaches generate important information on fatigue, illness, and other factors in human performance, they are most useful for identifying physiological factors as contributory issues in incidents or adverse events. These models have been useful in shaping policies on work scheduling and shift rotation (Lauber 1996; Weigmann and Shappell 2001).

**Psychosocial.** Psychosocial perspectives on error embrace work within complex productive systems as a social endeavor with multiple interactions among personnel with interdependent roles (Wiegmann and Shappell 2001). Human performance is viewed as being directly influenced by the nature or character of interactions among group members (Helmreich and Foushee 1993). The essential theme of
Psychosocial models is that errors and adverse events occur when there is a breakdown in group dynamics and interpersonal communication (Weick 1990; Wiegmann and Shappell 2001). With few exceptions (Lynch 1996; Mudge 1998; Patankar and Taylor 1999; Taylor and Patankar 2000), these approaches have not generally identified “upstream” factors that bring about these “breakdown conditions” at the system operator level.

**Organizational approaches.** Organizational system models of error causation have been utilized in a range of industrial settings for many years and are being advocated and adapted for application to healthcare systems (Ammons et al. 1988; Heinrich et al. 1980; Reason 1997, 2000; Uhlig et al. 2001). These approaches consider adverse events to be the product of the unexpected confluence of latent and active failure states. They identify and analyze individual, team, task, technical, and organizational factors in near-misses and adverse events to develop intervention strategies for the correction of failed or absent defenses and safeguards.

Organizational models view front-line personnel as the last defense against a chain of fallible decisions’ progressing through the organization to trigger an adverse event. These approaches are set apart from other models in that they place emphasis on the decision process at all levels of the organization (Reason 1997).

Culture and behavior can be thought of as “different sides of the same coin” (Uhlig et al. 2001). Just as it is reasonable to assert that organizational culture yields behavior, it is also reasonable to assert the reverse. New organizational behaviors that are embedded and accepted into the daily routines of practitioners can eventually define a new organizational culture (Schein 1996; Uhlig et al. 2001). The use of a structured communication methodology as an agent for the concurrent implementation of system error management and cultural change has been studied in corporate aviation settings and health care (Taylor and Patankar 2000; Uhlig et al. 2001). Such methodology actively limits error and, through debriefing, provides a means of prioritizing and analyzing information for proactive correction of error-provoking conditions in clinical space. These examples suggest that sustainable cultural transformation and continual monitoring of organizational-safety health can be achieved by careful redesign of interaction and communication at the delivery level of high-risk systems.

Despite the significant attention currently directed toward the development of reporting systems and “safety culture” in health care, very little is being written about practical, concurrent approaches to achieving error reduction and organizational change. A safety culture (or learning culture) is, fundamentally, characterized by collaborative interaction, an objective communication process, and nonpunitive approaches to learning from outcomes, whether favorable or adverse.

Establishing and sustaining a learning culture in healthcare systems require new communication behavior. The communication behaviors and social structure that enable active error reduction are built on forthright communication and an
The quest for a safety culture, continued

objective process for judgment and decision making as a team, and they embrace suboptimal outcomes as an opportunity to improve individual, team, and organizational performance.

These norms can be continually reinforced by a “mixed” administrative control model, wherein the organization requires team debriefing and feedback on system performance and then ensures rapid analysis and correction of the causal factors underlying problematic conditions reported by the team. Through prompt response, the organization continually reinforces the collaborative social structure and communication behavior necessary for active error reduction and correction of latent failure conditions.

According to Heinrich et al. (1980), the most robust methods of error and accident prevention “are analogous with the methods for the control of quality, cost, and quantity of production.” The fundamental methods and principles for systemic improvement of decision making, coordinated action, and production outcomes, which have been studied for several decades by organizational psychologists, are comparable to the principles and methods for managing active and latent failure in high-risk operational settings. These methodologies provide for continual monitoring and improvement of behavioral and technological countermeasures and safeguards against active failure at the operator level of the system while providing feedback for correction of system factors implicated in analysis of near-miss data. To achieve a six-sigma safety standard in health care, cultural change is imperative.

Creating a new culture of safety and excellence

Martin D. Merry—Health care cannot move beyond the approximately two- to four-sigma defect rate inherent in even the best of human systems without (a) addressing the powerful negative forces inherent in its present culture and (b) developing a leadership process that can build an entirely new “post-industrial” healthcare culture that fully incorporates the best of modern quality and error-prevention sciences.

It is probably erroneous to speak of a “healthcare culture” as if it were a monolithic entity. In fact, a basic reality of health care’s craft-based culture is fragmentation. This fragmentation—which patients experience as enormous difficulty when moving from one element (e.g., a hospital) to another (e.g., a physician’s office)—is a natural outgrowth of both the structural isolation of healthcare elements (hospitals, physicians’ offices, long-term care facilities, visiting nurse services, and so forth) and the professional isolation of the various categories of caregivers of present-day health care. For instance, consider how physicians relate to hospitals in the typical community hospital setting. Figure 5 on the next page represents a generic hospital organizational structure. Of note, the “medical staff” (i.e., the physicians) is actually a distinct entity, responsible primarily to its own elected leadership, and not under the purview or authority of executive management. As any
The present healthcare culture, continued

Student of management might predict, such a structure breeds isolation of two essential components of the hospital—and, with its ambiguous authority, inevitable power struggles between physicians and institutional management.

This isolation and fragmentation were plainly evident in the case study noted earlier. All three physicians who played roles in this tragedy were practicing in complete isolation. There was no evidence that they had any communication among themselves regarding this fatally ill young woman, and they most certainly had no common medical record that might have united them in their caring for her. Is it credible that the cardiologist, for example, would not have called someone if he had been aware of how this young woman appeared in the ER three days earlier?

While the newspaper story didn’t spell this out directly, those who are familiar with the current fragmentation of health services know that this cardiologist likely had access to no more information than the echocardiogram printout that he read and dictated. Had he been aware of the total clinical picture of this dying young woman and had made that telephone call, this case might instead have been a near-miss.

As the airline industry has clearly taught us, such near-misses are extraordinarily valuable learning opportunities. In this case, physicians and hospital personnel alike might have learned much from such a near-miss regarding the potentially dangerous lack of continuity from hospital ER to private physician’s office to hospital cardiology lab, and so on.

In addition to this structural impediment to unified action, consider the different professional profiles of physicians and healthcare managers (see Figure 6 on the next page). It is clear from this figure that the two separate and distinct training traditions of physicians (M.D., D.O.) and of healthcare administrators (M.H.A.,
The present healthcare culture, continued

M.B.A.) generate professional behavioral profiles that are very likely to misunderstand one another, and thus be in conflict.

A “culture of blame”

As if these impediments to a healthcare culture of collaboration around creating safe, high-performing systems weren’t enough, the IOM correctly identified health care’s “culture of blame” as a third major barrier to safer healthcare systems. What is a culture of blame? It is essentially one of fear and finger-pointing, based on the expectation that if one is found out to be in error, punishment is likely to ensue. If one is under duress in such a culture, the natural human protective reaction in such a culture is to defend oneself, to find somewhere else to assign blame.

And how does health care develop this culture? Yet again, we encounter its craft tradition. As a result of their training, craftspersons introject the notion that “Because I’m so highly trained and no one else can do what I do, I’m totally responsible for all the consequences of my actions.” In medical training, this translates to a tradition of developing a great sense of responsibility for all of one’s actions: “I check and double-check, because if I make an error, someone may die.”

While this statement is literally true and has an obvious benefit in creating a sense of personal responsibility, it also inadvertently places an impossible burden of perfectionism on the apprentice in training. This is an unintended consequence in a high-risk environment—one nearly totally dependent on human checking systems. It creates a constant fear of making a mistake (exacerbated by a harsh medico-legal climate) and a consequent adoption by those “implicated” of various psychological and legal “defenses,” such as denial, rationalization, and blaming others.

In fact, even as of this writing this “culture of blame” staggers on like a soulless
A “culture of blame,” continued

... zombie. Our case study’s final ending illustrates this point: The implicated hospital and physicians settled the ensuing malpractice lawsuit for a huge sum, and the ER physician was publicly censured by his state medical board.

Does anyone believe that these measures will create a safer environment for patients at this hospital? Is this ER physician likely to become a “better physician” as a result of his front-page, public humiliation by the state board? Is the cardiologist any more likely to pick up the telephone after he has read another “severely abnormal” echocardiogram as a result of this experience? Will the hospital establish a task force to address the serious danger of the fragmentation of its services as a result of its huge malpractice settlement? Will the hospital’s CEO, board of trustees chairperson, and/or president of the medical staff meet with members of the community to share with them what they are doing to create safer care in their hospital?

An honest answer to all these questions is “perhaps,” but as of this writing there is no documented evidence that fear of litigation or punishment has ever improved practice at either the practitioner or the institutional levels.

Getting from here to where we need to be

Health care desperately needs creative, robust solutions to its safety crisis. The IOM calls for nothing less than a new healthcare system for the twenty-first century. As noted earlier, health care’s 2000-year-old craft-based culture is not one that welcomes the innovation now essential to traversing its industrial/information/consumer revolutions. Figure 7 illustrates the contrast between what “has been” and what “must become.” Leadership, management science (including such elements as Six Sigma management and human factors), and conscious development of organizational culture—which were all relatively unimportant in the traditional craft-based system—are now vital to health care’s success.

But health care’s transformation is inevitable. One definition of insanity is continuing to do the same things you’ve always done in the past and expecting a different result. We will continue to get the same two- to four-sigma results until we build safe infrastructures. Public leaders and healthcare leaders alike must grasp the

<table>
<thead>
<tr>
<th>Feature</th>
<th>Craft-Based</th>
<th>Systems-Based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Focus</td>
<td>React to One Patient at a Time</td>
<td>Plan for 1+ Population</td>
</tr>
<tr>
<td>Leadership</td>
<td>Largely Irrelevant</td>
<td>Key Success Factor</td>
</tr>
<tr>
<td>Management Science</td>
<td>Minimally Relevant</td>
<td>Key Success Factor</td>
</tr>
<tr>
<td>Organizational Culture</td>
<td>Largely Irrelevant</td>
<td>Key Success Factor</td>
</tr>
<tr>
<td>Key Quality Factor(s)</td>
<td>Individual</td>
<td>Individual + System</td>
</tr>
<tr>
<td>Quality Capability</td>
<td>Two to Four Sigma</td>
<td>Five to Six Sigma</td>
</tr>
</tbody>
</table>

Figure 7. Craft- vs. Systems-Based Health Care.
fundamental truth that modern medical miracles can occur and progress only in a scientifically sophisticated—and inevitably complex and high-risk—system. All must accept that the price of continued clinical innovation will be the investment in safe infrastructures and the creation of latent workplace conditions that, as the IOM has suggested, “make it hard for people to err, and easy to do what’s correct.” In fact, our current two- to four-sigma (non)system is enormously costly in terms of waste, rework, inefficient use of professional time, and human suffering of patients and caregivers alike.

