

NUMMI—The Great Experiment

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1. Introduction

The purpose of this paper is to tell the story of one of the most interesting experiments in the history of the automotive industry—one of the first transplants of a Japanese auto manufacturer into an American culture. It is the story of New United Motor Manufacturing, Inc. (NUMMI), a Toyota-General Motors (GM) 50:50 joint venture that started in 1984. NUMMI is located in Fremont, California. Fremont is just east of San Francisco Bay between Oakland to the north and San Jose to the south. Although this story has been told many times and much research has been done on NUMMI, I believe it is such a remarkable one that retelling it anew is worth the effort. Furthermore,



it provides another insight into how the Japanese have dramatically influenced automobile and other manufacturing in the U.S. In fact I first heard of NUMMI when I went to work for the Douglas Aircraft Co. (DAC), a part of McDonnell Douglas¹⁾ in 1989.²⁾ As I recall, the executive in charge of implementing DAC's then nascent total quality management (TQM) program was hired away from NUMMI to take advantage of his knowledge in that area.

1) McDonnell Douglas has since merged with the Boeing Co.

2) I remember when I first saw this name thinking “What a strange name for a company.” Now it doesn’t seem so strange knowing the story of the company.

This paper is organized as follows:

1. Introduction
2. Why NUMMI?
3. Before NUMMI
4. NUMMI Begins
5. Post-NUMMI Startup
6. Factors Contributing to NUMMI's Success
7. Some Negatives
8. NUMMI Today
9. Summary and Conclusion

2. Why NUMMI?

NUMMI was an initiative of Toyota. Toyota's main objectives were to gain entry to the U.S. market to counter Honda and Nissan, and to ease trade frictions that had arisen between Japan and the U.S. Toyota also wanted to learn to work with an American workforce (Inkpen, 2005, p. 117). Toyota also wished to learn about American suppliers. According to Adler (1993b) "Toyota's primary concern with respect to suppliers was to identify potential suppliers and establish long term relations with them" (p. 185). As far as working with "an American workforce," this did not initially include a unionized workforce. As Adler (1993a) states it: "Toyota later claimed it had also wanted 'to gain experience with American union labor,' but at first Toyota wanted nothing to do with the UAW³⁾" (p. 98).

According to Inkpen (p. 117), GM's primary goal was finding a source for a small car (to fill a market gap)⁴⁾ and to utilize an idle plant—the GM-Fremont

3) United Auto Workers, the union that had represented the workers at GM-Fremont, the plant NUMMI was to use.

4) This turned out to be the Chevrolet Nova, a subcompact.

plant that had closed in 1982. It should not be surprising that GM was also interested in learning about the Toyota Production System (TPS), which was having such an impact on the American market by producing high-quality cars at highly competitive prices. However according to Inkpen (p. 117) initially this interest was, for the most part, only by the then GM Chairman, Roger Smith. It was only after NUMMI started to significantly outperform GM's other plants that GM began to seriously consider a systematic way of transferring TPS knowledge to GM's operation, and this didn't happen until about a decade after NUMMI came on-line.

3. Before NUMMI

To fully appreciate the difference NUMMI made we have to consider how things were while the GM-Fremont plant was in operation. This plant opened in 1963 and closed in 1982. According to Adler (1993b, p. 119) employment peaked in 1978 at 6,800 and then gradually shrank to 5,700 at the time of closing in 1982. The plant had a notorious reputation. As Adler (1993a) described it:

Productivity was among the lowest of any GM plant, quality was abysmal, and drug and alcohol abuse were rampant both on and off the job. Absenteeism was so high that the plant employed 20% more workers than it needed just to ensure an adequate labor force on any given day. The United Auto Workers local earned a national reputation for militancy; from 1963 to 1982, wildcat strikes and sickouts closed the plant four times. The backlog of unresolved grievances often exceeded 5,000. (p. 98)

Levine, et al. (1995) give us further insight into just how bad things were at GM-Fremont:

In a troubled company [GM], Fremont was the most troubled plant. Unexcused absenteeism often ran more than 20 percent, with levels so high on some Mondays and Fridays that the assembly line could not start. During

the three years between [union] contract talks, the accumulation of more than four thousand unresolved grievances was not unusual.⁵⁾ Quality levels and productivity were far below the GM standard which itself was falling ever further behind the world-class standard being set in Japan. (pp. 12–13)

Industrial relations probably couldn't have been worse at GM-Fremont. Again, quoting Levine, et al. (p. 12): “Managers often acted arbitrarily, played favorites, ignored safety issues, and pushed workers to increase productivity.” If a worker complained they were simply told to write up a grievance that seldom got addressed. The union, for its part, was completely confrontational “...defending all workers against managerial discipline. Even workers who were known to have stolen goods or to have shown up repeatedly too drunk to work were defended by the union” (p. 12). And since grievances were almost never resolved,⁶⁾ things never got better.

Such was the situation at what has been called “the worst plant in the world.” We shall have more to say about how things were at GM-Fremont when we discuss how the situation vastly improved once Toyota took over (section 5).

4. NUMMI Begins⁷⁾

The NUMMI story begins in 1980 when Toyota hired a Washington D.C. law firm to help them find a joint venture partner. Initially Ford was considered but when this failed GM was approached (Jacobson, 1986, 19–20 as cited in Adler, 1993b). Efforts with GM proved more successful with discussions starting in early 1980 and an agreement in principle signed in February 1983. Under this

5) Or, perhaps, even more—see previous quote.

6) According to Levin, et al. (p. 12) at contract time management and labor typically agreed to simply dismiss the backlog of grievances.

7) Most of the information in this section is from Adler, 1993b, pages 117 to 128 including associated notes on pages 184 and following. Unless otherwise cited this will be the reference for quotes.

agreement two cars would be produced at the old but refurbished GM-Fremont plant: the new Corolla FX and a new version of the Chevrolet Nova based on the Corolla Sprinter. Toyota would be responsible for the design and engineering of both cars and marketing of the FX. GM would be responsible for marketing the Nova. Toyota would also be responsible for the design and operation of the refurbished plant.

After what's been said about the abysmal condition at GM-Fremont it is understandable why Toyota didn't want to be involved with the UAW. However, given the control the UAW exercised over the plant, Toyota gave in and a Letter of Intent was signed with the union in September 1983. According to Adler (1993a, p. 99) this letter did the following:

- Recognized the UAW as the sole bargaining agent for the NUMMI labor force,
- Specified prevailing auto-industry wages and benefits,
- Stipulated that a majority of the work force would be hired from among the workers laid off from GM-Fremont,⁸⁾
- Agreed that the UAW would support implementation of a new production system, and
- Agreed to the negotiation of a new contract.

In June 1985 a new collective bargaining agreement was signed providing a “full complement of 15 full-time representatives as well as 67 union coordinators⁹⁾ in the plant.”

Perhaps the most important part of this agreement was Toyota's “no layoff” policy. Appendix A contains the full statement of this policy in the 1985 agree-

8) According to Levin, et al. (p. 13) of the 1,200 employed when NUMMI production began (December 1984), 99 percent of the assembly workers and 75 percent of the skilled trades workers were former GM-Fremont employees/UAW members!

9) Allocated two hours of overtime per week, the coordinators' job is to resolve problems through discussions with the workers.

ment but the key sentence is: “Hence, the Company agrees that it will not layoff employees unless compelled to do so by severe economic conditions that threaten the long term viability of the Company.” As it turned out a significant downturn in sales in 1987 and 1988 sorely tested this policy. At one point the situation was so bad that there were 264 more production workers than needed. Rather than consider laying them off, NUMMI assigned them to such things as work on a new car introduction to take place in 1989, *kaizen* (improvement) projects, additional training, and work formerly outsourced such as plant maintenance work. One serendipitous result of this policy is stated by Mark Hogan, one of the managers interviewed by Adler for his 1993b article: “Team members know that when they contribute ideas for more effective operations they are not jeopardizing anyone’s job” (p123). In the past, workers were reluctant to make suggestions that might improve a job so much the amount of labor could be reduced.

In general Toyota and the union agreed on a close working relationship that would embody “joint union/management investigation of work problems; advance consultations on layoffs, schedule changes, and major investments; and joint union/management review of unusual or mitigating circumstances in advance of discharges or suspensions” (p. 123).

In February 1984 NUMMI formally came into existence as an independent California corporation. Under the terms of organization, each partner contributed \$100 million: Toyota in cash and GM, for the most part, the Fremont plant. An additional \$250 million was raised by NUMMI as an independent corporation (Adler et al., 1998, p. 130). As for personnel, Toyota contributed a core staff of 30 to 35 managers who would stay on for three to five years. Supporting them was a group of 30 to 60 lower-level managers and engineers who served as trainers and rotated out after three months (Adler, 1993b, p. 185). GM, limited by a Federal Trade Commission (FTC) agreement¹⁰⁾ contributed only 16 managers

10) The FTC became involved right from the start due to worries that two of the largest

who would rotate back to GM after three years.

In May of 1983, the hiring process commenced and 5,300 applications were sent to former GM-Fremont workers. Of these 3,200 were returned. During the next 20 months 2,200 hourly employees were hired along with some 300 salaried employees. Each applicant, even for a management job, had to pass a three-day assessment that included “production simulations, individual and group discussions, written tests, and interviews” (p. 120). As per the Letter of Intent, the union played a significant role in the selection process of both the hourly and management personnel. Since GM-Fremont had done little hiring in recent years, NUMMI’s work force was relatively old with an average age of 41. Adler goes on to say: “Most had a high school education. Some 26% were Hispanic, 20% black, and 15% female” (p. 120).

