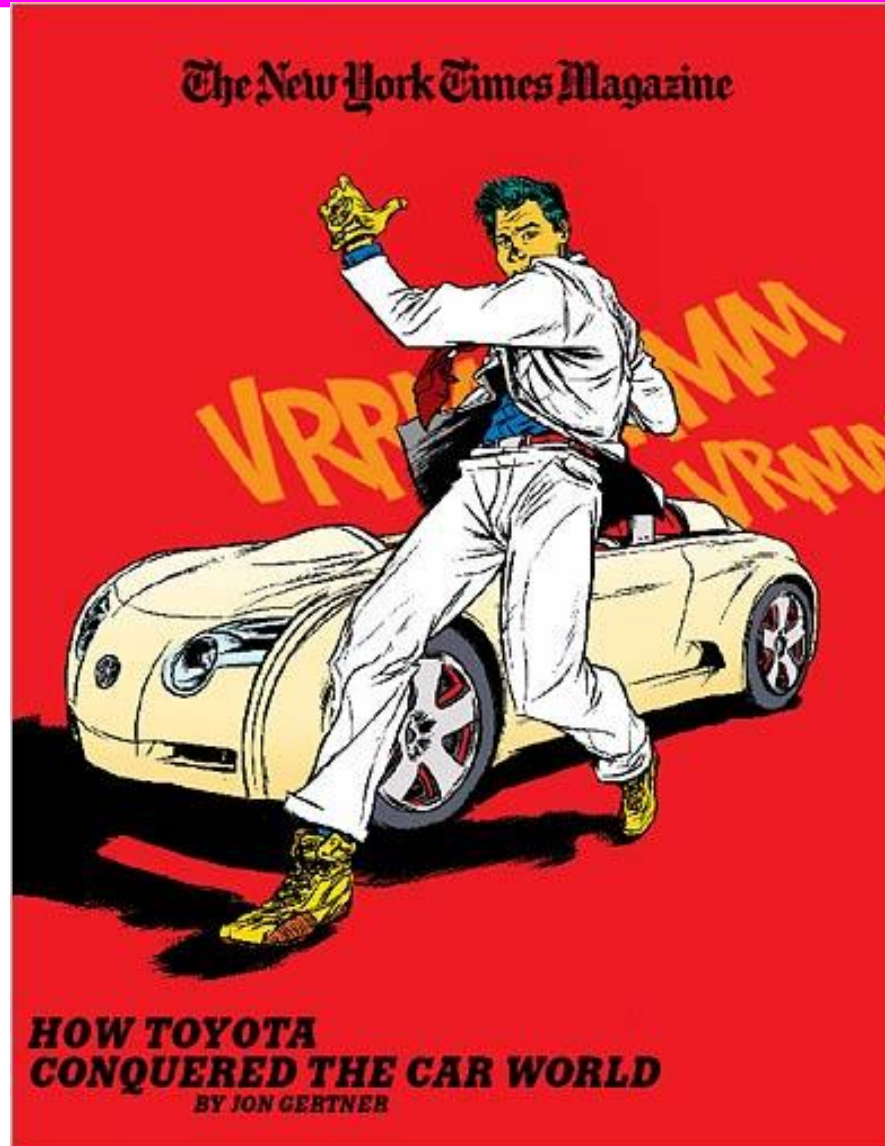


# **Toyota Motor Manufacturing (TMM)**

---

**A case on Just-in-time and  
Total Quality Management**

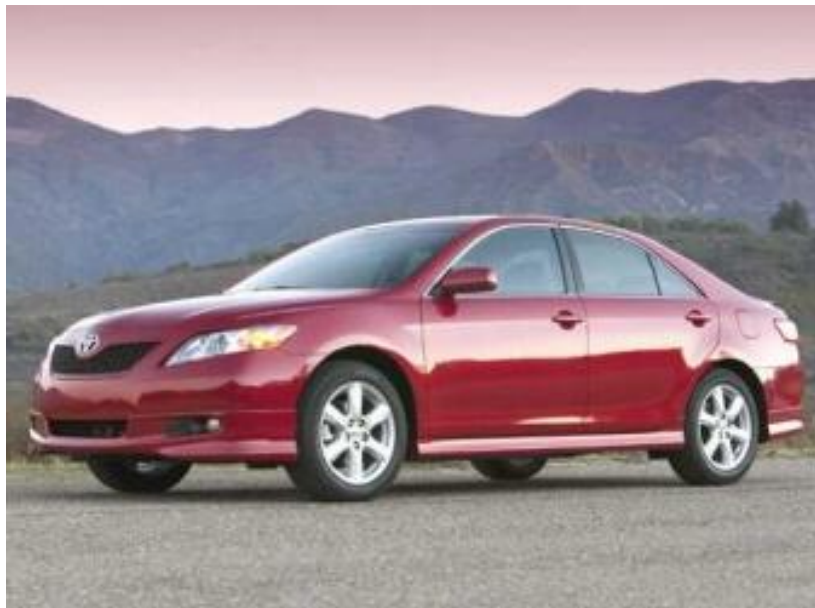
# TOYOTA - the Largest Car Manufacturer



# All of Toyota Plants in the North America



# Toyota Camry Then (1992) and Now (2007)



To Cincinnati



Toyota  
Georgetown  
Plant

Frankfort Rd



Lexington-Fayette

Versailles Rd

E New Circle Rd

Lexington

To Dallas



© 2006 Navteq

A EarthSat  
DigitalGlobe

© 2005

Google



# Georgetown Plant [www.toyotageorgetown.com](http://www.toyotageorgetown.com)

---



# History of the Plant

---

- Ground breaking, May 1986
- First Car, May 1988
- Fujio Cho named the second president, Dec 1988
- 1 millionth Camry, Oct 1993
- 2 millionth Camry, Apr 1997
- Camry #1 selling car in the US in 97, 98, 99, 00
- Gary Convis named fifth president, Apr 2001
- Camry #1 selling car in the US in 02, 03, 04, 05
- Sixth generation Camry starts, Feb 2006