Is Six Sigma a realistic goal?

Can health care realistically pursue Six Sigma? In terms of vital measures of patient safety, we can, like the airlines—and indeed must. In fact, anesthesiology, as a result of a sustained effort and the importation of high-risk system-design concepts, is already approaching Six Sigma in anesthesia-related mortality. (And it is yet another example of health care’s fragmented culture that the knowledge gained in this effort has not diffused into other medical areas.) But, like the anesthesiologists, for a time we will need to import help from quality-management and human-factors specialists outside the healthcare field. The simple fact is that neither clinicians nor current health administrators are being trained in systems thinking for clinical design.

Healthcare leaders will need conceptual models on which to build future systems. At least five key elements will characterize those leaders who successfully transcend today’s healthcare cottage industry in their pursuit of Six Sigma excellence. These healthcare leaders will master the following:

- A much-improved understanding of the population’s health needs and how people actually “flow” through various care subsystems.
- Systems thinking and quality-related sciences.
- Unprecedented collaboration between clinical and management science.
- The creation of a new “medico-management” culture—one that maintains the best of both clinical and management traditions, even as it casts off counterproductive elements from both.
- Abandonment of hierarchical, “command-and-control” leadership models in favor of the collaborative, dispersed team-based leadership models that always work better in complex, high-risk environments.

The necessary tools are available

For those who can begin working from such conceptual frameworks, the tools are already available. In fact, health care has already experienced the “total quality management” (TQM) wave that occurred between 1988 and its relative demise around 1995. But today there is considerable residual knowledge embodied by such organizations as Boston’s Institute for Healthcare Improvement and Salt Lake City’s Intermountain Health System. In essence, future healthcare design will revolve around TQM’s process improvement concepts, which are now augmented by modern Six Sigma and human-factors science.
Because it has no other real choice, health care will embrace management systems guru W. Edwards Deming’s dictum that improving quality through process improvement simultaneously decreases cost and enhances value delivered. This is precisely the formula needed for an industry grotesquely bloated from the combined cost of waste, inefficiency, and patient injury. With health insurance premiums spiraling out of control, and with no easy fixes on the horizon, could there be a better time for healthcare leaders to actualize Dr. Deming’s dictum?

In fact, the transformation has already begun. One of health care’s most gifted futurists, Jeff Goldsmith, created in 1995 the basic model from which Figure 8 is adapted. Though still well-entrenched in Stage 1 as of 1995, health care is obviously now on the threshold of Stage 2 and on its way, via the efforts of true innovators and early adopters, to Stage 3 (elements of which already exist sporadically throughout the United States). Stage 2 is enormously promising, but it predictably will be a stormy sea to traverse as health care’s 2000-year-old resident culture stages its last battle to preserve outmoded thinking and practices.

Is it revolution, evolution, or both?

As Charles Darwin said, “It’s not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change.” This truly is a(n) (r)evolutionary time for health care. Its ancient culture is giving way, finally, to an adaptive change that the authors of this paper believe will give rise to health care far better than anything we have ever experienced to this time. We believe that the factors outlined herein hold promise of successfully addressing the “golden quintet”:

- Significantly improved clinical outcomes
- Far better patient/customer satisfaction
- More humane, rewarding working conditions for caregivers
Is it revolution, evolution, or both? continued

- Greatly improved safety
- Surprising cost constraint

In sum, we have the ability to create something beyond our fondest imagination. And the challenge to create it is not just for our healthcare leaders. Health care belongs to society as a whole, and we all have potential roles in the unfolding of its future. As we contemplate our individual roles in health care's transformation, each of us might ask these simple questions: “If not now, when?” “If not me/us, who?”

References


Brown, Jeffrey P. Discussion with training captains from major world airlines. First annual Captains’ Leadership Symposium, hosted by Delta Air Lines, Atlanta, Georgia, March 2001.


References, continued


Taylor, James C., and Manoj S. Patankar. 2000. *The Role of Communication in the Reduction of Human Error*. Pre-publication copy provided by the authors.


Author information

Dr. Martin D. Merry received his undergraduate degree in industrial and labor relations from Cornell University and earned his medical degree at McGill University. He practiced general internal medicine for eight years while developing the role of Medical Director for Quality at St. Joseph’s Hospital in Elmira, New York.

In 1981, Dr. Merry began a career devoted to consultation and education in the areas of quality, medical staff leadership, and organizational transition. He also teaches the quality management course in the Masters of Healthcare Administration program at the University of New Hampshire and serves as Senior Advisor for Medical Affairs for the New Hampshire Hospital Association.

Jeffrey P. Brown is Principal of System Safety Group. He specializes in the design and implementation of organizational approaches to safety, utilizing error-management methodology developed for systemic implementation in high-risk domains.

Editorial assistance for this article was provided by Cathy Kingery.
Using I-charts to Enable Strategic Decision Making at Dunkin’ Donuts

Authors

Ismael Dambolena, Professor of Operations Research, Babson College, Wellesley, Massachusetts
Susan West Engelkemeyer, Associate Professor of Management, Babson College, Wellesley, Massachusetts
Stephen M. Gadziala, Manager of Retail Operating Systems, Allied Domecq Quick Service Restaurants, Randolph, Massachusetts

Introduction

By a small sample we may judge the whole piece. —Miguel de Cervantes, Author of Don Quixote

The quality literature abounds with examples of the use of control charts to monitor, control, and improve processes. The majority of applications to date have been in manufacturing but service applications continue to grow. Most control chart examples focus on particular processes and find themselves most useful to those responsible for the process; for example, the manufacturing manager who is directly interested in a quality product or the operations manager who wants hotel rooms to be impeccable when a new guest arrives. A question to consider is how useful are control charts to those in more staff-related or general decision-making areas, such as the financial manager, the sales manager, or the general manager? Well, this may surprise some of us but there is a control chart that any manager will find useful but, nevertheless, is not very widely known—the control chart for individuals, or I-chart.

This article presents an overview of control charts, highlights examples of I-chart applications, and gives examples of their use for strategic operational decision making at Allied Domecq Quick Service Restaurants in its Dunkin’ Donuts retail stores.

Process variation and control

By way of introduction to his chapter on statistical process control in Out of the Crisis3, W. Edwards Deming tells us that:

The central problem in management and in leadership...is failure to understand the information in variation. He that possesses even a fuzzy understanding of the contents of this chapter would understand...that the type of action required to reduce special causes of variation is totally different from the action required to reduce variation and faults from the system itself; would understand the meaning of the capability of a process and of a system of measurement; ...would understand that leadership that takes aim at people that are below average in production, or above average in mistakes, is wrong, ineffective, costly to the company; that the same holds for a leader that supposes that everyone could be an achiever. He would understand why it is that costs decrease as quality improves. It is essential, however, in industry and in science to understand the distinction between a stable system and an unstable system, and how to plot points and conclude by rational methods whether they indicate a stable system. The points might show, for example, weekly figures on sales, quality incoming and outgoing, complaints of customers, inventory, absenteeism,
Process variation and control, continued

accidents, fires, accounts receivable, beneficial days.

Dr. Deming spent considerable time and effort during his life helping managers understand that it was essential for them to know whether they were facing a stable or an unstable system. The difference is crucial because, as he points out, the type of action suitable in the former case is totally different from the type of action required in the latter case.

If a system is stable—in other words, if the variation in that system is due only to randomness—then this common variation can be reduced only by redesigning the system. For example, better machines could be purchased, training programs could be improved, or better lighting could be installed. Tinkering with the system by those who operate it (adjusting controls, for example) induces unwanted additional variation and, therefore, exacerbates the problem. On the other hand, if there are special causes for the variation in a system, then the causes of this special variation should be identified and eliminated. Special variation can be traced to a particular cause, such as poor quality or off-specification raw materials, machine tool wear, or an employee who performs poorly. Special causes are generally easy to detect using statistical methods because they result in unnatural variations that disrupt the random pattern of common variation.

Observers can determine whether the variation in a system is common variation or whether special causes are also present by collecting data on the system output and developing a control chart for it. In the following section we explain how this determination is made, and in the appendix we show how to develop a simple control chart and give further references on control chart development.

Control charts

Several types of control charts are widely used in manufacturing and service operations. For measurable quality characteristics, such as the length of rivets or the tensile strength of metal rods, the stability of both the average and the variability is controlled by periodically sampling items, measuring them, and plotting the average and range of these samples in two control charts. The average is plotted in an X-bar chart and the range in an R-chart. When the quality characteristic is of the yes/no type (e.g., the light bulb works or it doesn’t work), the frequency with which problems occur is controlled by periodically taking a sample of items or transactions and plotting the proportion defective in the sample in a P-chart. Other types of control charts can be applied; however the X-bar, R-, and P-charts are the most commonly used.

For some variables that are of particular interest to managers (e.g., sales, accounts receivable, the price of a stock, or the level of the stock market), only a single observation on the variable is available at any one time. The behavior of these variables can be monitored by means of a control chart for individuals, or I-chart.

One accurate measurement is worth a thousand expert opinions. —Grace Hopper, R. Adm., USN (Ret.)

The I-chart

Let’s first look at an example given by Wheeler² a few years ago. Figure 1 shows monthly U.S. trade deficits from January to October 1987. The first impression is
not favorable—from January to October the deficit grew from $10.7 billion to $16 billion, and of the nine monthly changes, six were up while only three were down.

However, could this have just happened by chance, or is there enough evidence here of a significant upward trend?