All new hires went through a four-day orientation that covered such things as the production system, quality principles, attendance rules, safety, and house-keeping. The first 450 Team and Group Leaders¹¹⁾ were set sent to Toyota’s Takaoka plant¹²⁾ in Toyota City near Nagoya Japan. There they attended a three-week classroom and on-the-job training program. These leaders then served as trainers for the new team members (production workers).

Production of Novas began in December 1984. Since the Toyota Production System (TPS) was entirely new to most of these workers the line speed started slowly and was only gradually increased to allow these new hires



1987 Chevrolet Nova

automakers in the world were combining for the NUMMI venture. The FTC agreement stipulated that the venture had to be abandoned after 12 years but this requirement was later rescinded.

11) We will discuss NUMMI’s team and group structure shortly.

12) The Takaoka plant serves as a model for NUMMI (and other similar Toyota plants).

time to master their jobs. In that first month, December 1984, only 17 Novas were produced. In 1985 this increased to 64,764. In 1986 Nova production peaked at 191,594. That same year production of the Corolla FX commenced with 14,246 being produced.¹³⁾



1987 Corolla FX

The NUMMI assembly process consisted of these five steps:

- Stamping of major body parts (hoods, doors, fenders, etc.)
- Welding these parts together for form the body of the car
- Painting the body
- Assembling the rest of the car
- Inspecting

Appendix C from Adler (1993b) shows a more detailed description of this process.¹⁴⁾

NUMMI, as any large company, has its management bureaucracy. However, following the “Toyota Way”,¹⁵⁾ NUMMI’s production work force is organized around a very specific team structure. A team consists of five to seven team members and a team leader. The leader, like the members, is an hourly employee. As Adler puts it, the team leader:

...filled in for absent workers; trained new workers; assisted workers having difficulty in their jobs; recorded attendance; assigned work when the line stopped; assisted team members in minor maintenance and house keeping; assessed new team members; led Kaizen efforts; and organized social events outside the plant. (p. 124)

13) See Appendix B for a complete list of annual production figures.

14) See Appendix E for an even more detailed and up-to-date description of the production process.

15) See Liker (2004) and Austenfeld (2006).

For this additional responsibility they are paid a little more each hour. Four teams make up a group and the Group Leader is the first level of management.

Compensation for production workers was at or above the prevailing national union rate and included cost of living and shift premiums. Also all hourly workers made the same rate. Bill Childs, one of the general managers interviewed by Adler (1993b), explained the rationale for this:

There used to be 80 hourly worker classifications with varying pay rates under the old system. This caused workers to grumble over why one worker got a 5 cents an hour more than someone else for what looked like equally strenuous work. We don't have those kinds of arguments any more. And that makes a big difference to our productivity. (pp. 125–126)

Furthermore, there were no more seniority, performance, or merit-based bonuses.

Attendance rules were also simplified. At GM-Fremont they were always arguing about whether an absence was excused or not. Bill Childs explains how this problem was overcome at NUMMI:

We've eliminated the distinction between excused and unexcused absences. Instead, after three occurrences within a 90-day period, we submit a write-up [a written warning]—automatically. After three more occurrences within 90 days there's a write-up and warning; and three more gets you a final warning. The worker is given counseling after the second and third warnings in an attempt to help them solve their attendance problems, but after three more occurrences you're out.

To round out the picture of the transition from the way GM-Fremont operated and the NUMMI/Toyota way Adler mentions three more things: consensus, consistency, and communications. By consensus is meant getting as many opinions as possible before making a decision, even one that an American manager would think only involves him or her. The idea is to not only take advantage of the ideas of others but to head off any resistance to implementation once the deci-

sion is made since more people will have “ownership” of the decision. This approach to decision making was especially difficult for American managers to accept. The Japanese word for this method is *ringi-sho*.

By consistency is meant managers are to remain constantly faithful to the company’s stated policies, especially those dealing with employee relations. An example is given by Carlos Romero, a team member interviewed by Adler (1993b). He had complained for more than a year to his American management about an oil drip above his workstation. One day a Japanese visitor came by and Carlos pointed out the leak to him.

About 1/2 hour later he came back with a few workers to lay down some canvas to catch the dripping. The next day, more people came by and blocked the leak with a metal plate, sealing the leak for good. (p. 127)

The third distinguishing feature of the NUMMI culture was communications. To illustrate this Adler quotes Bill Borton who was the Manager of the Stamping Department. In this quote Burton describes a typical monthly department meeting involving all the team members:

We first discuss the previous month’s sales of the Nova and FX; next we discuss plant safety and encourage people to remain vigilant. Then we talk about quality as reported to us by GM’s quarterly quality control audit. Next we go into job attendance... Then we’ll discuss the suggestion rate and report back on the status of employee suggestions. We then give some data on line performance that month, die change times per sift, scrap, and energy costs. The remainder of the meeting is opened for general questions... (pp. 127–128)

Having covered how NUMMI got started and to a limited extent what it looked like initially, we now ask the question what difference did it make, especially in terms of productivity, quality, and worker morale.

5. Post-NUMMI Startup

As far as productivity, Figure 1 from Adler shows the results of an “extensive analysis” of NUMMI’s in 1986, just two years after operations commenced. NUMMI’s productivity is compared with that of the old GM-Fremont plant in 1978, with a similar active GM plant—Framingham (MA),¹⁶⁾ and with NUMMI’s sister plant in Japan—Takaoka. Even when corrected for such things

	Framingham	GM-Fremont	NUMMI	Takaoka
Uncorrected Productivity (hrs/unit)				
Hourly*	36.1	38.2	17.5	15.5
Salaried	4.6	4.9	3.3	2.5
Total	40.7	43.1	20.8	18.0
Corrected Productivity** (hrs/unit)				
Hourly*	26.2	24.2	16.3	15.5
Salaried	4.6	4.9	3.3	2.5
Total	30.8	48.5	19.6	18.0
Product Quality (<i>Consumer Report</i> Reliability Index)	2.1–3.0	2.6–3.0	3.6–3.8	3.8–4.0
Space Utilization (sq. ft/unit/year)	8.1	7.9	7.0	4.8
Notes:	*Excluding stamping, molding, and seat assembly personnel.			
	**Corrected for number of welds, welding automation, product size, relief time, and option content.			
Source:	Krafceik (1986).			

Figure 1. NUMMI productivity, quality, and space utilization comparisons (Table 5 in Adler, 1993b, p. 128)

Note: The figures for Corrected Productivity for GM-Fremont do not add up correctly. Assuming the “24.2” is correct the total should be 29.1. Given GM-Fremont’s poor record it is probably much higher.

16) This plant has since closed.

as number of welds and welding automation, NUMMI's productivity in hours per unit was not only much better than that of the old GM-Fremont plant but also much better than a similar GM plant and almost as good as the Takaoka plant which had been open since 1966. This is particularly impressive given that, on average NUMMI's workers were ten years older than those at the Takaoka plant and much less experienced with the TPS. Not only was NUMMI's productivity much better than the Framingham plant, *but better than any other GM plant* (Adler, 1993b).

Similar results appear for quality in Figure 1. Again, NUMMI's quality is much better than the GM plants and on a par with Takaoka. Adler (1993b) notes that these *Consumer Report* figures are confirmed by internal GM data: "Krafcik¹⁷) also cites internal GM quality data on end-of-the-line inspections (Corporate Quality Audit) and owners surveys (CAMIP¹⁸) that mirror these results" (p. 129).

Speaking of the improvements in quality over the GM-Fremont plant, Adler (1993a) quotes a NUMMI team leader who had worked at the old plant:

Before, when I saw a Chevy truck, I'd chuckle to myself and think, "You deserve that piece of crap if you were stupid enough to buy one." I was ashamed to say that I worked at the Fremont plant. But when I was down at the Monterey Aquarium a few weekends ago, I left my business card—the grunts even have business cards—on the windshield of a parked Nova with a note that said, "I helped build this one." I never felt pride in my job before. (p. 106)

The third item in Figure 1 is space utilization. This is usually an indication of quality since one of the earmarks of *poor* quality is having large in-plant inven-

17) The source of the data in Figure 1.

18) Continuous Automotive Marketing Information Program—a quarterly marketing survey conducted by an outside firm for GM.

ories meaning more space is needed. That NUMMI was not that much different from GM and Takaoka was much better than the others reflects the fact that the NUMMI plant was still generally configured for the large inventories that existed in days of the GM-Fremont operation.

Granted that productivity and quality improved, how about employee relations? Were these any better under a Toyota-run operation? As an indicator of this we might consider such things as absenteeism, substance abuse, and employee participation in the suggestion program. Quoting from Adler (1993a) again:

...absenteeism has dropped from between 20% and 25% at the old GM-Fremont plant to a steady 3% to 4% at NUMMI; substance abuse is a minimal problem; and participation in the suggestion program has risen steadily from 26% in 1986 to 92% in 1991. (p. 99)

Adler goes on to talk about grievances:

When GM-Fremont closed its doors, it had more than 2,000 grievances outstanding. As of the end of 1991, some 700 grievances had been filed at NUMMI *altogether over the course of eight years*. The overall proportion of employees describing themselves as “satisfied” or “very satisfied” has risen progressively to more than 90%. (p. 99, italics added).