# Overview of the Production Process

---

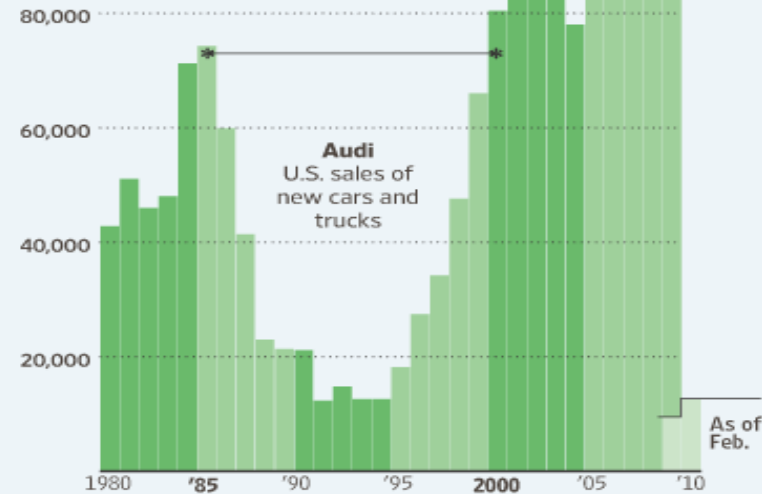
- ◆ Engine manufacturing, powertrain
- ◆ Plastics, used for panels, bumpers, connections, protections
- ◆ Stamping, shaping the steel coils into body parts
  - Uses 1300 dies (analogous to cookie cutters)
- ◆ Welding of the body
- ◆ Painting
- ◆ Assembly
  - Trim
    - » Heater, A/C, Wiring
    - » Bumpers, Headliners
  - Chassis, underbody work, engine marriage, **accelerator pedals**
  - Final line, air bags, instrument panels, **seats**
- ◆ Final test, driving

# Accelerator Pedals

## Back to Distant Past: Audi

### Uphill in Low Gear

It took 15 years for Audi sales to recover after a scare over sudden acceleration in 1986.



Source: MotorIntelligence.com

☐ Mar 20, 1986: NY's attorney general asks the transportation department to order Volkswagen of America to recall 200,000 Audi 5000s.

☐ Attorney general's petition says NHTSA (National Highway Traffic Safety Administration) is "clearly inadequate" to protect the public.

