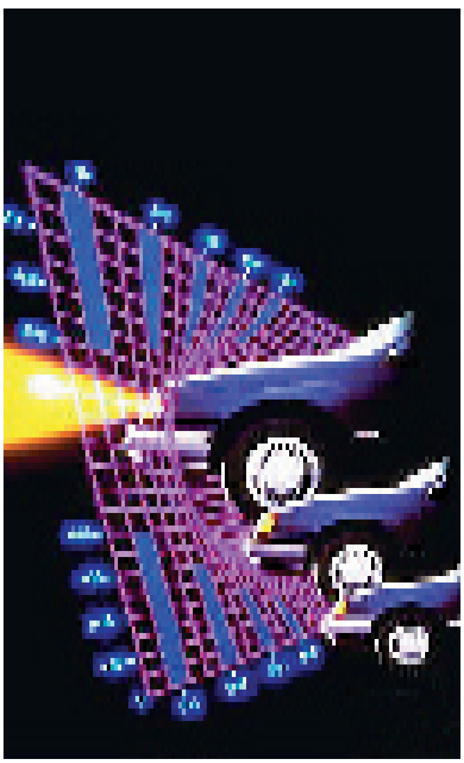
DVR Consulting, Inc.

231 Market Place Suite 621
San Ramon, Ca 94583
Cell 925.487.0214
Work 925.829-9484
www.icdremediator.com

Article written by 4D about DVR Consulting, Inc.

New United Motor Mfg. - written by 4D

General Motors constructed their Fremont, CA plant in 1962 when competition from foreign imports was almost nonexistent. At the time, the United States automobile industry dominated the world market and the GM factory prospered under such conditions, employing over 6,500 employees who produced an average of 300,000 automobiles per year. In 1978, however, GM's decline at the factory began when company sales decreased as foreign imports gained a greater share of the U.S. market.



Simultaneously, the plant was plagued by union-management strife and a profusion of disciplinary infractions which resulted, at an extremely high cost in labor time, in the production of inferior quality automobiles. Ultimately, economic pressures forced GM to close the operation in 1982.

In 1984, GM was able to reopen the factory with Toyota as a new partner, creating a revolution in cooperative automobile manufacturing. The joint venture was named New United Motors Manufacturing (NUMMI). Toyota's goals in the venture were to gain an understanding of American unionized labor that would be beneficial to future business dealings with the United States and to alleviate trade tensions between the two countries. While learning the American manufacturing system and employing American laborers, Toyota consequently saved money on export tariffs.

GM's goal in the partnership was to learn successful Japanese management and production techniques. The American company also benefitted from the enterprise by acquiring a first-rate automobile similar in style to the high-quality and popular Japanese products.

The three types of automobiles manufactured at the plant are the Geo Prizm, the Toyota Corolla and the Toyota truck. By the end of this year, 320,000 vehicles will be made at NUMMI.

In 1984, 80 percent of the employees hired to work for NUMMI were the same workers who had been laid off in the 1982 GM plant closure. Under improved management practices, disciplinary problems have been dramatically reduced and the automobile-per-worker production ratio has risen considerably; this being accomplished with virtually the same work force that burdened GM's previous system. The differences are direct results of innovative new management policies that now characterize the company.

Toyota provided personnel to fill the two top positions at NUMMI. Although strain originally occurred because of diverse decision making approaches and planning procedures—Toyota managers typically plan for long-term results while GM managers had planned for short-term solutions—the two dissimilar companies now work together in a precedent setting venture. The joint enterprise is so successful that it has been made a prototype of labor-management collaboration by the International Labor Organization.

This honor is partially due to kaizen, one of the company's guiding principles. A Japanese term, the word means the search for continued progress and perpetual improvement through a consensus-based decision making process. This concept allows the employees themselves to participate in the arbitration of new procedures.

Another important contributor to the efficiency at NUMMI is the assembly line computer system applied in 1989 to solve the encumbering tally sheet method used earlier. The tally sheets were legal sized papers listing principle automobile items to be checked and containing a grid on which inspectors marked each defect. Each paper traveled with its corresponding vehicle to the next area where repair personnel reviewed the defect tally marks and performed necessary repairs.

The confirmation group then verified whether the defects had been properly fixed. This process used daily tally sheets to report the number of defects found on general areas of the automobiles for a particular day. Weekly sheets were employed by team leaders to tabulate the total week's defects. Tally sheets were such an obstacle to competent and rapid production of automobiles that leaders at NUMMI urgently needed a powerful and reliable solution.