From this it is apparent there was a dramatic change in employee relations. Before there was this constant hostility between management and the union, with both trying to get the most out of the other. Now, as we shall see further, there is a spirit of cooperation between the two to “make the best cars.” The following words of a NUMMI team leader perhaps best describe this remarkable change:

There are people here who will tell you they hate this place. All I say is: actions speak louder than words. If people were disgruntled, there’s no way that we’d be building the highest quality vehicle. You wouldn’t have a plant that’s this clean. You would still have the drug problems we had before.

You would still have all the yelling and screaming. You can't force all that. And try this: go into any of the bathrooms, you'll see there no graffiti. If people have a problem with their manager, they don't have to tell him on the bathroom wall. They can tell him to his face. And the boss's first words will be: "Why?" Something's happened here at NUMMI. When I was at GM, I remember a few years ago I got an award from my foreman for coming to work for a full 40 hours in one week. A certificate! At NUMMI, I've had perfect attendance for two years. (Adler, 1993a, p. 101)

There is no question NUMMI was a changed place. Now we will take a closer look at why this was and continues to this day.

6. Factors Contributing to NUMMI's Success

Simply put there are three reasons for NUMMI's success: the Toyota Production System (TPS), standardized work processes, and the relationship between management and labor. Furthermore, there is a close relationship between these things as will be discussed below.

The Toyota Production System (TPS). The TPS is probably the ultimate exemplar of what has come to be known as lean manufacturing. The purpose of lean manufacturing is to eliminate waste. Waste can manifest itself in many forms such as over production, defects, motion, transportation, inventory, over processing, and waiting. A good lean manufacturing system strives to eliminate or at least minimize all forms of waste. For example according to Toyota's homepage (Toyota Production System, 2006) the TPS is based on two concepts: *jidoka* and just-in-time, both designed to eliminate production line waste. Fundamentally, *jidoka* means that quality is built in not, as is too often the case, "inspected in" after the fact. In other words to the extent possible the production system is designed to prevent a defective part or product from continuing along the production line. Levine et al. (1995) give an example of a wrench programmed to

tighten four bolts, if only three get tightened an alarm sounds (p. 15). *Jidoka* also is practiced by the team members on the assembly line. Should a problem be spotted, team members are not only authorized but expected to pull a cord which, if not pulled again within a minute, will cause the line will stop. Levine, et al. describes the process:

When the cord is pulled, a musical tune plays and a flashing light on an overhead board signals where the line pull occurred, alerting the group leader and team leader. If the cord is not pulled again within a minute, the line shuts down *until the problem is fixed*. On average, NUMMI workers pull the cord about 150 times per eight-hour shift, and the line is stopped approximately 20 minutes [total] each shift. (p. 15, emphasis added)

Note that this policy of stopping the line when there's a problem is not only to avoid any bad product being produced but also to "fix the problem" if, indeed, it was something other than a temporary aberration.¹⁹⁾ Contrast this with the traditional approach at a GM factory where workers were not allowed or even able to stop the line under virtually any circumstances (Levine et al., p. 15). Figure 2 graphically depicts this feature of the TPS.

The other concept upon which the TPS is based is just-in-time (JIT). JIT is a way to manage inventory so that what is needed for producing something arrives just when it's needed. JIT is the opposite of the traditional way of manufacturing known as "batch and queue." With batch and queue, large work-in-process inventories of material, parts, components, and even finished goods are created. The idea is based on the principle of economies of scale: once a machine is setup it would seem to make sense to make as many parts as possible to reduce the per-unit cost. The trouble with this is, once produced, these large inventories of parts and components need to be stored and managed, no small thing in a large manu-

19) In almost all cases, the problem is quickly resolved and the line doesn't stop.

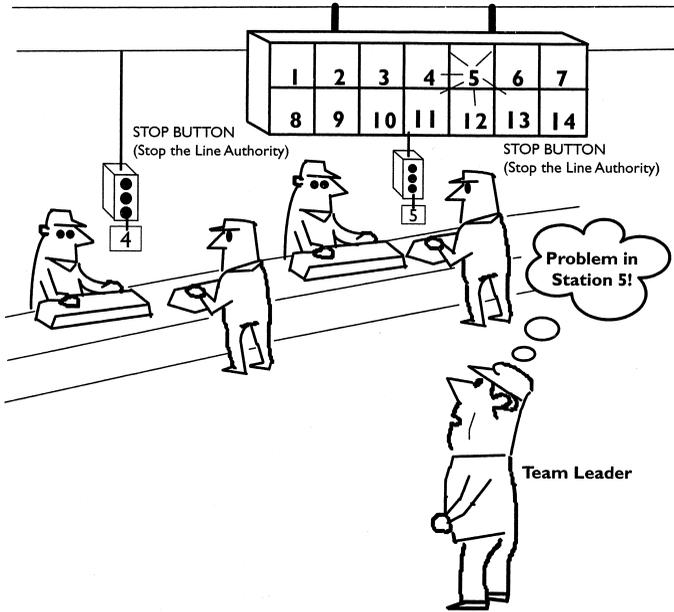


Figure 2. An assembly line with *andon* lights and work stoppage buttons (Liker, 2004, p. 131)

facturing operation. JIT, in its purest form, does away with all inventory so that each operation in the production process receives what it needs from the next upstream operation “just-in-time.” In reality, some inventory is needed; the trick is to constantly look at ways to minimize it. For example an integral part of the TPS is short setup times. By being able to quickly shift from making one part to another, the need to make a lot at one time goes away.

JIT is based on what’s known as a “pull” system. In other words, instead of having a lot of inventory to use, each production operation is designed to “pull” what it needs from the next upstream operation by sending some sort of signal to it. This is similar to the way supermarkets operate. Instead of having huge inventories on their shelves or in their back rooms, they let the customers “signal” them what’s needed by monitoring what’s been used from the shelves and then

restocking just what's needed to bring the shelves back to a certain level.²⁰⁾ The TPS operates this way, with the signaling being done with *kanbans*. Excerpting from Austenfeld (2006):

A *kanban* is simply some device to signal the next upstream supply source that more of whatever it supplies is needed. *Kanban* in Japanese means card and a card of some sort is usually used along with a standard size container for that particular item. Figure 3 illustrates the *kanban* concept. At the far right an operator is using up parts from a standardized container. Once those parts are used up, the empty container, along with it “parts retrieval *kanban*” goes back to a nearby replenishment store for refilling and return to the operator. Of course while this replenishment is going on another container²¹⁾ is in the system to allow the operation to continue.

In turn, as the replenishment store's stock goes down and reaches a certain level, a “production instruction *kanban*” is triggered and sent back to the producer for producing a certain amount to be sent to the replenishment store. This is shown on the left side of Figure 3. Of course not all production facilities are so close that such precisely timed replenishment can occur. Therefore some parts must be moved in larger quantities on a scheduled basis, for example parts coming from overseas. However, even these replenishments should be as often as practical to minimize inventory. (pp. 134–136)

Many benefits derive from minimizing inventory. For example, the amount of capital tied up in inventory is minimized. Furthermore, the costs associated with

20) As the story goes the inspiration for JIT was a visit by Taiichi Ohno, an employee of Toyota, to an American supermarket in the early 1950s. Ohno is probably the person most responsible for the development of the TPS.

21) Or however many are needed, but the number should be as small as possible to keep that inventory down.

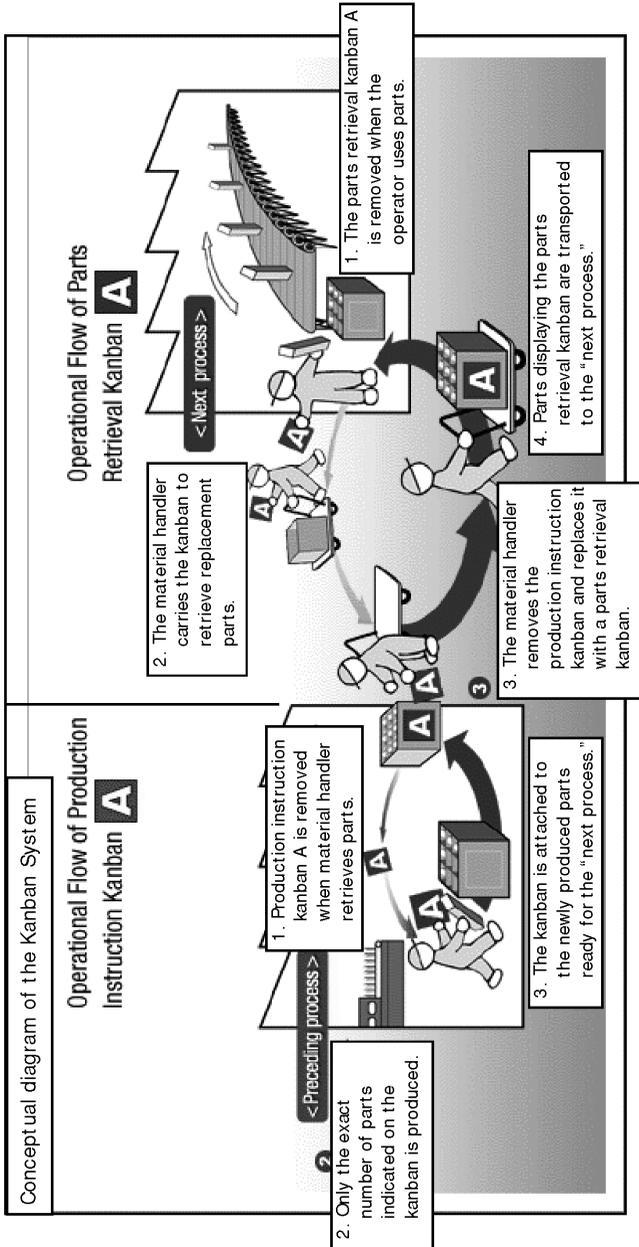


Figure 3. The kanban concept (adapted from Toyota Production System, 2006)

simply storing, maintaining, keeping track of, and moving inventory is greatly reduced. Also once some change in the product occurs, the problem of a lot of inventory immediately becoming obsolete and having to be written off is avoided. However, perhaps one of the biggest advantages in keeping inventory to a bare minimum is being able to find and fix problems quickly. With a large inventory of parts for example it is natural for a worker to simply grab another one when he or she finds a bad one. If instead there is only one part available and it is “bad,” the reason must be determined immediately to prevent bad product from being produced.