Figure 2 shows an I-chart for the same data. All the points are within the control limits, and there are no special patterns in the time series, such as cycles or an unusual distribution of the values (for details on special patterns, see Rao et al.3), so there is no statistical evidence of a significant upward trend. Moreover, Figure 3 shows monthly trade deficits for all of 1987 and 1988, and here we can see how

In March 1988 (month 15) and May 1988 (month 17), the process moved beyond the lower control limit. This signal, together with the fact that all deficits after October 1987 lie below the center line, provides an indication of a significant systematic decline in the level of the deficits.
The I-chart, continued

wrong our first impression was. Although the deficit hit a two-year high in October 1987, that point was still within the limits of random variation—and deficits in the fourteen months since the peak have all been smaller.

Let’s look at a second, hypothetical example. Jeff Wainwright, the sales manager of Mercer Corporation, got his quarterly report with the latest sales figures for domestic and international sales (see Figure 4).

At the next weekly meeting his praise for Jim Williams, the domestic sales manager, was unbounded. And shouldn’t it be? Fourth-quarter domestic sales for 1999 were 12.5% higher than in the previous quarter and up 17.4% from the fourth quarter of 1998. Jim wasn’t quite sure why he did so well, but of course he kept this to himself. On the other hand, Jeff was really critical of Mary Wells, manager of international sales. And didn’t she deserve this criticism? Fourth-quarter international sales were 5.5% lower than in the third quarter and down 6% from last year’s fourth quarter. Mary was incensed. She positively knew her sales had been going up year after year for several years.

The I-chart in Figure 5 shows that all the variation in quarterly domestic sales over the last five years is just randomness, so there isn’t a real reason to praise Jim (or give him a large performance bonus).

---

**Figure 4. Quarterly Sales for Mercer Corporation, 1995–1999.**

<table>
<thead>
<tr>
<th>Year</th>
<th>First Quarter Domestic</th>
<th>First Quarter International</th>
<th>Second Quarter Domestic</th>
<th>Second Quarter International</th>
<th>Third Quarter Domestic</th>
<th>Third Quarter International</th>
<th>Fourth Quarter Domestic</th>
<th>Fourth Quarter International</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>3,805</td>
<td>1,832</td>
<td>4,226</td>
<td>1,897</td>
<td>3,410</td>
<td>2,009</td>
<td>3,327</td>
<td>1,896</td>
</tr>
<tr>
<td>1996</td>
<td>4,112</td>
<td>1,836</td>
<td>3,556</td>
<td>2,046</td>
<td>4,353</td>
<td>2,060</td>
<td>3,882</td>
<td>2,186</td>
</tr>
<tr>
<td>1997</td>
<td>3,951</td>
<td>2,333</td>
<td>4,230</td>
<td>2,046</td>
<td>4,019</td>
<td>2,026</td>
<td>3,622</td>
<td>2,176</td>
</tr>
<tr>
<td>1998</td>
<td>4,326</td>
<td>2,349</td>
<td>4,329</td>
<td>2,458</td>
<td>4,691</td>
<td>2,383</td>
<td>3,532</td>
<td>2,815</td>
</tr>
<tr>
<td>1999</td>
<td>4,256</td>
<td>2,546</td>
<td>3,489</td>
<td>2,590</td>
<td>4,801</td>
<td>2,801</td>
<td>4,278</td>
<td>2,655</td>
</tr>
</tbody>
</table>

Sales are shown in thousands of dollars.

---

**Figure 5. I-chart for Domestic Sales at Mercer Corporation.**

Sales are shown in thousands of dollars.
Sales are in control, and variation from any quarter to the next is due to randomness.
The I-chart, continued

The I-chart in Figure 6 confirms Mary’s feelings about a significant upward long-term trend in international sales. Thus, Jeff’s criticism of Mary was undeserved.

![Figure 6. I-chart for International Sales.](image)

I-charts monitor the average level of variables. Technically, one should also make sure that any two consecutive individual values are not too far apart. A second chart, the moving-range chart, is used to control this inter-value variation. We discuss the moving-range chart in the appendix.

Strategy at Allied Domecq Quick Service Restaurants

Allied Domecq Quick Service Restaurants (ADQSR) is the parent company of Dunkin’ Donuts, Baskin-Robbins Ice Cream, and Togo’s Great Sandwiches. In 1996, ADQSR introduced a six-point strategy that included:

1. New retail store image and layouts for Baskin-Robbins and Dunkin’ Donuts (image and appearance of the stores).
2. Introduction of a Point-of-Sale (POS) system.
3. Introduction of a new retail operating system (to leverage the technology and store layout to provide exceptional customer service and value to customers),
4. A new marketing approach (which included the retirement of “Fred the Baker” for the Dunkin’ Donuts brand).
5. Multi-branding (incorporating two or three brands under one roof to gain economies of scope and scale).
6. For Dunkin’ Donuts, centralizing donut and bakery production to pull the manufacturing out of the stores.

The Dunkin’ Donuts brand was seeking to transform itself from its old image as a donut store with a manufacturing mind-set to a more modern, customer-focused business. Retail Business Innovation (RBI) was the name given to this initiative. To meet customer needs and transform the brand, the following points were identified as key levers:

- Increase speed of service at drive-thru and front counter
- Rely on teams during peak hours to make possible the parallel processing of orders
- Utilize technology (POS) to allow for parallel processing of orders.
Successful implementation of these aspects would result in increased throughput (measured by number of customers served), especially during peak hours. Increased throughput, in turn, would result in increased sales and profit for the facility. Utilization of appropriate data would enable Dunkin’ Donuts to demonstrate the value of implementing new innovations, such as POS technology. Prior to 1996, all Dunkin’ Donuts stores utilized a cash register based system. It was believed that a POS system would enhance store results. However, the benefits would have to be demonstrated before the system was implemented in the 1,200–1,500 stores with a drive-thru, where a POS system was believed to be beneficial. In addition, it was unclear what the benefits would be of using a single terminal to take orders and also collect payments, against using two POS terminals in a store, one for taking orders and the second one for collecting payments.

The improvement work, which was done with advice from the IBM Retail Consulting Group, identified two primary bottlenecks in the drive-thru system: the menu board where the order is placed, and the window where the order is delivered and cash is exchanged. To alleviate these bottlenecks, several key variables for improvement were identified at the drive-thru:

- The use of technology, including POS (with a dedicated order taker and cashier), headsets, drive-thru timers, and a drive-thru order confirmation board.
- The development and communication of standards, procedures, and processes.
- Service time standards.
- Clearly defined steps of customer service: greet the customer, ask for their order, assemble the order, take payment, deliver the order.
- Teamwork.
- A dedicated bagel and sandwich assembly area with a dedicated assembler in close proximity to the drive-thru window.
- A four- to five-car queue between the drive-thru window and the menu board to allow for ample time to assemble.
- The training of people on standards, procedures, and processes.
- The focusing and motivation of people on customer service, procedures, and processes.

Two Massachusetts stores, in Medford and Pepperell, were selected for testing. The Medford store is located just off a rotary on a highly traveled road. Medford itself is a dense urban area just outside of Boston, where there is tremendous competition for the QSR dollar. The Pepperell store, on the other hand, is in a very rural location. Pepperell is a town with a relatively small population and no competition for the QSR dollar. Neither store had an optimum layout to maximize the benefits of the process changes, but despite layout limitations, significant throughput gains were realized in both stores.

The Medford store had two drive-thru POS terminals, and most of the variables mentioned above were in place, but one key component was absent: the proper location of the menu board. It was decided to relocate the drive-thru menu board to accommodate a five-car queue, because it was felt that this would provide additional assembly time.
The store at Medford, continued

for the drive-thru team and therefore reduce the amount of time a car would spend at the window waiting for orders to be prepared. The primary objective was to decrease the amount of time a car spends in the system, thereby increasing throughput. Data were collected prior to the relocation of the menu board as well as after, using sales volume and the number of cars served at the drive-thru as metrics. The I-chart was then used to evaluate the results. Figures 7 and 8 clearly show the significant upward trends in sales and throughput after the change was implemented. These figures provided strong evidence to management that the right menu board location is critical to the improvement of throughput.

![Figure 7. I-chart for Daily Drive-Thru Sales Volume at Medford Store.](image1)

The menu board was relocated on day 27. Control limits are based on data collected on days 1–26, prior to menu board relocation. After the process becomes stable at a higher average level of sales, the center line and control limits for the chart should be computed once again.

![Figure 8. I-chart for Drive-Thru Throughput at the Medford Store.](image2)

The Pepperell store

In the Pepperell store most of the variables were also in place. As in Medford, this store had previously implemented POS technology, but early data indicated that...
the drive-thru process could not serve more than ninety-one cars per hour with only one POS at the drive-thru. A second POS terminal was installed to determine the impact. It was felt that this would result in a more balanced work load, particularly as it related to the two primary bottlenecks, because order taking at the menu board would now be separate from payment collection and order delivery at the drive-thru window. Pepperell had a four-car queue and, again, the primary objective was to improve the speed of service and increase throughput. The I-chart in Figure 9 demonstrates that a second POS enabled a significant increase in throughput, measured as the number of cars served between 5:00 a.m. and noon.

Figure 9. I-Chart for Drive-Thru Throughput at the Pepperell Store.

<table>
<thead>
<tr>
<th>Day Number</th>
<th>1</th>
<th>3</th>
<th>5</th>
<th>7</th>
<th>9</th>
<th>11</th>
<th>13</th>
<th>15</th>
<th>17</th>
<th>19</th>
<th>21</th>
<th>23</th>
<th>25</th>
<th>27</th>
<th>29</th>
<th>31</th>
<th>33</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cars</td>
<td>300</td>
<td>350</td>
<td>400</td>
<td>450</td>
<td>500</td>
<td>550</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A second POS was added on day 26. The control limits are based on data collected on days 1–25, prior to the addition of the new POS.

Figure 10 presents yet another view of the effect of a POS for the store. The total time a customer waited at the drive-thru was reduced by over 50% with the addition of a second POS terminal. In addition, the time at the menu board and window approached the service target, which would enable the store to serve over 100 cars during peak hours. A twelve-month review of this location showed that this parlayed into a 20% sales increase in year-over-year sales for the franchisee while the local market saw about a 5% increase.