Challenge On The Assembly Line

Each inspector at NUMMI examines 470 vehicles per shift. The inspector has 60 seconds in which to check over 100 items on every car. The tally sheet process was slow and inefficient as pages were often misplaced or damaged. At the end of the month, the papers were stapled together and filed in a box to be stored in another section of the building. To track a defect, an engineer had to go to the storage area, find the particular box and search through the papers to obtain pertinent figures. Any reports or graphs necessary had to be produced manually.

Team leaders, who were paid overtime, counted the tally marks to create a report that was eventually available after the shift had ended. This represented a significant amount of money spent on overtime hours. "It used to take us hours," says Frank Maldonado, the NUMMI LAN administrator and ex-team leader. The team leader had to go to each station on the assembly line (which is 1.3 miles long) and, for an hour or more, copy the tally marks, add them up, find the top three defective items, and create a daily report of the results. This caused, says Group Leader Hal Campbell, "a tremendous amount of homework time" for the workers who tabulated the reports.

Although defective cars were repaired, this system lacked the capacity for prompt and specialized information processing. For example, hundreds of vehicles could be impaired by one repetitive flaw before management discovered the widespread problem and remedied the situation. "What these guys are looking for is very specific," says developer Don Von Rotz, "it's not like 'is a door missing?'" An individualized computer application was necessary that would not only show in minute detail each item on the vehicle, but could also work quickly enough to maintain the vital assembly line pace.

Besides consuming time, the tabulation process provided no way of tracking defects. Cathy Kirstein, an inspector on the new truck assembly line, reports that the tally system "didn't give you the right defect. It would just say 'part missing,' but it didn't say what part was missing." Detecting the source of the defect is important to prevent future flaws from occurring. With the tally system, work was slower and more frustrating for the inspector who continually reported and repaired the same recurrent defect without being able to pinpoint the source of the problem.

Choosing The Consultant

Upon the reopening of the plant, NUMMI managers decided to eliminate the tally sheets and introduce computers to the assembly line. Their goal was to save time and money and to manipulate statistics in a manner which would ultimately improve automobile quality. Many companies vied for the NUMMI contract to solve the inefficiency problems existing at the automobile manufacturer. However, the systems suggested by all but one of the competing firms were not only extremely intricate and difficult to use, but their software was viewed as unable to fulfill NUMMI's needs. DVR Consulting, a firm specializing in designing innovative client/server applications, presented a solution that was readily seen to be quicker, easier to use, and offer more flexibility and reliability. As a result, NUMMI decision-makers decided that DVR Consulting was the right firm to head up the project.

DVR President Don Von Rotz and his team, which included Fred Radley and Bill Hawes, built a prototype exemplifying workstations that could be installed on the assembly line. His platform choice was that of the Apple Macintosh.

"Usually I try to exceed expectations and I can do that with the Mac. It's great because with the Mac, you can come in with a presentation that's better than anyone else's." With his Macintosh and 4th DIMENSION, Von Rotz created a winning combination of versatility and power.

DVR Consulting, explains Von Rotz, was chosen since it "was the only one who was able to show them what they wanted and we did all this in 4th DIMENSION." The interface and relational capabilities of 4th DIMENSION enabled Von Rotz to enhance his data management system. Those capabilities, combined with 4th DIMENSION's ability to store graphics within the database and create custom applications, convinced Von Rotz that ACI, ACIUS, Inc. was essential to his solution.

Frank Maldonado immediately recognized the indispensable qualities of 4th DIMENSION. The other software programs he was shown were not able to provide his group with the graphics and speed required on the assembly line. He decided to implement Von Rotz' suggestion after seeing 4th DIMENSION's picture fields and scripting capabilities since they were as unique as what he had envisioned for his solution.

One of Maldonado's specifications for the new application was that a person without computer knowledge could learn it quickly and understand it well enough to use it effectively. He believes that DVR's choice of 4th DIMENSION fulfills this prerequisite well. "I love 4D because it's easy to use," he says. "It's logical; it makes sense to me." Von Rotz maintains Maldonado's support of 4th DIMENSION. "With 4D," he says, "a relatively non-technical person can use the data that's in the database and make it work for them."