Besides *jidoka* and JIT, there are several other features to the TPS such as leveling out the workload (*heijunka*), use of visual controls, error proofing (*poka-yoke*), using only thoroughly tested technology, having a culture of stopping to fix problems to get quality right the first time, and standardized work processes. See Liker (2004) for complete discussion of these plus the Toyota philosophy in which these features are embedded (The Toyota Way). See Austenfeld (2006) for a briefer discussion of The Toyota Way.

Standardized work processes. Although NUMMI, under Toyota control, adopted all these features of the TPS, the one that seems to get the most attention in the literature is standardized work processes. The idea of a standardized work process represents sort of a bridge between the two cultures: Japanese and American; and it is how each approaches this matter that has become the focus of so much attention.

A traditional American assembly line is based on pure Taylorism, that is “experts” in job design develop the “one best way” to do the job and give this to the worker. As a person²²⁾ quoted in Adler (1993b) put it: “In most plants, management assumes the ‘divine right’ to design jobs as they see fit” (p. 143). That

22) Joel Smith, then UAW West Coast Representative.

person goes on to explain why this just doesn't work:

An industrial engineer would shut himself away in an isolated office and consider how long it took for somebody to twist their wrist and move their arm in such and such a way, and calculate times from some manual and try that way to come up with a task design. The IE would take this “properly” designed job to the foreman. The foreman would nod his head, but then said “screw you” to the IE’s back and redesigned the task to his own liking. Then he’d take his task to the worker and said “Do it this way or you’re out.” The worker would nod but would pull the same trick on the foreman. In the end, the job got done however the worker could. When the boss walked by, the worker might pretend to do the job the way the foreman had told him. Everybody involved knew this was going on *but no one cared enough to do anything about it.* (pp. 143–144, emphasis added)

Two points here: (1) Take this reality and multiply it by the all the tasks required to build a relatively complicated product like a car and it should not be surprising that good quality becomes almost impossible. (2) As emphasized in the preceding quote it is a big game that no one cares to correct be they management or labor. In other words, there’s a psychological dimension to the operation that also must be reflected in the quality of the product and in the fact that things are not likely to improve!

At NUMMI, after being trained in such things as work analysis and job description, the team members themselves design the jobs. Adler (1993a) describes the process:

Team members begin by timing one another with stopwatches, looking for the safest, most efficient way to do each task at a sustainable pace. They pick the best performance, break it down into its fundamental parts, then explore ways of improving each element. The team then takes the resulting analyses, compares them with those of the other shift at the same work sta-

tion, and writes the detailed specifications that become the standard work definition for everyone on both teams. (p. 103)

Since they are involved in this design process, there is a commitment by every team member to follow it exactly. And what you have accomplished is at the heart and soul of good quality: a reduction in variability. And this “one way” of doing the job is the best way known at that point in time, another key to good quality. Adler (1993a) points out some of the other advantages besides increased quality:

- Safety improves as the job is designed to reduce stress and strain to a minimum.
- Inventory control becomes easier with a smoother workflow.
- Job rotation is easier since every one learns the “one best way” to do each job. This also makes any absences easier to accommodate because any team member including the team leader can easily step in and do any job.
- Since all team members are, in effect, IEs they can work together to make adjustments to the line speed should a drop in demand necessitate a slow-down. Adler states that NUMMI for example “can convert to a new line speed in four to six weeks” versus what might take GM six months to a year. In fact, GM-Fremont would not even try to do this but would simply lay a shift off.
- The work force feels empowered by having control of its own processes instead of being dictated to by some IE on high. This is perhaps one of the most important advantages of the workers having ownership of their job design.

Besides all the advantages of having the workers themselves design their own jobs, standardized work has far reaching implications for continuous improvement and the creation of a learning organization. Let’s take the example of a

golfer trying to improve his golf swing. The first requirement is for his swing to be the same each time; i.e., standardized. Until this happens, it will be virtually impossible to move to the next step of improvement. The same can be said for improving a job task: until it is standardized there is no way to make meaningful changes to it. Imagine the way GM-Fremont operated as described above with everyone doing the job the way they thought best. If there were any improvements they were surely haphazard at best based on what each person thought, and probably seldom shared with others.

At NUMMI workers are encouraged to make suggestions for improving their work processes. According to Adler (1993a) "...[NUMMI] workers made more than 10,000 suggestions in 1991, of which more than 80% were implemented" (p. 104). Adler also explains why NUMMI's suggestion program is so successful. With most suggestions programs workers have little knowledge of what happens to their suggestions and the programs are mostly to screen out dumb ideas. At NUMMI the program is designed "...to help workers see and understand the criteria [for judging ideas], evaluators, process, status, and results." Workers know that their suggestions will be fairly evaluated and the "bureaucracy" is not there to turn down all but the very best ideas but to support the worker and aid him or her in refining and implementing any idea that has potential merit.

Just the act of establishing a standardized work procedure inevitably begins to reveal weaknesses in the production system that can then be worked on to improve it. Then, as these improvement ideas are implemented and the process standardized once more, new ways to make even more improvements will surface. Adler refers to this as the workers "teaching" the system and the system, in turn, "teaching" the worker:

Continual reiteration of this disciplined process of analysis, standardization, re-analysis, refinement, and restandardizaion creates an intensely structured system of continuous improvement. *And the salient characteristic of this*

bureaucracy is learning, not coercion. (p. 104, emphasis added)

The relationship between labor and management. As can be seen, contributing greatly to this favorable climate of empowerment and learning is the relationship between labor and management. Section 3 of this paper described the, quite frankly, atrocious conditions at the GM-Fremont plant before Toyota took over: an openly hostile relationship between labor and management, numerous and usually ignored grievances, and workers often absent or showing up drunk or on drugs. There is no question that such a situation could no longer be allowed to continue if NUMMI was to produce high-quality cars. NUMMI management, drawing on the way Toyota does things,²³⁾ sought to establish a relationship of trust with the workers. Perhaps one way to express this relationship is as a team working together towards a common purpose: prosperity for both the company and its workers. Right from the start NUMMI took steps to foster this team idea. Quoting from Adler (1993a):

For example, the company tried to undercut the customary we-they divisions between workers and management by eliminating special parking and eating facilities for managers and by introducing an identical dress code—uniforms—for everyone. (pp. 100–101)

And as just discussed the management bureaucracy plays an active support role versus being a coercive force to get the most out of each worker. Figure 4, from Adler (1999) compares the two approaches. Ironically, the Toyota/NUMMI approach also seeks to “get the most out of each worker” but in a positive way that benefits both the company and the worker. It would seem to be a classical application of Douglas McGregor’s Theory Y.²⁴⁾ Quoting a department manager,

23) In 1962 Toyota signed a Labor-Management Joint Declaration setting forth its commitment to fostering mutual trust between labor and management. See Appendix D for a relatively current description of this relationship of mutual trust and respect.

24) McGregor believed that most workers really do want to do a good job and will if managers treat them with respect and do what they can to support them. The opposite ↗

Coercive Systems and Procedures	Enabling Systems and Procedures
Systems focus on performance standards so as to highlight poor performance.	Focus on best practice methods: information on performance standards is not much use without information on best practices for achieving them.
Standardize the systems to minimize gameplaying and monitoring costs.	Systems should allow customization to different levels of skill/experience and should guide flexible improvisation.
Systems should be designed so as to keep employees out of the control loop.	Systems should help people control their own work: help them form mental models of the system by “glass box” design.
Systems are instructions to be followed, not challenged.	Systems are best practice templates to be improved.

Figure 4. Comparing coercive systems/procedures with enabling ones (Table 2 in Adler, 1999, p. 44)

Adler (1993a) sums this up very well:

Our assumption at NUMMI is that people come to work to do a fair day’s work. There are exceptions, and you would be foolish to ignore them. But 90% of people, if you give them a chance to work smarter and improve their jobs, and if they find that by doing that they have created free time for themselves, will spontaneously look for new things to do. I’ve got hundreds of examples. (p. 100)

As has already been mentioned the “no layoff” policy also contributes this feeling that the workers are part of a “team,” not just some expendable resource. Liker (2004) quotes a manager, Dennis Cuneo, who lived through those early days of NUMMI and saw the good effects of this policy:

We built trust early on with our team members, GM had problems selling the Nova in 1987 to ’88 and they substantially cut the orders to our plant. We had to reduce production and were running at about 75 percent capac-

↘ (coercive) style of management he termed “Theory X.”

ity, but we didn't lay anybody off. We put people on *kaizen* teams and found other useful task for them. *Of all the things we did at NUMMI, that did the most to establish trust.* (p. 75, emphasis added)

Compare that with GM-Fremont (a NUMMI team member):

I'll never forget when I was first hired by GM many years ago. The personnel manager who hired us got the...workers who were starting that day into a room and explained: "You new employees have been hired in the same way we requisition sandpaper. We'll put you back on the street whenever you aren't needed any more." (quoted in Adler, 1993a, p. 100)

The ties Toyota forged with the UAW also have contributed greatly to this idea of everyone in NUMMI being part of a team effort. This relationship with the UAW has already been discussed in section 4 above. However as an indication of how NUMMI put it's "money where its mouth was," Adler (1993a) relates this very telling story: (see p.106).