Figure 10. Pepperell Store Drive-Thru Statistics.

<table>
<thead>
<tr>
<th>Service Statistics</th>
<th>Target</th>
<th>With One POS</th>
<th>With Two POS</th>
</tr>
</thead>
<tbody>
<tr>
<td>At menu board</td>
<td>20 seconds</td>
<td>43 seconds</td>
<td>21 seconds</td>
</tr>
<tr>
<td>At window</td>
<td>30 seconds</td>
<td>43 seconds</td>
<td>31 seconds</td>
</tr>
<tr>
<td>Total time (since the car joins line until it departs the window)</td>
<td>180 seconds</td>
<td>256 seconds</td>
<td>120 seconds</td>
</tr>
</tbody>
</table>
Benefits to management

Perhaps the key benefit to ADQSR management, as well as to franchisees, was that they could clearly see the upside of implementing proper processes to meet customer needs: fast, friendly, and accurate service. The results after process changes demonstrated that there was a demand for the brand that was not being met by the existing store design, work processes, and standards. This work, along with other projects, led the company to think more strategically about how to decrease service times and increase throughput. This, in turn, led to the testing of an order confirmation board at the drive-thru, as well as to the implementation of drive-thru timers. It also encouraged people to think about how speed of service could be improved in stores without a drive-thru, or inside service in a store with a drive-thru.

A new store design, unveiled in June 2000 in Methuen, Massachusetts, incorporated into inside service much of what was learned from the Pepperell and Medford stores. It might be best described as a drive-thru inside the store, where customers order and pay, then proceed to pick up items or add condiments themselves at a defined station. Initial results showed a 15.5% decrease in total system time, employees who were less stressed, and growing average ticket size. Subsequent analysis has shown that, as the crew became more efficient, the decrease in total system time approached 25%. These results have allowed for continued expansion of the test with several improvements designed to improve speed of service even more, and have also led to the addition of three new stores, two in Methuen and one in Lawrence, Massachusetts, to further test the concept of the drive-thru inside the store. Each of these new stores has incorporated the learning from the first test store in Methuen, with an interior layout like a drive-thru specifically designed to improve service speed.

In summary, a major key point is that the I-chart helped confirm the hypotheses put forth by the IBM Retail Consulting Group. It becomes very hard to refute data. Also, it led ADQSR to think about throughput from a strategic point of view, and thereby take the risk of designing a store that operates like a drive-thru in the interior of a store. Besides, it helped bring a focus to work standards and speed of service that did not exist before this work was done.

Conclusion

The application of I-charts to the decision about the appropriate number of POS terminals enabled Dunkin’ Donuts to clearly demonstrate the impact on throughput and store sales with an additional POS terminal at the drive-thru. This helped the company justify the expense throughout the chain in stores that had enough volume to support the POS technology. The value-added of a strategic decision was documented through the application of control charts.

Appendix

In this appendix we illustrate the use of Excel software to develop the basic information necessary for computing the center line and control limits for I-charts and moving-range charts (MR-charts). Once these values are computed, the chart can be easily graphed in Excel.
Appendix, continued

Figure 11 shows a simple Excel template that can be used for developing the information we need. Cells B3–B12 in the spreadsheet contain the ten monthly U.S. trade deficits from Figure 1. Cell B14 shows the average of the ten deficits, which was computed using the AVERAGE function within Excel. We denote this average as X-bar.

Cells C4–C12 contain the moving ranges for the monthly deficits. The moving range for any given month is the absolute value of the difference between the deficit for that month and the deficit for the previous month. The moving ranges were computed by entering the formula =ABS(B4–B3) in cell C4 and copying this formula down into C5–C12. As we mentioned in the body of our article, these moving ranges measure the inter-value variation for this time series of deficits, which should be in control. No two consecutive deficits should be too far apart, and the MR-chart is developed to ensure that this does not happen. Cell C14 shows the average of the nine moving ranges, and this average is denoted as R-bar.

For our data, X-bar = 13.02 and R-bar = 1.32. Based on these two values, the center line, upper control limit (UCL), and lower control limit (LCL) for the I-chart are computed as follows:

Center line = X-bar = 13.02

UCL = X-bar + 3(R-bar/1.128) = 13.02 + 3(1.32/1.128) = 16.531

LCL = X-bar – 3(R-bar/1.128) = 13.02 – 3(1.32/1.128) = 9.509

We can verify in Figure 2 that the center line and control limits are set at these values. The center line and control limits for the MR-chart are computed as follows:

Center line = R-bar = 1.32

UCL = 3.267; R-bar = 3.267 (1.32) = 4.312

LCL = 0

Figure 12, on the next page, shows an MR-chart for the trade deficits, and we can verify that these are the values at which the center line and control limits are set.

A brief, applied description of I-charts and MR-charts can be found in Rao et al.4 This reference also includes the rationale for the formulas we used in this appendix5, as well as a general procedure for control chart development6. This material requires an introductory knowledge of statistics, which is also covered in the same reference.
CASE STUDY

Using I-Charts to Enable Strategic Decision Making at Dunkin’ Donuts

References


Author information

Israel Dambolena is Professor of Operations Research at Babson College in Wellesley, Massachusetts. He holds a B.S. degree in industrial engineering from Texas A&M University, an M.S. in engineering from Stanford University, and a Ph.D. in operations research from the University of Massachusetts at Amherst. He has consulted as an international expert for the United Nations, and has been a visiting professor at IBM’s International Education Center in Belgium and at the Universidad Nacional del Sur in Argentina. His main academic interests are in the areas of total quality management and the prediction of corporate failures. He has published in Quality and in the Center for Quality Management Journal, among many other journals, and has recently co-authored Total Quality Management: A Cross Functional Perspective, a Wiley & Sons book.

Susan West Engelkemeyer is an Associate Professor of Management and former Director of Quality at Babson College in Wellesley, Massachusetts. She also serves as Director of Strategic Initiatives, and of the Summer Academy, for the American Association for Higher Education in Washington, DC. Susan holds a B.A. from Stephens College, an M.B.A. from East Carolina University, and a Ph.D. in industrial management from Clemson University. Dr. Engelkemeyer has served as a Senior Examiner for the Malcolm Baldrige National Quality Award since 1995. Her consulting and research interests include quality and strategic operations management. She has published in the Quality Management Journal and Quality Progress, and has authored several chapters in quality-related books.

Stephen M. Gadziala is Manager of Retail Operating Systems at Allied Domecq Quick Service Restaurants. He earned a B.A. from St. Bonaventure University, an M.A. from Ohio State University, and a Certificate in Special Studies in Management and Administration from the Harvard University Extension School. At ADQSR Stephen served as project manager in the development of the Retail Business Innovation Operating System for Dunkin’ Donuts and oversaw the development and documentation of the Multi-brand Retail Operating System for Dunkin’ Donuts, Baskin-Robbins, and Togo’s. Additionally, he has taught retail management at North Shore Community College.

Editorial assistance for this article was provided by Laurence Smith.
Sherwin-Williams' Data Warehouse: The Intelligence in the Supply Chain

Author

Jim Revak, Manager, Enterprise Services and Strategic Projects, The Sherwin-Williams Company, Cleveland, Ohio

Introduction

Sherwin-Williams is the world’s leading developer, manufacturer, and distributor of architectural coatings and related products, such as stains and wood-care products. Our headquarters is located in Cleveland, Ohio. We own thirty-six plants and fourteen distribution centers, and we have operations in South America and the U.K., as well as licensees in China, Europe, Jamaica, and Japan.

Sherwin-Williams can be viewed as a manufacturing company because we make our own products. Because of the many facilities we maintain, we are also a distribution company. And we’re a retail company as well, with 2500 retail stores of our own. Thus, we are an “end-to-end” business, with involvement all the way across the supply chain, from the raw materials to the retail marketplace.

We are expanding gradually by making acquisitions in the global marketplace. Because of this growth, we have well over 300 brands and 130,000 products. In the year 2000, our annual sales totaled $5.2 billion. We have 25,000 employees, most of them in our retail stores. About 3000 work in our Cleveland headquarters. We sell our paints and paint products to some 25,000 diverse customers (including stores, merchandisers, distributors, and outlets).

The practice of “co-opetition”

Our stores division (which comprises our Sherwin-Williams stores) is actually a customer of another division, known as the consumer group. That group manufactures and distributes all our products across the entire company, with our Sherwin-Williams stores being the major customer. We also market to a diversity of other customers, including mass merchandisers such as Wal-Mart and K-Mart, and department stores such as Sears. Because we are in the commodity business, it’s the service we provide that distinguishes us from the competition.

How do we compete with our own customers? Our stores division, which does nothing but retail, is a customer and is treated as such. Thus, we are a perfect example of cooperative competition, or “co-opetition.” In other words, we have to cooperate with the folks that we compete against.

A major element of that practice is refraining from discussing a company’s business with somebody else: We don’t talk about Wal-Mart’s business with K-Mart, for example. Home Depot buys all our wood-care products, but they purchase bucket paint from another company. They want to sell our paint, but
The need for a data warehouse

Between 1985 and 1995, Sherwin-Williams made twenty-eight acquisitions. With these acquisitions came numerous plants, distribution centers, and offices, each one with its own culture. Trying to manage through all that became a huge challenge for us because of all the customers, brands, and products involved.

With the multiple lines of business—and the hundreds of brands across those lines—that we have, our big challenge was to understand that complexity while remaining customer-centered and customer-focused. We wanted a data warehouse that would give us a single view of the supply chain.

An award-winning effort

In 2000 we received a Best Practices in Data Warehousing Award from the Data Warehousing Institute in Gaithersburg, Maryland. This award was for our successful implementation of architected data marts as a way to quickly satisfy the corporate need for information.

Our data-warehousing efforts began in 1997. This process entailed building an enterprise-wide data warehouse—one section, or data mart, at a time. We started in the sales area, went down the chain to the raw-materials-purchasing side, and then continued up the chain to the customer side (Figure 1). While we were building the data marts, as we added data we started to also build an enterprise-wide data warehouse. That’s what the bottom half of Figure 1 represents. We then used our data warehouse to form the foundation for our customer-relationship management.