Steering Through The Options

NUMMI's initial plan had been to emulate the Fujitsu computer application utilized in the Japanese Toyota plant. However, that system, which featured a touch-board with a changeable overlay similar to a McDonalds cash register, was extremely slow. This, among other obstacles, made importing the computer application to the United States prohibitive. Consequently, NUMMI managers opted for an original application. The subsequent solutions demonstrated before NUMMI used everything from bar code readers to complete MIS systems to touch screens. Maldonado was disappointed with them. "The other companies were having trouble with graphics," he says. Their pictures weren't clear, an aspect of vital importance when an inspector must refer to the screen to verify the exact appearance or position of an automobile part.

Another major problem with the various systems was that the screens typically redrew too slowly. According to Maldonado, every second to the inspector "is an eternity." When the equipment cannot keep pace with the workers, productivity suffers.

Although Von Rotz originally wanted to use a Hypercard-like interface, he recognized the necessity of having a database. Being familiar with 4th DIMENSION, Von Rotz admired its adaptable and graphic qualities. In addition, he perceived the value of 4th DIMENSION's Quick Report editor which builds immediate columnar reports with user-specified data. His choice of 4th DIMENSION would permit rapid, quality information management as well as allow for potential expansion and individualization of the system.

The Assembly Line System

"It works," says Von Rotz of the assembly inspection computer system, or AICS as it is called by NUMMI employees. "It doesn't create a new problem, it solves problems." AICS accommodates Von Rotz' preference for the Apple Macintosh and 4th DIMENSION. At the center of the application is a DEC VAX 11/750 mainframe connected to the master console via DEC PathWorks file sharing software. The VAX sends automobile information such as sequence number, model, interior and exterior color, and options to the master console which consists of an Apple Macintosh IIci.

Every thirty minutes, the VAX sends a new file to the master console. The file is automatically imported in background with 4th DIMENSION to the server which is an Apple Macintosh IIƒx using AppleShare and a Hammer 300 megabyte drive. These elements are connected by the Ethernet network.

To print, a FastPath gateway is used in conjunction with a QMS 820 laser printer and an Apple ImageWriter. Predesigned Quick Reports made in 4th DIMENSION are printed at this station to immediately inform the repair department of detected flaws. Each inspector's defect entries are automatically inputted into the database and team leaders periodically create Quick Reports using that data. Since these defect ratio reports are available at any time, repairs can be made before cars even leave the assembly line.

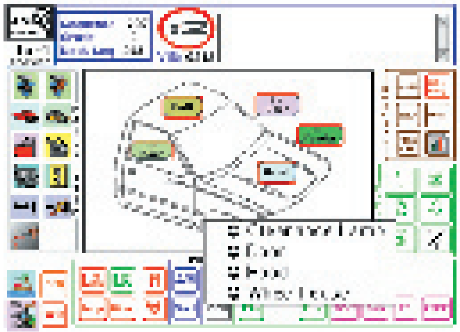
Each of the 23 workstations (6 on the passenger line and 17 on the truck line) consists of a Macintosh IIci with five megabytes of RAM and a 40 hard disk. The monitors are Apple 13" color fitted with touch screens from Troll. Since time restraints on the assembly line are such a significant concern, Von Rotz decided to forgo a keyboard in favor of such a touch screen. His primary condition for the screen, since most react only to porous surfaces, was its compatibility with a gloved user. The Troll was one of the few suitable solutions for the gloved NUMMI inspectors. Each screen uses 256 colors except at the confirmation center where, because photographs are displayed on screen, the monitors are accelerated by RasterOps 24-bit color cards.

In both the passenger and truck lines, the automobiles are examined by the inspectors, fixed by the repair persons, and verified by the confirmation group. An off-line confirmation center for severely defective vehicles exists for the truck line as well. Here, the screen contains scanned pictures of the repair person responsible for fixing a defect in order to link responsibility to a specific individual. In this area, the confirmation group can actually specify the reason for a defect.

Similar upgrade refinements are being added to the passenger line this year.

4th Dimension At The Wheel

Last year's AICS system contained records for 300,000 vehicles—a number expected to increase this year. This data utilized approximately 235 megabytes. These records were entered by users on 23 computers. Since the system is multi-user, certain precautions were taken in order to maintain database speed. Optimizations include storing data locally for each workstation and referencing the file server only if absolutely necessary. Numerous arrays created at launch time are essential to the design. The arrays are kept in memory to increase operation speed. Buttons on the data entry screen are grouped into five external areas instead of being controlled individually. Although operating on generic code, each station features a unique layout. The System Control File screen lists all the characteristics possible for the various workstations. Instead of creating new layouts for each screen, DVR Consulting has designed a single versatile layout on the Station Set Up screen which contains all the screen possibilities to be utilized in any combination. This option enables the designers to change anything at a workstation without entering the design mode and re-compiling the application. Depending on the needs of a particular area, sets of data entry buttons controlled by the same code can be mixed and matched to create new screens.