...when the plant first began operations, the new NUMMI managers responded quickly to requests from the workers and union representative for items like new gloves and floor mats, which surprised workers used to seeing requests like these turn into battles over management prerogative.

After a few months of getting everything they asked for, workers and union representatives started trying to think of ways to reciprocate. Eventually, they decided that chrome water fountains were unnecessary and told management they'd found some plastic ones for half the price. A few weeks later, management upped the ante one more time by giving work teams their own accounts so they could order supplies for team members without prior approval from management. This kind of behavior led workers to conclude that they did indeed share common goals with management.

To sum up then, the factors that most contributed to NUMMI's success were the Toyota Production System (TPS), standardized work processes developed by

the workers with the help of management, and a “team” relationship between labor and management—all absent from the GM-Fremont operation. Although the impression to this point might be that everything was “peaches and cream” at NUMMI, there were some negatives. I’ll discuss three.

7. Some Negatives

Dissension within the union. Initially there was strong unity within the UAW local representing the workers, Local 2244. In fact the first contract was endorsed by 92 percent of the workers (Adler, et al., 1998, p. 146). However within a couple of years dissatisfaction with the union’s dominant Administrative Caucus brought about the formation of the People’s Caucus. The People’s Caucus felt that the Administrative Caucus was “too ‘cosy’ with management and had not done enough to protect workers’ rights in cases such as injuries, transfers, or over-loaded jobs” (Adler, et al.). Over the next several years there was this constant tussle between the two caucuses to the point that “many union committees were not functioning, and long standing members were bitter about the high level of acrimony at union meeting.” The basic problem was that neither caucus had a compelling vision for how it would represent the workers in this new environment of labor and management working together. The Administrative Caucus simply wanted the workers to trust them when, in fact, it was important, according to Adler, et al., for the union to bring the workers into fuller participation concerning its dealing with the NUMMI management. This “trust me” attitude led many of the workers to the feeling that the Administrative Caucus was not doing enough to represent their interests. As quoted in Adler, et al., one veteran worker expressed it in these terms:

I don’t want the type of union muscle we used to have. You could get away with almost anything in the old plant, because the union would get you off the hook. It was really crazy, but it wasn’t productive. I still want a union

that's honest and that can help the people that really need it. But we've never seen the Administrative Caucus really stop management with that 'Hey, wait a minute!' Maybe they did do it, but if they did, it must have been behind closed doors, because we never saw it. (p. 147)

Unfortunately the People's Caucus too failed to develop a definitive way for taking advantage of the new cooperation between labor and management at NUMMI; the same worker continues: "The People's Caucus is also a mixed bag. I've got family and friends on both sides."

Despite all this dissension within the union, according to Adler, et al. (1998), cooperation between NUMMI management and the workers was not seriously affected:

[Union and management] continued to discuss normal union-management issues such as penalties for absences. There was no radical shift in the union's strategic posture nor in its ability to cooperate with management on issues of common concern. And in 1997, the Administrative Caucus was voted back in. (p. 155)

But that is not to say there were no complaints about working conditions. Perhaps the best example of this was the ergonomics²⁵⁾ problem NUMMI faced in the 1990s, the second negative I want to discuss.

The ergonomics problem. According to Adler, et al. (1998) the ergonomics problem came to a head with a major model changeover in 1993.²⁶⁾ Prior to this NUMMI's record as far as health and safety was far from impressive and in striking contrast to its achievements in the areas of quality and productivity. Adler, et al. cites three policy reasons for this: (1) a lack of ergonomics expertise, (2) a job

25) The study of how a workplace and the equipment used there can best be designed for comfort, safety, efficiency, and productivity.

26) Beginning with this changeover two models would be built on the same assembly line: the Toyota Corolla and the Chevrolet Prizm.

rotation policy that was *not* designed to reduce stress by moving workers from more to less stressful jobs, and (3) an ergonomics evaluation methodology that failed to take into adequate consideration certain potential stress areas such as vibration (p. 149). Besides these policy reasons another factor contributing to the problem of poor ergonomics was a view by management that many “injuries” were being faked by workers trying to “game” the system. Also those most responsible for monitoring such problems, the assistant managers and group leaders, were more preoccupied with quality and productivity as this was the message they were getting from higher management. In general, there was little real interest in ergonomics on management’s part. And even the union had only one health and safety representative and that person was fully occupied with safety issues.

Adler et al. describes how the 1993 model changeover exacerbated the ergonomics problem. A pilot team was assembled more than two years before the August 1992 production start date. This would seem to be enough time to iron out all the problems associated with bringing a new model on line. In fact, the new Corolla had already begun production in 1991 at NUMMI’s sister Takaoka plant. This gave the pilot team an advantage in that many bugs had already been worked out of the production process. Despite all this, when the changeover to the new models took place and production restarted in August, many serious quality and workability problems arose. As described by Adler, et al.:

Many parts of the new car simply did not fit together: Gaps formed between pieces of the interior, and cars rattled when they were driven. Even when the parts did fit, the ease with which they could be assembled—workability—was often seriously deficient. (p. 152)

This was attributed to these factors: (1) the shift from Japanese suppliers to U.S. suppliers causing 36 new suppliers to be added to the supplier base, (2) parts that had been altered in Japan but whose drawing had not been updated, and (3) the relative inexperience of the pilot team—only two of its 34 members had prior

major model change experience (p. 152).

The result was not only serious quality problems but also an increase in the number work-related injuries and illnesses. To make matters worse, due to workers not being fully trained on more than their primary job, job rotation, which might have helped alleviate the problem, became impossible. Gary Convis, then NUMMI's Vice-President for Manufacturing and Engineering, points out in Adler, et al. how this caused a vicious circle: when a worker had to be absent due to an injury it meant the team leader had to fill in instead of substituting for another worker to let him or her get trained in a secondary job. Thus, without any rotation, a team member might have to continue to work at an extremely stressful job for long periods and him or herself become a victim of ergonomic stress (pp. 152–153).

As conditions continued to deteriorate, the union appealed to the California Occupational Safety and Health Administration (Cal-OSHA) in October 1992. After a visit to the plant the OSHA representative was not impressed with what NUMMI was doing to solve the problem. According to Adler et al., NUMMI was focused on the root cause which was poorly designed parts and work procedures, not immediate solutions. As a result, NUMMI was cited for an “alarming” increase in “serious employee injuries due to repetitive stress.” Additionally these problems were to take their toll on labor-management relations, Although some workers saw the problems as to be expected, many felt NUMMI management was letting them down. In fact the previously mentioned discord within the union was contributed to by these problems: in 1994 the more “militant” People's Caucus won all major union offices except that of the President from the Administrative Caucus.

Eventually NUMMI cleaned up its act with the launch of the 1995 launch 285T (Tacoma) truck in 1995. In fact, it would appear NUMMI learned a lot from its problems with the 1993 changeover:

Unlike the 1993 Pilot Team members, the 285T Pilot Team members were given extensive ergonomics training. Toyota and NUMMI engineers worked with the Pilot Team to make the 285T easier to assemble than its predecessors. NUMMI's quality department put more emphasis on workability issues than in the 1993 case, spending a lot of time analysing parts before and after each pilot. The quality department also established better communications with suppliers, and suppliers in turn were able to respond more rapidly to design changes. (Adler et al., pp. 153–154)

Furthermore, unlike the Corolla/Prizm changeover, NUMMI made it a policy that all team members would rotate between at least two jobs from the time of the very first vehicle.

Losing the "TPS" edge. One other example to show that things weren't always "perfect" at NUMMI was another "launch" problem in 2002 when NUMMI was changing over to a new model of the Corolla.

NUMMI had hired nearly 1,000 new people to help build the new model, but the launch did not go as smoothly as expected. The "tribal knowledge" about lean manufacturing had not been passed down to the new workers, and even some veterans needed a refresher course. (NUMMI Plant a Model..., 2006)

Apparently this caused Toyota to realize that there was a need to reemphasize TPS at NUMMI. Accordingly they brought in a former manufacturing executive from Ford Motor Co., Ernesto Gonzalez-Beltran, to be Vice President, Manufacturing in 2002.²⁷⁾ According to Gonzalez-Beltran as quoted in Waurzyniak (2005):

27) This surprised me since one of Liker's (2004) 14 "principles" of the Toyota Way is to grow your leaders from within. Perhaps this is a reflection of the hybrid nature of NUMMI being part Japanese and part American. For American companies bringing an outsider in to "turn things around" is fairly common.

When I came over, the big challenge that I was given was how do we regain the level of TPS that we had at the beginning, because, according to the management, there had been an erosion of knowledge in TPS and knowledge of application over the years.