Our company officers fully sponsored this project from the beginning. That’s the only way to get results delivered. We also had to build flexibility into the process. We built an architecture that was fluid enough to change in case the people who were company officers at the beginning of the project subsequently left the company.

---

Figure 1. Architecting for the Business.
CASE STUDY

Sherwin-Williams’ Data Warehouse: The Intelligence in the Supply Chain

Process and methodology led the effort

When building data marts, a major mistake is to begin by concentrating on the data. You cannot dive right in like that. Before you even look at the actual data, you must spend time analyzing the business itself and identifying the key subject areas. You must also spend time modeling and writing down what the processes are.

The process and the methodology led the effort. We built business models prior to doing anything—before we even talked about or looked at any data. We built dimensional models that allowed us to look at data in five different ways. Some of the questions we wanted answers to were such things as “How are our sales in K-Mart for this time period, for this group of sales reps [and for up to ten other factors we want]?” That’s the essence of data warehousing. It goes beyond asking questions like “What’s out there in such-and-such warehouse?” or “What did we ship to this location?” You can use your operational systems for that.

Rapid implementation was important

One of the requirements of this project was that we needed to be able to implement it quickly. As mentioned earlier, our objective was to obtain a single view of the supply chain, which we desperately needed.

For instance, Wal-Mart was buying Minwax, Thompson’s, Krylon aerosols, automotive touch-up paint, and regular Dutch Boy paint from us. Every time they bought one of those products, they had to fill out a separate purchase order from a separate part of our system. You can imagine their frustration; we knew that if we waited three or four years to implement a new system, Wal-Mart would no longer want to do business with us.

Incredibly, to determine what our total sales for K-Mart were, we had to extract data from seven different programming languages and then put the assorted data all together, without even knowing whether it was reconciled or not.

“I don’t even know how to ask for what I need.”

We interviewed our customers’ executives to gather their wants and needs with regard to this project. When asked her thoughts about dealing with our data-handling system before our project began, Pat Macko, the national account manager for Ace Hardware, made an interesting statement. Everyone has heard people say, “I don’t know what I need,” but she said, “I don’t even know how to ask for what I need.” I thought that was not only profound, but an accurate comment about the situation our company’s data-handling system was in.

Costs were a concern

Our budget was constrained because Sherwin-Williams functions as a supplier in a commodity marketplace. Stores like Home Depot and Wal-Mart don’t like it when we ask for a price increase. If anything, they want prices to be lowered. On top of that, our raw-materials suppliers had recently increased their prices significantly.

Getting the project started: Asking the right questions

This wasn’t a typical systems development effort; the way we gathered requirements was a bit unique. We tried to anticipate how people were going to think through making a decision. Instead of saying to them, “Tell me what you want,” we
Getting the project started: Asking the right questions, continued

asked, “What keeps you up at night?” “How do you measure your success?” “How do you know when you’ve had a successful day?” We used this methodology, together with some discipline, to ensure that the IT group wasn’t leading the whole project. We wanted the businesspeople to lead it.

We found the best way to get the rapid implementation we needed was to use a phased approach. We contracted a firm called Decision Works to come up with a list of business requirements for the project (see Figure 2 below). Before they did that, we had them talk to all of our executives to get their input.

Once we had a list of requirements, we used it to come up with thirteen major subject areas to focus on: (1) sales performance, (2) raw materials purchasing, (3) freight tracking, (4) order fulfillment service, (5) customer/product profitability, (6) warehouse optimization, (7) external data (syndicated), (8) plant operations management, (9) product sourcing/logistics planning, (10) customer point-of-sale (POS) analysis, (11) consumer relationship marketing, (12) call-center operations management and call tracking, and (13) customer report cards. To compile this list, we gathered all our executives together to discuss their needs and decide where the data-warehousing project should start. The first subject area that they picked to focus on was sales performance, so we created our Sales Analysis Mart first.

One data mart at a time

During the construction of a data warehouse, when you build things one data mart at a time, you want to have a pendulum effect going; in other words, as you complete one data mart, you also begin working on the next one. Once our designers had finished working on one, they handed it off to the developers so the designers were free to start working on the next one.

We constructed our data marts by following the arrows shown in Figure 2. We started with sales performance and then went to customer/product profitability.
One data mart at a time, continued

Once that was completed, we then continued with sales productivity.

Then we moved to raw materials purchasing, which is a huge area for us. Now we are moving into the concept of collaborative planning, forecasting, and replenishment, or CPFR, where we are focusing on trying to collaborate with our customers. CPFR is an agreement between a customer and a supplier to share resources (including hardware and software) for forecasts and orders.

I’ll concentrate here on four of our data marts: the Sales Analysis Mart, the Contribution Analysis Mart, the Raw Materials Analysis Mart, and the Category Management Mart.

The Sales Analysis Mart

When you think about what a data warehouse does, you realize that it doesn’t give you answers; it actually creates more questions. For instance, one person might look at a screenful of data and say, “Here’s what sales look like by region or by time period,” and somebody else might look at it and ask, “Yes, but what are the sales for a given customer across all business units? How are sales changing in the current period versus the same period last year? What is yesterday’s sales performance against budget—by customer, sales rep, and product?”

To enable the Sales Analysis Mart (which we call SAM for short) to answer these types of questions, we included a drill-down capability into the five dimensions of time, warehouses, plants, customer channels, and product types. This allows someone to look at sales by those dimensions in any way they want.

SAM serves as a single repository for the combined sales information of our entire company. This was an immense accomplishment for us to achieve because of the complexities we encountered through all our mergers and acquisitions.

The Contribution Analysis Mart

The second data mart we concentrated on was the Contribution Analysis Mart, or CAM. For this one, we wanted to know how each salesperson was contributing to sales in each quarter.

We wanted to know such things as what the sales reps were doing, besides getting top-line sales, to contribute to our overall sales. We added cost to the mix so we could determine the costs associated with selling to a given customer, by both prime accounts and sub-accounts. This data mart also allows us to look at margins, ranked by brand and by customer.

When we created the Contribution Analysis Mart, we already had product data, customer data, territory data, and accounting data in our data warehouse. We added salespeople data for this data mart. Everything had been arranged by sales territory before, and a salesperson was assigned to each territory. Profit contribution of the individual sales reps provides the best foundation for incentives. But if you’re going to do incentive programs, you can’t pay territories; you pay people. Adding this data element fixed that problem.

This data mart allowed the company to measure our sales representatives’
The Contribution Analysis Mart, continued

productivity and deduct all of the expenses they incurred, such as the free product samples that they gave to their customers. Sherwin-Williams then built a sales incentive program around this information. This data mart changed our sales force's incentive to their overall contribution to sales—not just top-line sales.

It was always a dream of our company's executives to be able to give our salespeople incentives and pay them according to how they contribute to the company's sales. They weren't able to do it until we used this data mart to create this new concept of a salesperson's task.

The Raw Materials Analysis Mart

Questions that we wanted the Raw Materials Analysis Mart to answer included the following: What is the cost contribution of each raw material for a given finished good? What volume of a given raw material are we buying in drum versus in bulk, by plant? How many suppliers provide us with a given raw material, and is there any incentive for us to consolidate suppliers?

We were looking to get better discounts from our suppliers. We also wanted to consolidate some of our suppliers because we found that our plants were doing some independent purchasing on their own. After looking at the complexity of our old business processes, we decided to simplify them to save money.

When we started working on this data mart, we already had the customer and product information in our data warehouse. For this data mart, we added more data elements: the raw material, the freight, and the forecast.

The Raw Materials Analysis Mart was a little more complex than the sales-related data marts we had already worked on. For sales we had only one measurement area to work with, called a fact table, that had all the measurements in it. With this raw-materials data mart, however, we wanted to look at four different measurement areas: purchase orders, receipts, forecasts, and payments.

Thanks to this data mart, we can now take those four sets of metrics and look at them using the five dimensional models described earlier. As a result, this data mart is a very powerful tool that enables us to see how smartly we are purchasing.

Even small improvements in raw-materials purchasing have resulted in enormous benefits. Every year we spend well over $2 billion on raw materials. Our executives had a goal of saving 10% after this data mart was implemented. We actually saved only one-half of a percent, but that percentage equals $10 million. And building this data mart cost only about $400,000. That's a significant saving.

The Category Management Mart

Once we had a foundation of three established data marts, we set out to find answers to category management questions that we had. These included the following: What is the performance scorecard for a retailer's categories? Are we meeting our penetration goals for major accounts? How do we compare to the competition? Our Category Management Mart provides an "out-the-door" view of sales and extends the supply-chain management to our customers.
The Category Management Mart, continued

We asked several of our customers (our Sherwin-Williams stores, Wal-Mart, K-Mart, Lowes, and Sears), “Wouldn’t it be great to see, side by side, data that shows what’s being shipped to you from us and data that shows what’s going off your shelves so that you can view the whole supply chain at once?” The answer was a resounding yes. And we, too, wanted to know what products of ours were moving off their shelves.

We strive for operational excellence all the way through the supply chain. Using category management and analyzing POS data has enabled our customers to get a great view of the supply chain: They can easily see what’s coming into and what’s going out of their stores.

The Category Management Mart’s first application

We did our first application using the Category Management Mart for Wal-Mart’s paint department, which has a number of different categories (e.g., bucket paint, wood sealers/stains, and sundries). Wal-Mart has the country’s largest data warehouse short of the military. Every transaction that goes through a Wal-Mart register is thrown back within minutes to a huge NCR data warehouse located in their corporate headquarters. We have obtained the necessary approvals and authorizations from Wal-Mart to download that data via the internet.

Wal-Mart’s system is split up into retail categories known only to wholesalers and manufacturers; they use a completely different vocabulary than we do. But their retailing database allows us to get unbelievable amounts of data. With that data we’ve been able to do performance scorecards, which show, on a weekly basis, sales and profit performance of our products versus target goals, as well as comparisons to our competitors’ products. These scorecards subsequently enabled us to become Wal-Mart’s “Category Captain” (more on this later).

We have also been able to build POS data marts with this kind of retail data. We can create scorecards from that retail data and submit them to our customers. We’ve done this for Sears, Lowes, K-Mart, and Wal-Mart. Now we have a generic model that we can apply to multiple customers. We have an extensive list of 20,000 customers—including Fred Meyer, a large retailer—lined up and waiting to go.