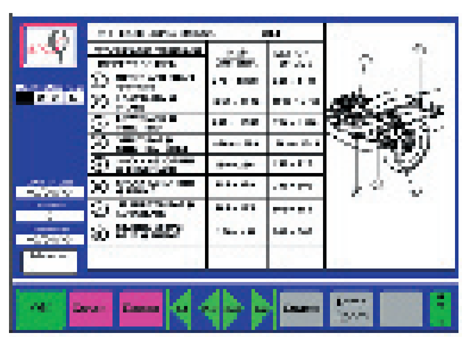
To log on to the system, the user must select the appropriate identification number listed on the screen and then enter his/her personal password. A security file in the database structure identifies each user, validates authorized access and tracks the time and date of activity. Each user is permitted three attempts to log on correctly and periodic reports are printed which detail the number of failed attempts at system entry. Besides preventing unauthorized access to the system, password control is important in tracing personal responsibility for each inspected and repaired automobile. After logging on, the inspector reaches the data entry screen. The NUMMI defect reporting process is basically a "next record," "previous record" system that allows the user to switch between records at will. Each record represents one vehicle. The graphic automobile identification system colors the car logo to match the interior and exterior colors of the car. Vehicles are further identified by their sequence numbers which appear both on the cars themselves and on the touch-screens. The sequence number of the following automobile to be examined also appears on the screen. These numbers are read into the database from the VAX and change automatically when the inspector pushes the Vehicle Logo button to progress to the next record.

Major Item icons change the graphic within the center, or Portion area, of the screen. The Portion area features detailed pictures of the particular automobile segment being inspected at that position. Layered buttons, related files in the database structure, further display secondary and tertiary part elements of the major automobile component. These minor elements allow highly specific defects to be reported.

The bottom section of the screen contains Phenomena buttons which specify the type of defect found. Such problems as "Missing," "Disconnected," and "Damaged" can be reported through these buttons. To avoid mistakes, certain phenomena are applicable only to certain vehicle parts.

To report a defect, the inspector presses three buttons: the Major Item to display the main vehicle component, the Portion to specify a particular part, and the Phenomena to classify the type of defect. To accelerate this reporting process, five Memory buttons are available to record specific defects and report those exact flaws when pressed again. Easily changeable, the Memory buttons can be reset by pressing a "C/E" button and entering information for the new problem. A defect confirmation scroll box lists all the flaws entered by the inspector to be reviewed later by the repair and confirmation groups.

Special buttons on each screen can be utilized for a variety of reasons. A Message button is provided to permit inspectors to send and receive electronic messages throughout the system. Pre-written messages such as "Shortages on this Vehicle" or "Hold for Engineering" can be attached to an automobile record. Additionally, messages to an individual station or a group of stations can be sent using this option.



A Delete Entry button is useful to modify an incorrect entry and a Previous Car button allows the user to recall a vehicle record for any necessary alterations. To view a graphic description of an automobile part, a Specification button exists for immediate, manual-free reference. The Help button gives information about various screen functions. The last of the Special buttons, the Station Activity Chart button, instantly displays a color coded graph of defects for an individual vehicle, a brand of vehicle, or even a certain colored vehicle. This option is simple to use—the inspector presses the screen only once—and it produces detailed graphic reports on the assembly line.

Two other data entry screen buttons are the Break and Log Off. The Break button displays a screen saver when pressed and, if the user logs on again, returns the data entry screen. The Log Off button chronicles employee working hours, exact vehicles checked during the shift, number of defects entered and amount of times the Help screen was requested.

A Skip button allows specific vehicle records to be placed aside in the case of a serious defect. To access these records, the Sequence button can be pressed to display a pop-up menu containing the sequence numbers of the skipped vehicles. Since this particular sequence number is the only non-repeatable number for each vehicle, this is the field by which records are sorted.

The NUMMI system has been installed for over six years and has been completely dependable. "It's an unusual application and it's not like an office setup. I mean, you're down for five minutes and five cars go by," says Von Rotz of the system's critical demand for reliability.