Gonzalez-Beltran attributes the high acceptance of TPS at NUMMI's beginning to a couple of factors: the workers' "appreciation for having a job" having been laid off from the old GM plant and, maybe especially, the improved working conditions that came with the TPS way of doing things. He goes on to say:

They were desperate for the change. The traditional combative or antagonistic relationship between union and management was something they didn't want to go through again, so they embraced the new concept of working together, mutual trust and respect, and the level of involvement in the Toyota Production System that was required from them.

The Waurzyniak article goes on to discuss some of the ways Gonzalez-Beltran is carrying out his mandate, in particular the renewed emphasis on training as evidenced by the soon to be completed all-new training building where, according to the Waurzyniak, "TPS training annually for every one of the 4,800 members working at the plant" will take place. Other things NUMMI is doing to enhance its TPS knowledge are having its team members work on *jishuken* projects and carrying on a regular exchange of best-practice information among NUMMI's sister plant in Japan, Takaoka, and the other Toyota plants in North America. A *jishuken* project, apparently much like a *kaizen* team event, is to "emphasize learning a specific skill or project-solving in a short time of a week or less" (Waurzyniak). The information exchange is part of the North American Production Joint Meeting (NAPJM) program and member plants have representatives meet every fourth month in a different location. According to Gonzalez-Beltran "The whole concept is to not only share each others' results, as well as the actual condition of the plant, but also an opportunity to share best practices." He

also notes, referring to the TPS, that “...there is always something new. There’s always something changing.”

8. NUMMI Today

The purpose of this section is to give the reader a feel for NUMMI as it exists and operates today. It is broken down into two parts: facts about NUMMI and a very simplified description of the production process (factory tour).

*NUMMI facts*²⁸⁾

- Products:

Toyota Corolla: The first Toyota Corolla FX16 was produced at NUMMI in September 1986. The last FX16 was produced in September 1988. That same month, NUMMI began producing the Toyota Corolla four-door sedan



The Toyota Corolla

Toyota Tacoma truck: NUMMI builds 17 models of the award-winning Tacoma, including a PreRunner Double Cab, 4×4 Double Cab, 4×2 Xtracab, PreRunner Xtracab, 4×4 Xtracab, S-Runner, 4×2 Regular Cab, PreRunner



The Toyota Tacoma



The Pontiac Vibe

28) Unless otherwise stated all “facts” are from the NUMMI Web pages at <http://www.nummi.com> as of October 2006.

Regular Cab and 4×4 Regular Cab.

Pontiac Vibe: The Vibe is a unique vehicle that combines the best of a sports car, sport wagon and SUV. It features an athletic, clean look to the outside and a driver-oriented cockpit inside. Standard goodies include an AM/FM radio with CD player, roof rack and a 110-volt household-style electric outlet.

- Facility size:
 - Plant: 5.3 million square feet (492,400 square meters).
 - Property: Approximately 380 acres (153.8 hectares).
- Annual volume:
 - Cars: Approximately 250,000.
 - Trucks: Approximately 170,000.
- Employment:
 - Represented by UAW Local 2244: Approximately 4,550.
 - Salaried: Approximately 890.
 - Total: Approximately 5,440.
- Economic impact:
 - North American suppliers: Approximately 3,600 (1,000+ in California).
 - Total number of jobs supported by NUMMI: Approximately 50,000!
- Major operations: The major operations are stamping, plastics, body and weld, paint, and assembly. See Appendix E for a brief description of each of these operations adapted from NUMMI's Web pages.
- Environment and Corporate Citizenship: Although NUMMI prides itself on quality, it also is proud of its record on the environment and corporate citizenship as evidenced by the many awards it has received. See the last two categories of Appendix F, NUMMI Awards—Environmental Achievement and Corporate Citizenship. Note that since 1989 NUMMI has been recognized every year at least once and usually more than once

for its contributions to the environment.

*A factory tour*²⁹⁾

Note: To see an excellent slide show of how NUMMI builds its Tacoma trucks go to the NUMMI homepage (<http://www.nummi.com>), under “home” click on “cyber tour,” then click on “View the article and slideshow” near the top of that page. Finally click on “PHOTO ALBUM: 2005 Toyota Tacoma Factory Tour.”

Stamping

- NUMMI cars and trucks begin as giant rolls of coiled steel, 100% of which come from the Midwest. These coils weigh 20,000 pounds or more. Every day NUMMI uses over a million pounds of steel to manufacture its vehicles.
- Sheets of metal pass through stamping presses which use different dies and molds to form three-dimensional parts. The dies weigh 40–60,000 pounds each.



A stamping press

Body and Weld

- We have a large robot welding line that uses over 50 robots to weld outer bodies together.
- Throughout NUMMI we have 496 robots, 25 different types.
- The number of welds per vehicle are:

Corolla:	3,694
Vibe:	4,001

29) Adapted from an article posted to a NUMMI Web page (http://www.nummi.com/web_tour.html) by InsideLine.com, an automotive research company. All pictures are from NUMMI’s Web pages.

Tacoma 2 door: 1,638
Tacoma extended cab: 1,811
Tacoma 4 door: 1,925



Body and Weld shop worker

Paint

- Inspection is the key in the Paint department. Vehicles are repeatedly checked throughout the entire paint process.
- When the vehicle comes out of Body and Weld it may have dirt, dust and grease on it. It goes through a 12-step cleaning process and then a phosphate bath that roughens the surface to make paint adhere better.
- That's followed by what's known as an Elpo bath, which prevents rust and corrosion and adds an electrical charge that helps paint bond better.
- Next, sealer is applied to all seams for waterproofing and noise reduction. Asphalt sheets are applied inside the vehicle to reduce road and engine noise.
- Then robots prime and paint the vehicle—edges and door jambs are done by hand, and robots finish the job.
- The vehicle is oven cured at four stages—after cleaning, after sealing, after priming, and after painting.
- Finally, a team member inspects everything to ensure quality.
- Total time in the paint process is about 11 hours.



Paint shop worker

Plastics

- Plastics supplies the assembly lines with bumpers, instrument panels and

numerous small parts.

- Small plastic pellets are melted then inserted into molds in a process called injection molding. Using cooling lines, the plastic solidifies to make the finished product.
- Then, the mold is separated, and the part is gently removed (it's easily scratched at this time) and sent to Paint.



Plastics shop worker

Assembly

- After Paint, the first step in Assembly is to detach the doors, making it easier for team members to work on the vehicle as it travels down the line. The door is finished in another area of the plant. Toward the end of the line, the door meets up with the body and is reattached.
- Other steps in the Assembly process include installation of parts such as...
 - engines
 - tires
 - seats



Happy Assembly workers

Quality Control

- Quality isn't something we only check for at the end of the process; it is built into NUMMI cars and trucks at each stage. Our Quality Control and Quality Assurance departments conduct inspections, tests and audits to ensure customer satisfaction.
- They also work with all areas of the plant to address and prevent prob-

lems and to increase awareness of the importance of maintaining quality in each work station.

- The end result is a quality vehicle that finds its way to a General Motors or Toyota dealer and, eventually, the customer.

Finally, an article that describes a recent look at NUMMI³⁰ is summarized in Appendix G. These eighteen points give a further insight into “NUMMI today.”

9. Summary and Conclusion

This purpose of this paper has been to tell the story of one of the most interesting events in the history of the automobile industry: the transplantation of the Japanese way of making cars into an American setting. NUMMI was (and is) a Toyota initiative with these objectives: (1) to reduce trade frictions between Japan and the U.S., (2) to defend against moves by Japanese competitors who were then beginning to enter the U.S. market, and (3) to learn about operating in a U.S. environment. It is probably safe to say that NUMMI achieved all of these objectives. But beyond that surely there must have been an underlying one of wanting to see if the TPS could be transplanted into an American setting. And not just any American setting but, once it became inevitable, a unionized one. And not just any union but probably one of the most militant in the country: UAW Local 2244.

It is to Toyota’s credit that it not only accomplished the integration of TPS into this unionized setting (most of its initial workforce were former UAW members), but soon reached world-class levels of quality and productivity. In fact, as can be seen from Appendix F, NUMMI has over the years of its existence consistently received awards for quality. Therefore, I think it is safe to say the “experiment” was a success. The question is why has this experiment been so successful? To sum it up, probably for two main reasons: (1) the TPS, especially with its em-

phasis on standardized work, and (2) Toyota approach to management-labor relations, one built on the principle of mutual trust and respect. As this paper has pointed out in section 7, the latter has not been without its ups and downs but overall it appears to have been a successful approach for achieving employee involvement in continuous improvement and organizational learning—hallmarks of Toyota’s way of doing business (see Liker’s 2004 book *The Toyota Way*).

So as not to paint too rosy a picture, Adler, et al. (1998) sums things up this way:

For our part we conclude that NUMMI was not a stunning success which dominated its competitors on all counts, but nor was it a stunning failure—and this, in itself, was remarkable enough. NUMMI demonstrated that unionized American workers could achieve levels of productivity and quality very close to the constantly advancing standards set in Japan—a result that skeptics doubted was possible when NUMMI opened its doors. However, NUMMI did not set a global standard for performance: Japanese plants maintained their lead in the technical dimension. Nor did NUMMI set a new global standard for industrial relations: Saturn in the USA and at other plants in Europe created more collaborative and effective partnerships which were more advanced in the social dimension. But NUMMI was remarkable in its unrivaled combination of excellent performance and innovative industrial relations. (p. 158)

A final remark seems in order regarding NUMMI’s impact on American industry. As mentioned early on in this paper, GM eventually did avail itself of learning from NUMMI and this is now reflected in the higher quality of its products. But beyond that, NUMMI has become sort of a showplace for the TPS and Toyota’s way of labor-management relations. Numerous people from all sorts of companies have toured (and studied) NUMMI to learn the “Toyota secret of success.” Surely this must have had—and continues to have—a major impact on

improving quality in America and, in fact, could be the real significance of this great experiment!