Now we want to do the same thing for our big suppliers, such as Dow, DuPont, and Union Carbide, who are eager for this data. This is an exciting part of the data-warehousing project for us, and we are elated to have it grow.

The entire company supported the project

Throughout our data-warehousing project, we had executive funding and support from our CEO and the board of directors. The initial budget was $3.5 million. Half was for hardware, software, and internal labor; the other half was for the external labor provided by Sequent/IBM (which I’ll explain in a moment).

Because the Sales Analysis Mart was the first data mart we worked on, our executive vice president of sales drove the strategy for that part of the project. Other executive sponsorship was provided by our four division and corporate IT directors.
The entire company supported the project, continued

Our five business group vice presidents and our sales accounting manager provided business sponsorship. The sales accounting manager’s job was to work with the company's sales managers and provide them with reports. He was the key person to understanding, financially, how those sales managers are driven. Sherwin-Williams’ twenty business unit directors made up the rest of the business sponsorship.

Our executive sponsorship and business sponsorship combined to form a steering committee for the project. Thus, our data-warehousing project efforts started with the business and stayed with the business.

A look at the technical side

The key technical elements of our data-warehousing process are shown at the bottom of Figure 3. This figure illustrates the initial solution that we constructed at the beginning of our data-warehousing project in 1997. Amazingly enough, it still works just as well today.

At the far left side of the figure are multiple data sources. In general, a large company has to concentrate on gathering data, staging it, cleaning it, and then constructing it in such a way that it's possible to look at it by multiple dimensions. Then you can build your data marts from there.

---

**Figure 3. An Architecture for Repeatable Processes.**

<table>
<thead>
<tr>
<th>Data Sources</th>
<th>Data Acquisition</th>
<th>Data Engineering</th>
<th>Data Storage (Warehouse)</th>
<th>Data Services</th>
<th>Data Marts</th>
<th>Data Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Legacy OLTP (On-Line Transaction Processing) Systems</td>
<td>- Data Extraction</td>
<td>- Data Translation</td>
<td>- Relational DBMS (database management system) (3NF) (Third Normal Form)</td>
<td>- Data Subscription Management</td>
<td>- Data Marts Delivery and Scheduling</td>
<td>- ROLAP (Relational On-Line Analytical Processing) Query Tool(s)</td>
</tr>
<tr>
<td>- External Data Suppliers</td>
<td></td>
<td>- Data Quality</td>
<td></td>
<td>- Data Extraction</td>
<td></td>
<td>- Reporting Tool</td>
</tr>
<tr>
<td>- ERP (Enterprise Resource Planning)</td>
<td></td>
<td>- Data Transformation</td>
<td></td>
<td>- Data Mart Delivery and Scheduling</td>
<td></td>
<td>- Intranet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Data Cleansing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Staging Area and Posting Schema</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Enterprise Metadata**

- Warehouse Architecture and Infrastructure (Repeatable Processes)
- Operations and Administration
- Scheduling and Event Management
- Change Management, Standards, Performance, Exception Management, Audit, Logging, Security

**Platforms (Legacy, Unix Mid-Tier, Web, Client)**

**Key Technical Elements about This Architecture:**
- Processes are engineered to be easily reproducible across multiple data marts.
- Consistent design methods allow the data marts to change and grow with the business.
- It can support multiple tools simultaneously, including Web-based services.
- Its integration with the existing infrastructure allows its rapid assimilation into the environment.
A look at the technical side, continued

Building the right processes was our main goal. We wanted to use consistent design methods and multiple, open tools. We used a product called Business Object as the key tool for the front end, where a user constructs reports and queries. We built our database with Oracle, and we run it on an IBM NUMA-Q machine.

We wanted our system to be compatible with a wide range of platforms, which would make it easy to swap different platforms in and out. We therefore used an open platform so it would run on mainframes, middle-range boxes, and PCs. This also let us integrate our existing infrastructure with that of any other large company.

Small applications feed our data warehouse. We take in POS data from our customers through the web, via either Netscape or Internet Explorer, and feed that into our Oracle database. Then we extract the data, and it’s ready for use on PCs or via an internet browser.

Across all the processes you have to keep an eye on metadata, which is a data dictionary or glossary. In simple terms, it’s data about data.

The key thing is to make sure your technical architecture is able to grow with the business as it grows. After all, mergers and acquisitions never stop. Your business may shift, so you’ve got to be ready to grow with it.

Before we began this project, our company had seven major order-management systems. These were derived from the seven divisions our company used to have: (1) stores (retail), (2) manufacturing, (3) transportation, (4) consumer brands, (5) diversified brands, (6) automotive, and (7) corporate. This project reduced them to just two. As you can well imagine, dealing with data integrity and commonizing data were huge tasks for us—and they were immense accomplishments to achieve.

We did these tasks internally in partnership with Sequent, a small company that specialized in data-warehousing applications, high-end boxes, and large amounts of data. (They have since been purchased by IBM.) We couldn’t do these tasks ourselves because we didn’t have the expertise we needed in-house.

Sequent/IBM had data warehouse experts, and we built a team together. They had an architect, a project manager, and some developers/programmers, and we did the same thing on our side: We had our own project manager, architect, and developers/programmers. We also had a person who concentrated totally on the data—commonizing it and raising issues about what he saw in the data that the businesspeople didn’t know about. There was also a Sequent/IBM person who did that. The reason we did these tasks in this manner was that we wanted to make a good knowledge transfer while still retaining control of the whole project.

Immediate business benefits

We saw many immediate business benefits as a result of our data-warehousing project. As mentioned earlier, first and foremost was that we now had a single data repository for integrated supply-chain management. Thus, there was one central place to go for answers, rather than seven different places. This made life much less confusing for our sales analysts and executives.
Immediate business benefits, continued

Other benefits included the following:

1. We were able to expedite successful mergers and acquisitions. We could bring data about new business acquisitions into our data warehouse after applying our rules and processes to that data. We could feed the data into the warehouse as newly defined business and technical metadata terms to quickly integrate that new business. Then we could get a single view of the entire company with that new business in it.

2. Our data integrity improved. In some cases we previously had had as many as fifteen different representations of the same customer.

3. We built the foundation for CPFR with our customers. We plan to start sharing forecasts in an automated fashion (i.e., via computer) with our customers.

4. We built a foundation for our category-management and customer-relationship-management (CRM) efforts. Our executives expect each business unit to do that with its set of customers.

Innovations resulting from the project

This data-warehousing project resulted in many innovations for us.

• We now have a single view of our customers and products across diverse divisions of the company.

• Contribution analysis imposes direct charges, allocates overhead back to a sale, and permits us to create a scorecard of a sale’s profitability. Not many companies do this. In addition, because we have access to POS data, our salespeople have an incentive to get our products moving off our customers’ shelves. Thus, they are motivated to give our customers more of a push to sell our products instead of letting the products sit in the back room. Our salespeople are now paying attention to inventory and shipments because these factors affect their paychecks.

• Reconciliation of legacy systems from the warehouse allows us to supply a “single point of truth.” All the data is now collected in one repository, which means there is no longer any need to have separate spreadsheets or to write programs that enable us to combine data from multiple sources. In addition, all the data is validated and triple-checked for accuracy. As a result, the accuracy of our data is greatly improved, and data retrieval is easier than before.

• This project was a catalyst for process change. When we started going through our business requirements and defining our processes, it started out just like every other joint application development (JAD) session our businesspeople had ever been through. As a result, initially it was not met with much enthusiasm. But eventually our executives grabbed it, and each of them said, “This is my model. This is my business.” Then our project team stepped back, and the businesspeople drove the whole effort, taking ownership and pride in it. It’s just a beautiful thing to see that happen because that’s the only way to be successful.

• Our data-warehousing system was designed to be expandable up and down the supply chain. We are still adding more data marts at all points along that chain.
Innovations resulting from the project, continued

For instance, we want to do a Freight Analysis Mart, which will concentrate on several issues, including how much we spend on freight to move product; traffic and freight management in our operations area; the warehousing system itself; plant deficiencies; and issues about our truck fleet.

- We were able to cross-link existing dimensions to form new ones. For instance, we took a sales territory and a brand and combined them to create a job definition for one of our salespeople. We also took two data warehouses and combined them to get a third operational entity, called an operational data store, that we can feed back to other operational systems. In other words, the data store created a “new” piece of data that none of our systems had before and that we now also use in our organization’s non-data-warehousing systems.

Overcoming common problems

During the course of this project, we had to overcome some common problems, including the following.

1. Data commonality problems, which I mentioned earlier. We are still working on those now. We’re asking such things as “Why do we still have fifteen representations of Wal-Mart in our system?” There’s multiple stores, but just one buying group. Another question we’re trying to answer is “Why does Wal-Mart have to complete six POs to get just one order from us?”

2. We experienced sweeping organizational changes during the course of this project. We also had many detractors when we were working on it—people who said it wouldn’t work, called it a crazy idea, and questioned why we were spending all that money to do it. The organization was going through changes as we continued to work on the project, but our main purpose always remained the same: We sold products to our customers through some kind of sales territory. We always focused on that purpose so that no matter how the organization might change in the future, we would be able to deliver that view for everyone in the organization.

   Each time our company created a new division or went through a reorganization, I went to the person in charge and asked, “Do you want our team to continue working on this data-warehousing project? Does it even make sense to keep going?” Fortunately for the company, they said yes every time.

3. We had to avoid “scope creep,” which refers to being unable to manage the size of a project. To keep our project under control, we started out by asking our business leadership specific queries about what was keeping them up at night and what made them successful. Then we built our warehouse in phases. Once the first phase was completed, we were able to build on the foundation of that first phase and were soon able to show actual deliverables.

4. Training, awareness, and reconciliation issues. These were big issues for us because we’re such a financially driven company. The comptrollers in the separate divisions of the company are the ones with all the power. Even the salespeople always look at the profit-and-loss statements and analyze the business based on them.

As we worked on this project, we were asked to reconcile everything back to
Overcoming common problems, continued

the ledger, which was impossible. This project wasn't designed to match the P&L; it was built mainly for sales and marketing, and it was designed to identify trends.

The salespeople should have been using the data warehouse to see trends, not to try to balance. (That's just the nature of our culture.) But, again, our data warehouse enabled everyone in our organization to get the whole view of just about everything, from financial data to operational data, across the supply chain.