The Result: High Quality Automobiles

Says Maldonado, "We've achieved our goal which was to eliminate overtime, to generate accurate information, to provide real time data when needed and, using all of these, to save car quality." Both efficiency and productivity have been improved by DVR's application. Most importantly, however, is that the quality of the American-produced NUMMI automobiles has increased significantly.

Since reports can now be created at will, it is easy to publicize repetitive defects at an early stage. Consequently, necessary repairs and production modifications can be performed before additional flawed automobiles are manufactured. The newly implemented communication network between the master console and the workstations decreases the amount of future problems. According to Von Rotz, the system works because, "you're able to go through and detect defects much earlier because of the database and the ability to get information at will. So basically, you're able to cut back on the amount of defects because you have a way of tracking the quality."

Now that the system is computerized and is able to trace flaws at an early stage, the average defect to car ratio has improved 150 percent. After the first six months of installation, Maldonado ran a computerized summary that listed defects per vehicle per month and the graph showed a significant—almost 45 degree—decrease of flaws. NUMMI managers are pleased by results such as these which demonstrate a marked improvement of defect control and vehicle quality.

The system encourages standardized work by monitoring each inspector, thus ensuring that he or she is checking the correct car at the correct time. Standardization was implemented at the plant by the Toyota managers to guarantee that, no matter who is on the job, it is accomplished in the most efficient manner possible.

This increased efficiency has resulted in financial benefits for the company. The money saved by eliminating overtime is substantial. What used to take two people over one hour each to accomplish now takes one team leader less than 15 minutes. Time that was once spent adding figures is now spent tracing defects, an improvement that, according to Maldonado, helps avoid automobile recalls.

Now that the inspectors use the computers, they agree that the system works well for them. Says team leader W.C. Lee, "I think the computer system's great because it makes our job a lot easier." Lee maintains that the system was easy to learn, especially since NUMMI management consulted frequently with the inspectors and team leaders in creating an application that was completely personalized to the workers' needs. The training classes for new assembly line employees are two hours long. Hal Campbell, a group leader, reinforces Lee's opinion, "anyone who works with the system likes it."

Since the technology was unfamiliar, the management at NUMMI originally doubted the feasibility of the project. Now, however, they are pleased by the decrease in defects. Von Rotz qualifies the system's success in terms of his customer's satisfaction. "I think this thing has totally exceeded all of their expectations" he says. Initially, his group installed six workstations at NUMMI. Today, the total has reached 50, a number that will increase later this year. NUMMI is so pleased with the results that it has retained DVR Consulting's services to develop further uses of the system. "The initial thing was just a pilot and they were so thrilled with the way this thing was working that we just kept going," says Von Rotz.

Future Application Upgrades

Besides the upgrades on the passenger line, new enhancements of the system are being planned at NUMMI.

A new division to be added to the passenger line is vehicle performance. This innovation tracks if, at any time or place, the automobile has a performance problem. The 4th DIMENSION application for this sector will be more individualized for particular problems. Whereas the Phenomena buttons on the assembly line screens report problems such as "missing," "damaged," or "cracked," similar buttons in the vehicle performance screen will specify if a tire, for example, is "flat," "low on air," or "not whitewall."

In all the areas, new confirmation screens will be added to the application. The confirmation group will have the ability to read the inputted defects on the computer screen and check them off once the repair group has succeeded in fixing the defect. This addition will completely computerize the assembly line, an improvement which will further promote efficiency.

Expansion of the system might also include the installation of Quick Time, Apple's new media technology package, to include video training clips if the user has a question about standardized work procedures.

Speed is so vital to this multi-user application that Maldonado plans to add the 4D SERVER to his system. The 4D SERVER is the client-server technology from ACI, ACIUS, Inc. that accelerates multi-user data manipulation by actually performing calculations, thus decreasing the number of network passes to two. Additionally, the server possesses a multi-user design mode which permits multi-user development.

These upgrades further exemplify the principle of kaizen. The original computer system was installed on behalf of NUMMI employees and was created under the guidance of their suggestions. Ongoing improvements are continuously being added at the request of the assembly line workers to further increase their efficiency. Through such ideas as these, NUMMI has succeeded in building a productive assembly line which runs at maximum efficiency and manufactures high quality automobiles. Through the computer application, Von Rotz has contributed to this accomplishment and is proud of NUMMI's system. For according to Von Rotz, "if you don't make somebody's life easier, then you haven't done your job."