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Appendix A

NUMMI's No-Layoff Policy

(As stated in its collective bargaining agreement of 1985, italics added)

New United Motor Manufacturing, Inc. recognizes that job security is essential to an employee's well being and acknowledges that it has a responsibility, with the cooperation of the Union, to provide stable employment to its workers. The Union's commitments in Article II of this Agreement are a significant step towards the realization of stable employment. *Hence, the Company agrees that it will not layoff employees unless compelled to do so by severe economic conditions that threaten the long term viability of the Company.* The Company will take affirmative measures before laying off any employees, including such measures as the reduction of salaries of its officers and management, assigning previously subcontracted work to bargaining unit employees capable of performing this work, seeking voluntary layoffs, and other cost saving measures.

Appendix B

NUMMI's Annual Production Figures

(Source: NUMMI's Web pages, Quick Facts, 2006)

	Nova	Toyota FX	Geo/Chevrolet Prizm	Toyota Corolla	Toyota Truck	Pontiac Vibe	Toyota Voltz	TOTAL
1984	17	0	0	0	0	0	0	17
1985	64,764	0	0	0	0	0	0	64,764
1986	191,594	14,246	0	0	0	0	0	205,840
1987	143,655	43,722	0	0	0	0	0	187,377
1988	71,117	40,910	1,827	14,571	0	0	0	128,425
1989	0	0	112,342	80,130	0	0	0	192,472
1990	0	0	101,959	103,330	0	0	0	205,289
1991	0	0	94,994	111,143	2,535	0	0	208,672
1992	0	0	75,497	105,440	75,862	0	0	256,799
1993	0	0	85,271	121,719	116,061	0	0	323,051
1994	0	0	114,803	114,597	135,199	0	0	364,599
1995	0	0	94,280	135,112	123,257	0	0	352,649
1996	0	0	65,475	158,947	141,047	0	0	365,469
1997	0	0	60,838	149,041	147,927	0	0	357,806
1998	0	0	45,301	158,219	159,226	0	0	362,746
1999	0	0	49,965	160,762	156,387	0	0	367,114
2000	0	0	50,008	147,694	146,339	0	0	344,041
2001	0	0	46,020	142,937	162,714	0	0	351,671
2002	0	0	0	137,642	164,550	59,556	8,108	369,856
2003	0	0	0	158,145	161,276	74,500	1,751	395,672
2004	0	0	0	168,319	142,605	69,430	200	380,554
2005	0	0	0	185,729	169,617	62,159	0	417,505
TOTAL	471,147	98,878	998,580	2,353,477	2,004,602	265,645	10,059	6,202,388

Note: Chevrolet dropped the Geo nameplate with its 1998 lineup. The Geo Prizm is now called Chevrolet Prizm.

Appendix C

NUMMI Assembly Process Circa 1987

(Adler, 1993b, p. 121)

1. Stamping Plant

- rolled steel
- 26 presses between 400 tons and 2600 tons
- stamp 35 major body panels—hoods, doors, fenders

2. Body Shop

- various metal parts and panels are welded together
- 170 robots
- approximately 3800 welds used to form each body
- each body checked for defects in metal or welds

3. Paint Shop

- coating
- sealing
- painted—9 different colors with 4 combinations of 2-tone paint available
- oven dried

4. Assembly

- final assembly line is 1.3 miles long
- most of the 2000 parts added as body travels along line

5. Inspection

Adler's source: Presentation by M. Hogan*, Stanford University, December 4, 1987

*Mark Hogan, then Manager, General Affairs and Comptroller for NUMMI.

Appendix D

Mutual Trust Between Labor and Management

(Toyota Environmental & Social Report 2003, under Social and Economic Aspects, Employees)

The basic concepts of mutual trust between labor and management are: improvements in the lives of employees are realized through the prosperity of the company, and labor and management thus share the same goal of company prosperity as a common value; management will take into consideration to the greatest possible extent stable employment and will continuously strive to improve working conditions; and employees will cooperate with the company's policies in order to promote the company's prosperity.

In the Labor and Management Resolutions for the 21st Century signed by labor and management representatives in 1996, mutual respect was added to mutual trust as a foundation of labor-management relations, and this is reflected in the current Guiding Principles at Toyota Motor Corporation. (Below is Toyota's view of the "mutual trust between labor and management.")



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Brief Descriptions of NUMMI's Major Operations

(Adapted from: http://www.nummi.com/manu_process.html, retrieved October 2006)

Stamping

Each weekday nearly one million pounds of steel are trucked in and transformed into 121 different parts for the Tacoma, Corolla and Vibe.

Plastics

NUMMI's Plastics department manufactures instrument panels, bumpers and other plastic parts for the Vibe, Corolla and Tacoma.

Body and Weld

- Stamping manufactures more than 100 individual parts for our vehicles. Body and Weld uses those parts, along with others provided by vendors, to construct the metal shells of our vehicles before sending them on to Paint.
- More than 90 percent of welds are done by machines.
- NUMMI uses two kinds of machines for this automated task: multiwelders and robots.
- A multiwelder is a large, stand-alone piece of equipment that typically performs dozens of welds at one time. Usually, a team member will load several metal parts into it, push a button, and let the machine complete the task.
- NUMMI's robots look more like the type of machines you see in science fiction movies. They are more humanlike and zip around performing a series of single welds.

Paint

- Paint takes over where Body and Weld leaves off, and like any paint job, the

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Brief Descriptions of NUMMI's Major Operations (continued)

bulk of the work is in the preparation. Vehicles first go through a phosphate bath to remove dirt and oil. Then, a rust-prevention coating is applied and the vehicle is baked in a huge oven at 320°F for 20 minutes.

- Sealer and two more coatings are added to muffle sound, prevent chips and waterproof the vehicle. This is followed by a second trip to the oven, this time for 10 minutes at 230°F.
- Primer and interior paint come next. Interiors, trunk and engine compartments are sprayed manually, while exterior paint is applied by robots. After team members inspect and sand vehicles to remove any defects, they are washed, blow dried and baked at 250°F for 10 minutes.
- Finally we get to the colorful part of the work. A base coat and—for all colors except white—clear coat are applied. Again, team members paint the interiors while robots spray the exteriors. Then it's back to the oven for another 45 minutes.
- This is followed by another inspection for defects and any repairs that might be necessary.

Assembly, car

- This department builds about 400 cars per shift, or one every 60 seconds.
- When a car body leaves Paint, it first passes through an inspection station where team members make certain the paint job is flawless before accepting the vehicle. The doors are removed to make it easier to move in and around the car during assembly and to prevent dents and scratches.
- The vehicle proceeds through a series of Trim workstations where team members begin by installing weather stripping, moldings and pads. Then

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Brief Descriptions of NUMMI's Major Operations (continued)

they put in wiring, vents and lights.

- After an instrument panel, windows, steering column and bumper supports are added, it starts to look less like a shell and more like a car. A rear axle, assembled in another area of the plant comes next.
- Trim finishes up by attaching items such as the emergency brake, gearshift, speakers and radiator.
- After a 28-point quality assurance check, it's on to the Chassis line. This is where many safety-related items are installed. Things like brake lines, gas tanks and power steering are double-checked by electronic fail-safe devices known as *poka-yokes*.
- The engine is installed, along with the starter and alternator. Then come suspension and exhaust systems.
- From there the vehicle enters the Final line, which covers many interior items such as the console, seats, carpet, glove box and steering wheel. This is also where bumpers, tires and the battery are added, as well as finishing touches like covers and vents.
- Finally the doors—which have been traveling down a separate line receiving trim, wiring, panels, handles, locks and windows—are reattached. The doors are adjusted to fit properly, all of the connections and fluids are checked, and the body side moldings are added.
- At this point, the vehicle has spent about 6.5 hours traveling through over 200 workstations in Assembly. Now it will be handed off to Quality Control for a final check before it's shipped out to its new owner.

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Brief Descriptions of NUMMI's Major Operations (continued)

Assembly, truck

- Because trucks are more complex, truck assembly is different from car assembly. The car is all one piece (unibody), but the truck has separate parts: the frame, cab and deck, along with variations in each of those parts.
- The truck assembly line is about a half a mile long. At full capacity, NUMMI produces over 300 trucks per shift, or one every 85 seconds. Only stamp parts for the cab are stamped at NUMMI. Frames are delivered every hour from Stockton [California] and beds come daily from Baja, California [Mexico]. The beds come pre-assembled and pre-painted and are sent to assembly in the proper color sequence to be added to a matching cab.