One problem area we are now working on is those parts of the company where “co-opetition” is occurring. For example, if Sears has to raise its sales and profits by 15%, how will that impact our Sherwin-Williams stores? Our Sears paint is a great product, and its sales are doing very well. But nobody has stepped back to take a single view and ask how that product has impacted some of the other areas of our company. Managing that kind of complexity is one of our next challenges.

The project’s positive impacts on the company

This project has had several positive impacts on our company. In addition to winning the Best Practices in Data Warehousing Award in 2000, we saw a $30 million annual profit increase after we implemented our data marts. It’s a beautiful thing to see the executives embrace a project, take ownership of it, and then start selling it to the entire company for you by saying, “Look at the payback we got.”

We were selected as a Wal-Mart Supplier of the Year in 1999, and, as mentioned earlier, in 2000 we were named their Category Captain for the paint department. Being able to see your competitive data on the same computer screen as your sales, out their door, separated by their categories and their sales regions, is just an incredible thing for us.

Becoming the Category Captain at Wal-Mart also enables us to collect data about our competitors. We can then use that data to produce scorecards to show Wal-Mart how we are performing in relation to our competitors.

Wal-Mart also presents challenges to us. They’ll say, “How are you going to increase your premium line of products by 15%?” We have to tell them how we plan to do that. And we have the scorecards right there to show how we will do it.

Looking to the future

This year we are in the process of converting our remaining two major order-management systems into one new system. We’ve come a long way by reducing our original seven systems to two, but these two systems have different kinds of data representing the same products. We need to reduce it to just one system.

For the future, we are considering the following projects.

• Target marketing, which involves going after a specific demographic of customers (e.g., female paint shoppers or people who buy paint in college colors, which are popular in certain geographic regions). Our customers constantly strive for that, but it’s expensive. I don’t think we’ll ever get there, but we will keep trying.

• We are considering store-level vendor-managed inventory. Everybody has done VMI, but to do it on a per-store basis is an ambitious goal. For starters, there
Looking to the future, continued

are 2500 Wal-Marts and 2400 K-Marts. Can you imagine attempting to manage every single one of those stores individually? We are also working on managing regions as they are defined by our customers. Wal-Mart, for instance, defines its sales regions by weather patterns.

- A strategic project of ours is to build an integration backbone. We are using IBM’s MQ series and some brokers to create a hub-and-spoke way of moving and integrating data. Before we began our data-warehousing project, we had systems that were pointing to every other system. If you draw such a configuration, it looks like a bunch of spaghetti. An integration backbone delivers data to a hub just one time; then all that data can be subscribed to by everybody else connected to that hub. At the core of an integration backbone is a well-organized data warehouse.

In a hub-and-spoke environment, IBM’s MQ series is the broker piece, or the hub. It’s the part that has the intelligence; it knows where to put the data. We’re using IBM’s tools to build this environment for moving data, but the important thing is that we’re building it ourselves. We’re using the “best of breed” tools out there, but we want sole ownership of what we create.

- We are also doing e-procurement now with a company called DataStream for those raw materials that are our maintenance, repair, and operations (MRO) items (i.e., what we need to keep our plants running). This does not pertain to core raw materials for our products.

- E-business is another area of interest. This is where one of our suppliers—say, DuPont—asks us to provide them with information from our data warehouse online. Because our companies are both web-enabled, it’s very easy to do that.

We have a lot of web interfaces for our customers who know how to use them. We also have laptops that they can use, or they can ask for help from the sales analysts and administrators at our headquarters. Each one of these staff members covers between fifty and 100 customers.

The retailers with which we do business, on the other hand, haven’t done that; their cultures are different. Wal-Mart, for example, worries about IT. They build systems to feed their suppliers data, and they build relationships. But they don’t want to be “store people.” Sears, on the other hand, does. They carry suppliers’ products in their stores, but they want to do all their own marketing. Home Depot’s approach, meanwhile, is to train every employee in each department in every store to the point where they are all highly trained people who can cut their own POs. And we have to be flexible enough to be able to handle all these different approaches.

- We are now looking at using portals. With portals, multiple systems located in various places in a company are combined, and their output is shown on intranet-based screens; a user has no clue where in the company the data he/she is looking at is coming from. But to that user it doesn’t matter; it simply looks like a regular computer screen to him/her.

- Pay-for-scan is another concept that we are exploring. This is when retailers regard their suppliers’ products as consignment inventory. In other words, the
Looking to the future, continued

supplier’s products that are sitting on a retailer’s shelves are considered to be under the supplier’s ownership until a customer purchases them. As soon as a product is scanned at the register, the retailer’s financial system is notified to pay the supplier for it. At this point the retailer recognizes the product as inventory.

- Balanced scorecards. Devised by Harvard Business School professors Robert S. Kaplan and David P. Norton, balanced scorecards are collections of leading and lagging indicators covering each key component of success: financials, people, operations, suppliers, customers, and support systems. They show where an organization is going as well as where it has been. I don’t think our company’s management has recognized the real value of them, but it would be nice to see them used more.

Building a competitive advantage

At Sherwin-Williams we are trying to get back to the basics as a company. What we have uncovered with our new data warehouse are little things, such as glitches related to billing our customers. For instance, we had a new comptroller walk in and ask, “Are we billing everybody?” It took us six months to investigate our procedures and confirm that we were indeed billing everybody. Now our company is working on answering another question: “Are we collecting the money?” We’ve spent three months working on finding an answer to that, and we still don’t know yet.

Our strategy is to build what we think is a competitive advantage. With our data warehouse, we’ve got some great data aggregated in useful ways. We believe that being able to move data quickly is a huge advantage because it will give us many opportunities in the future. We are ready right now to present data to any one of the major retailers in any manner in which they might want to see it. That data is our company’s heart and soul.

For further reading

For more information about CPFR, visit www.cpfr.org.

Author information

Jim Revak has been a project manager with data-warehousing technologies for seven years. He has managed three enterprise data-warehouse projects, two of which were recognized as Best Practices in Data Warehousing Award winners by the Data Warehousing Institute. His focus is on developing applications for supply-chain improvement, ranging from manufacturing and distribution to retail.

Editorial assistance for this article was provided by Cathy Kingery.
Implementing a 360° View of the Customer

Giri Durbhakula, Global Programme Director of Knowledge Management, Gateway, Inc., San Diego, California

Gateway evolved using a strategy centered on customer satisfaction. In the process the company developed a system that allows us to create a 360° view of the customer and see them beyond a database number or an isolated transaction here and there. Today's economy mandates strong customer service. A company must master customer knowledge management and operational knowledge management to successfully create and leverage the 360° customer view for a sustained advantage and a positive customer relationship.

The strategy is centered on our being the client's trusted guide (Figure 1).

Figure 1. The Pillars of Our Overall Strategy.

- Unsurpassed Understanding of the Client’s Needs
- Technology Leadership in Integration and Innovation
- Competitive Pricing Achieved Through Creative Design and an Efficient Engine

The Bottom Line: To Be the Client’s Trusted Guide.

Gaining the customer's trust requires Gateway to focus on understanding the client’s needs, creating innovations in technology and services, and setting a price reasonable to the consumer and to our bottom line. By understanding the client's needs we can surpass their expectations. As clients’ needs always evolve, we constantly try to determine what our clients want before they do and have solutions ready when they approach us with these new needs. Furthermore, we must be the innovator and not the laggard in generating new technologies and ideas that our customers will want. Finally, we need to set a price that generates a profit while simultaneously attracting customers.

The economy and culture have shifted a business’ emphasis from solidifying brand recognition to focusing on the customer. Some companies have even added a customer equity section to their mission statement or even their annual report. Business has changed from being manufacturing based to being customer based. Diminishing product margins are one of the challenges in the technology industry. As computer prices decrease, we are looking at profits beyond the PC. We offer our clients special promotions and offers as a way of showing we care about them. We feel excellent customer service will keep consumers coming back to Gateway. Acquiring a
new customer costs more than retaining an old one. A minor increase in customer retention can increase profits as much as 40% or 50% or more; hence the importance of understanding our customers and their needs. Customers who have been with us from the beginning tend to buy more and stay with the company longer. Customer service is vital in today’s market, but it is becoming increasingly difficult as we encounter shifting demographics and constantly evolving customer needs (Figure 2).

Figure 2. Background Statistics.
- It is five to ten times more expensive to acquire a new customer than to retain an existing customer.
- A 5% increase in customer retention can increase profits 60% to 100%.
- Long-term customers buy more, take less of a company’s time, and are less sensitive to price.

Personalizing customer interactions using timely and accurate personal information is vital in creating a 360° view of the customer. We must establish customer intimacy and humanize an account so a consumer is not just another number or transaction. The idea is to get to know a customer individually, based on previous buying patterns, demographics, number of family members, number of pets, and other personal information (Figure 3).

Figure 3. Key Drivers of Our Customer-Focused Strategy.
- Have more current, timely, and accurate information about the customer.
- Gain customer intimacy.
- Create specifically tailored profiles and products for our customers (e.g., 1:1 interaction).
- Personalize content based on customer profiles—products, offers.
- Help ensure consistency of experiences across entire customer experience
- Help manage customer consolidation of accounts.
- Our formula:
  1:1 Customer relationship management
  + Personal and relevant content management
  + Intimate customer interactions
  = Increased personalization and focus on customer.

Knowledge management defined and detailed

However, this personal information is useless unless the knowledge is managed correctly. Knowledge management involves turning raw data into information and information into power once we know how to use it. Gateway evolved its knowledge management system to better serve customers. Customers who interacted with Gateway in the past, via our telephone sales representatives, the internet, direct retail outlets, and support teams, encountered manners that were sometimes confusing to the customer.

The system failed to create a unique customer ID across the various touch points. Misspelling one customer’s name could have created seven different database
entries for that person. Although the issue seems minor, it was creating poor customer service. We called each entry’s phone number and sent catalogs and mailings to each address. Receiving seven Gateway catalogs irritated the customer and caused us to waste time and money attempting to reach that consumer six additional times. This further tends to alienate our customers. We needed to create unique customer ideas across all channels, regardless of where they bought their computer or the number of times they contacted our support team. Lacking a unique customer ID created unnecessary costs and wasted time.

To create a 360° view of the customer, all of a business’ management levels must contribute to the effort. At Gateway, we need executive sponsorship so executives know what they are responsible for, signing off on, and reviewing. Executives must also understand that they are responsible for funding and for committing resources to a project in a timely manner. We need our employees to communicate their business logic behind a certain business plan or technology. We find that the logic is often only in someone’s spreadsheet or in someone’s head. Without the data to support a new endeavor, creating consumer technology is very difficult. Companies need their employees to come to the table with the data, and be able to explain why a certain plan or strategy is necessary or better.

We also need our employees who interact with the customer to articulate their needs. A business needs to know not only a consumer’s current concerns, but also what their needs will be in the future. We do not want to design a system or an environment that is obsolete in a few months. Employees must provide requirements for a new technology and be engaged in key aspects of the project, such as user acceptance testing, implementing the pilot system, signing contracts, and essentially all key project management decisions.

From the knowledge management team side, we need to communicate and integrate a company’s business analysis, strategy, and methodology with all of its employees. Gateway has an organization design department responsible for designing and implementing internal communication strategies in the form of a corporate newsletter or via the internet. Their efforts ensure that Gateway’s message reaches the entire company. Engaging all management levels in a project, from information technology to communications, provides tangible results early on and helps confirm if we are on the right track. The key is to communicate with each department often and frequently. This strategy has worked at Gateway, with the final result being a more complete and accurate customer view.

Expanding on the theme of knowledge management, customer knowledge management is another key component is establishing a 360° view of a client. This entails managing the information we have on our customers in a usable format (see Figure 4 on next page). Gateway wanted a single source that gave us an unsurpassed understanding of our clients’ needs. The data needed to be available, accurate, and easy to personalize as well as analyze. Ultimately, customer knowledge management
Adding the customer to knowledge management, continued

comes down to executing and managing customer interactions in a timely and effective way. We needed to create personalized implementation strategies, frequent buyer programs, loyalty programs, and one-to-one marketing, and anticipate when the customer may want to renew a warranty or take a computer course. Again, anticipating these contributes to the 360° view of a customer.

Customer knowledge management hopes to answer questions like these: What are our customers buying? Why and why not? Who are our customers? The knowledge we need is not only their identification numbers but who are they really; what are their names, what are their buying patterns, what are their interests, what are their preferences, how can we get them to buy more, and how can we get them to stay for life? If they were our customers before, where did they go, why did they leave us, and how can we get them to come back? How can we increase our customer base and be more personal with them? One of the more important questions is what channel is most effective in reaching a consumer? If we know a customer likes being dealt with via the web or prefers talking on the phone, we will design a particular strategy comfortable for that consumer. We want to take our transactions to the level of personalized interaction.

Our customer knowledge comes directly from our clients through retail stores, direct mail catalogs, telephone, and the web. We take the information gathered from a transaction and enter it into a massive database, nearing some 3 terabytes in size. Some of the fields at the beginning levels include what a customer bought, when they bought it, what kind of modem their hard drive has, did they get financing, and did they get training. This information gives the company an opportunity to cross-sell additional products or services to a consumer at a later date. This detailed information is crucial to have a better understanding of a client’s needs. We also obtain external information from third-party providers about a customer and his or her company if it’s a corporate customer. We know if they run a small or medium-sized business and the location of their headquarters, so we can customize a marketing strategy for the local mom-and-pop shop up to a multinational company. For an individual consumer we have their name, their wife’s name, their child’s name, how
many pets they may own, their ethnicity, rough income, and purchase pattern behavior. Possessing all this data allows a company to create a 360° view of the customer and create a personalized marketing strategy to reach them at an individual level as well as cross-sell and up-sell to a consumer.

Cross-selling involves getting a consumer to buy additional products to complement products or services they already own. If a customer bought a printer we may cross-sell him/her a digital camera. Up-selling involves selling a consumer a more powerful product than the one they currently own. If a customer bought a 5300 laptop, we would up-sell him/her the 9300 model, which has more RAM, or other additional features.

Combining our 360° customer view with cross-selling and up-selling allows us to implement individual marketing campaigns. If a customer attended a computer training class in our store we would send her information on a training class that her seven-year-old girl may enjoy. If we know they like to be dealt with on the web we will e-mail promotions to them. For the customer who prefers retail stores we would mail him/her information about a new store opening and offer him/her a gift to get him/her to the store. Once the customer is there he/she will play with the computers, and we may have his/her children watch a Disney DVD, play an educational software game, and maybe purchase some more from Gateway.

Retail store experiences offer a unique opportunity to capture the behavior about a consumer’s experience there. We track the positive interactions in addition to the negative interactions. We learn a lot from the negative experiences, so the next time we interact with a customer who had a bad retail experience we will try to improve his/her next visit to the store. We may not let the same associate who talked to a customer last time meet with that customer on the next visit. Sales associates take notes on a customer’s experience and Gateway also sends out observers in peak rush times to note peak traffic times and behavioral patterns, and watch the store’s overall flow. The information obtained from the associates and observers is then entered into a database and studied. We have a “suppression database” where we store this type of information. The retail store information helps us determine peak rushes and predict models and behavior so we know how to do better next time. Retail experiences also help us gather information about what type of person each customer is: Are they a business executive? Are they living in California? Are they living in Boston? Do they like games? Do they like cameras? This data adds to the complete customer view and helps determine what kind of a treatment we have for them as a customer.

The old direct marketing method involved our planning and designing a campaign, and sending it to the vendor who would execute the campaign and hopefully generate sales. Our ability to track the campaign’s effectiveness was poor because we lacked the ability to properly capture the information. In addition, the timeliness of the data was usually three to four months behind, and had questionable usefulness. Now with a 360° customer view we can take a holistic view of the...
Marketing before and after the 360° customer view, continued

situation, develop a personal contact strategy to interact with the customer, plan the campaign, create a list of customers for the campaign, and execute the entire project in-house. We can analyze the campaign, learn from the experience, and then formulate another campaign. The customer data is now updated on a weekly basis, giving us much more capability than before. This information allows us to put together customer-tailored offers while answering questions for us, such as did we lose money on this? Did we get our results? What can we learn for the future? What were the best channels? In what season was the campaign most effective? What channel should we use: e-mail, direct mail, or catalog? Our new campaign process starts with analyzing and planning followed by design and communication, and it ends with tracking and feedback. By basing a new campaign on previous purchase patterns, we can bundle products more effectively.

The operational side works a little differently than the marketing side. The operational side focuses on how we are supporting employees and our performance in the retail stores, on the web, and in the telephone centers. The main idea with operations is to proactively manage the business before something bad happens. This means making sure store inventory is not running low and trying to figure out why a store may not be selling as well as another store in the same area. The 360° customer view helps make sure we are responding to their needs at the operational level and on a one-to-one basis. The data tells us how we can better outfit our staff to improve customer service, if the consumer is satisfied, and how we can improve operationally. We want to improve our decision-making capabilities in a proactive manner to result in a happier customer base. The data on the operational level is updated every thirty minutes, which means we do not need to wait until the end of the month, week, or quarter to know how we are doing and implement a plan to improve (figure 5).

Figure 5. Operational Knowledge Management (OKM): What Is It?

- A comprehensive source of sales, support, and plan information
  - Drives targeted marketing, sales, and service activities in a more real-time and personal manner
  - Enables better understanding of sales/support techniques
- Channel effectiveness
  - Evaluation of effort per sale over time
- A method of improving
  - Sales technique effectiveness
  - Productivity
  - Discounting techniques.

The data has multiple uses at the operational level. By updating the reports every thirty minutes we track how a store is doing in meeting its sales quotas on a day-to-day basis. This allows us to know if a store is going to be behind or ahead of their forecast before the end of the selling period. The information answers questions on how store traffic compares to store revenues. Increased traffic does not equal...
increased revenue. This allows a company to gather more information on what is actually happening in a store and how we can be more proactive about the situation. The data can be used to change a company’s behavior. We can see what representative is not meeting his/her quota and maybe offer additional training or have the top sales representative from a store talk to his/her co-workers about the sales knowledge gained. Modifying a company’s behavior with the customer data can improve sales effectiveness and productivity at the operational level, and this improves our ability to better serve our customers (figure 6).

Figure 6. With OKM, We Are Addressing Five Questions.

1. How are our sales reps doing? Right now? At the end of the day?
2. What do we need to do to enable them to serve our customers better in a more personal and timely manner?
3. Are our customers satisfied? Why? Why not?
4. How can we improve ourselves operationally?
5. How can we improve our decision making to obtain a happier customer base?
6. Which channel is the most effective?

The end result of creating a 360° customer view is the belief that one customer is not more important than another. We want to treat each consumer as an individual and as if he/she is the only thing that is important to us right now. This applies to both our residential and commercial customers. We now have greater customer intimacy and can do much more for our customers in terms of better service, products, sales, and support.

Author information

Giri Durbhakula has over fourteen years of experience in the information systems industry, with emphasis in Data Warehousing and Decision Support, Customer Relationship Management (CRM), Knowledge Management, and Business Intelligence.

As Global Programme Director of Knowledge Management at Gateway, Inc., Giri is responsible for Knowledge Management, Business Intelligence, and Data Warehousing. Prior to this, he was employed at Ernst & Young LLP within the management consulting practice, where most recently he was the Midwestern Region Data Warehouse Practice Leader. Prior to this, he was employed at IBM Corporation in a variety of managerial and technical positions, primarily within Global Services and Sales/Marketing.

Mr. Durbhakula has industry experience in a number of areas: high tech, consumer products, manufacturing, telecommunications, cable, managed care, finance and credit card, life insurance, agricultural/chemical, retail, state and local government, federal government, utilities, higher education, and other forms of commercial enterprises.

He has a B.S. degree in Electrical Engineering with a minor in Applied Mathematics, and a Masters in Management Information Systems from Washington University. In addition, he has attended numerous executive education seminars and industry/subject-matter related seminars. He also has spoken at a number of leading conferences and seminars such as DCI, Business Intelligence, Informatique World Conference, and many others. He has received numerous awards, including CIO Magazine CRM Top100 for 2000 and the Informatique Very Large Database Award.