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NUMMI's Awards

(<http://www.nummi.com/awards.html#top>, retrieved October 2006)

Product Quality

Corolla

- 1993: J. D. Power and Associates' New Car Initial Quality Study: Among the Top 10 Models in Initial Quality
- 1998: American Automobile Association: Top Car under \$15,000
- 1999: American Automobile Association: Top Car under \$15,000
- 1999: J. D. Power and Associates' Initial Quality Study: Best Compact Car in North America
- 1999: R. L. Polk and Co.: Four-door Compact Leader
- 1999: IntelliChoice Complete Car Cost Guide: Best Overall Value in Compact Class
- 2000: R. L. Polk and Co. Four-door Compact Leader
- 2000: The Corolla has also ranked as Consumer Digest's "Best Buy" two years in a row.
- 2000: J. D. Power and Associates' Initial Quality Study: Best Compact Car in North America
- 2001: R. L. Polk and Co.: Four-door Compact Leader
- 2001: The Corolla has also ranked as Consumer Digest's "Best Buy" two years in a row.
- 2001: J. D. Power and Associates' Initial Quality Study: Best Compact Car in North America
- 2002: J. D. Power and Associates' Initial Quality Study: Best Compact Car in North and South America
- 2004: J. D. Power and Associates' Initial Quality Study: Best Compact Car in North and South America
- 2006: J. D. Power and Associates' Initial Quality Study: Best Compact Car in North and South America

Toyota Truck (Hilux)

- 1992: J. D. Power and Associates' Initial Quality Study: Best Compact Pickup in Initial Quality
- 1993: J. D. Power and Associates' Initial Quality Study: Best Compact Pickup in Initial Quality
- 1995: J. D. Power and Associates' Initial Quality Study: Best Compact Pickup in Initial Quality in North America

Tacoma

- 1996: J. D. Power and Associates' Initial Quality Study: Best Compact Pickup in Initial Quality in North America
- 1997: J. D. Power and Associates' Initial Quality Study: Best Compact Pickup in Initial Quality in North America
- 2001: Four Wheeler magazine: Ultimate 4x4 (Tacoma with TRD package)

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NUMMI's Awards (continued)

- 2001: The Toyota Tacoma tied for first place as the "Most Appealing Compact Pickup" in the 2001 J. D. Power and Associates' APEAL study. The study ranks Automotive Performance, Execution and Layout (APEAL).
- 2002: J. D. Power and Associates' Initial Quality Study: Best Compact Pickup in Initial Quality in North America
- 2004: Motor Trend: Truck of the Year.
- 2004: Automobile magazine: 2005 All-star Pickup

Prizm

- 1994: J. D. Power and Associates' Initial Quality Study: Best Model in the \$13,000 to \$17,000 Price Class in Initial Quality
- 1994: J. D. Power & Associates' Initial Quality Study: Among the Top Ten Models in Initial Quality
- 1995: J. D. Power and Associates' Initial Quality Study: Best Model in the \$12,000 to \$17,000 Price Class in Initial Quality
- 1995: J. D. Power & Associates' Initial Quality Study: Among the Top Ten Models in Initial Quality
- 2000: According to owner surveys for the 1998 through 2000 model years, nine out of 10 Prizm owners would recommend Prizm to a friend.

Vibe

- 2001: Autoweek Editors Choice Award
- 2001: Autoweek's Best of the Best – Most significant new vehicle runner up

Plant Awards

- 1994: J. D. Power and Associates' North American Plant Quality: Silver Plant award (tie)
- 1995: J. D. Power and Associates' North American Plant Quality: Bronze Plant award
- 1996: J. D. Power and Associates' North American Plant Quality: Bronze Plant award
- 1999: J. D. Power and Associates' North American Plant Quality: Silver Plant award
- 2000: J. D. Power and Associates' North American Plant Quality: Silver Plant award
- 2000: J. D. Power and Associates' Chairman's Award for Quality.
- 2000: NUMMI was the first manufacturing plant ever to receive the Chairman's Award.
- 2002: J. D. Power and Associates' North and South American Plant Quality: Bronze Plant award (tie)

Environmental Achievements

- 1989: California Water Pollution Control Association's Treatment Plant of the Year
- 1990: Bay Area Earth Day Committee's Northern California Environmental Achievement in Business Award
- 1991: Metropolitan Transit Commission's Special Recognition for Rideshare Program

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NUMMI's Awards (continued)

- 1991: RIDES for Bay Area Commuters' "Best New Rideshare Program" 1991: Union Sanitary District's Certificate of Merit
- 1992: Bay Area Air Quality Management District's Clean Air Champion Award
- 1992: California Water Policy Conference: Innovative Water Conservation Award
- 1992: PG&E's Energy Efficient Award
- 1993: RIDES for Bay Area Commuters: One of "Best 100 Employers in Bay Area"
- 1993: Association of California Water Agencies' California Water Awareness Award
- 1993: California Water Pollution Control Association: Northern California Plant of the Year
- 1993: California Integrated Waste Management Board's Waste Reduction Awards Program
- 1994: California Water Pollution Control Association's Company of the Year (Large Industry/Northern California)
- 1994: California Integrated Waste Management Board's Waste Reduction Awards Program
- 1995: California Water Pollution Control Association's Company of the Year (Large Industry/Northern California)
- 1995: California Integrated Waste Management Board's Waste Reduction Awards Program
- 1996: California Integrated Waste Management Board's Waste Reduction Awards Program
- 1996: Peninsula Conservation Center Foundation's Business Environmental Award for Resource Conservation
- 1996: Union Sanitary District's Certificate of Merit for Continuous Compliance
- 1997: California Integrated Waste Management Board's Waste Reduction Awards Program
- 1997: Union Sanitary District's Certificate of Merit for Continuous Compliance
- 1998: California Integrated Waste Management Board's Waste Reduction Awards Program
- 1998: DNV Certification Inc. Environment Management System Certification (ISO 14001)
- 1999: California Integrated Waste Management Board's Waste Reduction Awards Program
- 2000: California Integrated Waste Management Board's Waste Reduction Awards Program
- 2000: Union Sanitary District's Certificate of Merit for Continuous Compliance
- 2001: California Integrated Waste Management Board's Waste Reduction Awards Program
- 2001: DNV Certification Inc. Environment Management System Certification (ISO

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NUMMI's Awards (continued)

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- 2001: Spare the Air's Employer Impact Award
- 2002: California Integrated Waste Management Board's Waste Reduction Awards program
- 2002: Union Sanitary District's Certificate of Merit for Continuous Compliance
- 2003: Waste Reduction Awards Program (California Integrated Waste Management Board)
- 2003: TMMNA Environmental Award for Energy Conservation
- 2003: The Industrial Environmental Association and California Manufacturers & Technology Association Award for corporate commitment to community and Environmental Responsibility
- 2004: Waste Reduction Awards Program (California Integrated Waste Management Board)
- 2004: DNV Certification Inc. Environment Management System Certification (ISO 14001)
- 2005: Susanne Wilson's Business Environmental Award for Pollution Prevention.
- 2005: Union Sanitary District's Certificate of Merit for Continuous Compliance
- 2005: Waste Reduction Awards Program (California Integrated Waste Management Board)
- 2005: Environmental Protection Agency's Energy Star Partner of the Year
- 2006: U.S. Environmental Protection Agency's Energy Star Sustained Excellence 2006 Award
- 2006: Union Sanitary District's Certificate of Merit for Consistent Compliance

Corporate Citizenship

- 1990: Industry Week magazine: One of 12 best manufacturing companies in the U.S.
- 1990: National Association of Suggestion Systems' Group Winner Performance Excellence Award
- 1991: California Cooperative Education Association's Outstanding Cooperative Education Award
- 1993: Alameda County Industry Education Council's Outstanding Community Service Project
- 1998: National Association of Manufacturers' Award for Workforce Excellence
- 2001: East Bay Leadership Foundation's Corporate Leader of the Year
- 2002: American Heart Association's Heart Saver of the Year Award for use of a defibrillator
- 2002: California of Recognition for use of a defibrillator
- 2002: American Cancer Society's Collaboration Award for Daffodil Days campaign participation

Appendix G (page 1 of 2)

Eighteen Points About “NUMMI Today”

(Summarized from NUMMI Plant a Model for Ailing Car Industry,
March, 2006)

1. NUMMI hasn't had a layoff since starting.
2. NUMMI “builds cars that sell,” especially now since all their products are relatively small and fuel-efficient.
3. NUMMI continues to succeed while Ford/GM are hurting.
4. The keys to its success are good labor relations and the TPS.
5. In 2002 during a new model year for the Corolla, NUMMI realized they needed to educate new workers better and reeducate some of the older workers. This apparently was about the elements of the TPS such as *kanban*, *kaizen*, and *jishuken*. Note: see *Losing the “TPS” edge* in section 7.
6. This renewed education effort apparently has resulted in significant improvements in production and safety.
7. NUMMI makes (at least at that time) 960 cars/day and 650 trucks/day. A car comes on every 55 sec. and a truck every 88 sec. A car takes 6.5 hours to make.
8. NUMMI is where the two largest carmakers can see what each other's doing.
9. NUMMI is an independent, private company. It doesn't disclose its profits.
10. NUMMI is a place where GM and Toyota can learn from each other.
11. GM has learned a lot from NUMMI and this is reflected in recent recognized improvements in its quality. The problem is it now has a bad reputation to overcome.
12. NUMMI's workers are dedicated to building great vehicles.
13. A new and better (for the workers) four-year contract was negotiated in August 2005.

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Eighteen Points About “NUMMI Today” (continued)

14. Supposedly NUMMI can't build enough cars fast enough to meet demand.
15. NUMMI runs two shifts a day starting at 6 a.m.
16. The next big challenge will be in 2008 when both the Vibe and Corolla will undergo “either a metamorphosis or some significant modifications.” The focus will continue to be fuel efficiency.
17. Toyota and GM design the cars built at NUMMI.
18. NUMMI must work even harder than most auto manufacturers in the U.S. since producing in California “costs 30 percent to 40 percent more.” This is due to higher costs for such things as energy, real estate, labor, and workers' compensation.