☐ It continues by noting that nearly 400 accidents involving sudden acceleration happened in 1978-1986.

Audi 5000's accident rate is 1/500.

☐ May 30, 86: Audi recalled 132,000 Audi 5000s with automatic transmissions. It said that the brake and accelerator pedals were positioned incorrectly.

☐ Aug 18, 86: NHTSA probes 300,000 Audis with automatic transmissions produced in 1978-1986.

☐ Audi decides to install automatic shift locks in 1978-1986 cars and all to be produced in the future. Lock prevents shifting the car to drive or reverse without pressing the brake.

☐ Sep 3, 86: Audi's analysis of accidents: Many of accidents occurred in cars that are relatively new (<6K miles); many drivers were not the primary driver of the car; many drivers were women under five foot six inches. Report concludes with a cause: drivers are inadvertently pressing the gas pedal rather than the brake. Audi starts shipping safe-driving videos.

☐ 1989 report: Electronic faults in the idle-control systems of Audi 5000s can cause a short-term power surge that could startle drivers into inadvertently hitting the gas pedal. It suggested:

1) Move the pedals apart (Audi moved them apart by 4cm.)

2) Raise the brake pedal to make it harder to hit both the brake and gas at once.

3) Install a "shift-lock". (Audi already installed them.)

# Accelerator Pedals

## Back to 2011: Toyota

- ❑ Car manufacturers are regulated by NHTSA
  - ❑ **Lack of capacity:** NHTSA employs 57 people and receives 35,000 complaints per year.
    - ❑ NHTSA relies on manufacturer supplied data and safety record. It does not have the capacity or expertise for independent testing of a car.
  - ❑ **Possible conflict of interest:** “[Ex-NHTSA] Regulators Hired by Toyota Helped Halt Acceleration Probes” Feb 13, 2010 [www.bloomberg.com](http://www.bloomberg.com).
- ❑ NHTSA investigated Camry and Lexus ES in 2004 for unintended acceleration.
  - ❑ Toyota started installing **electronically controlled pedals** into Camries in 2002. This technology gives fuel efficiency and is later used in Lexus ES.
  - ❑ NHTSA had 37 complaints in 2004, 30 of which involved accidents
    - ❑ 27 long duration-incidents: Driver may have confused the gas pedal for the break pedal according to NHTSA.
    - ❑ 10 short duration-incidents: NHTSA had found no pattern of safety problems and investigation was closed on July 22, 2004.
  - ❑ More complaints in 2005 and 2006, NHTSA opens a new investigation in March 2007.

**2007**

March 29

NHTSA opens an investigation into the 2007 Lexus ES350 based on five consumer complaints of pedal entrapment.

Sept. 13

NHTSA finds that the fatal crash of a 2007 Toyota Camry was caused by floor-mat pedal entrapment and tells Toyota a recall is needed.

Sept. 26

Toyota recalls all-weather floor mats. NHTSA warns Toyota owners to remove or properly secure mats.

**2009**

Sept. 25

After a fatal crash of a 2009 Lexus ES350, NHTSA tells Toyota it expects a recall to address the defect in the pedal design, not just floor mats.

Oct. 5

Toyota recalls 3.8 million vehicles for pedal entrapment by floor mat.

**2010**

Jan. 16

Toyota tells NHTSA that certain pedals may have a defect. NHTSA later tells Toyota it expects prompt action.

Jan. 21

Toyota recalls 2.3 million vehicles. Days later NHTSA informs Toyota that it must stop selling the affected vehicles if they find a defect. Sales halt the next day, and Toyota soon recalls 1.1 million more vehicles.

# Accelerator Pedal Problems

---

- ◆ January 2010: Toyota suspends US sales of 8 car and trucks. It recalls 2.3 million vehicles first and afterwards recalls 1.1 million more vehicles. The recalls are related to “accelerator pedals”.
- ◆ October 2009: Toyota recalls 4.3 million vehicles over a concern of unintentional acceleration. Acceleration pedal may get stuck under the floor mat. Toyota suggests removing driver’s side floor mats.
- ◆ It is not clear if the unintentional acceleration is due to floor mats or an internal malfunctioning in the accelerator pedal.

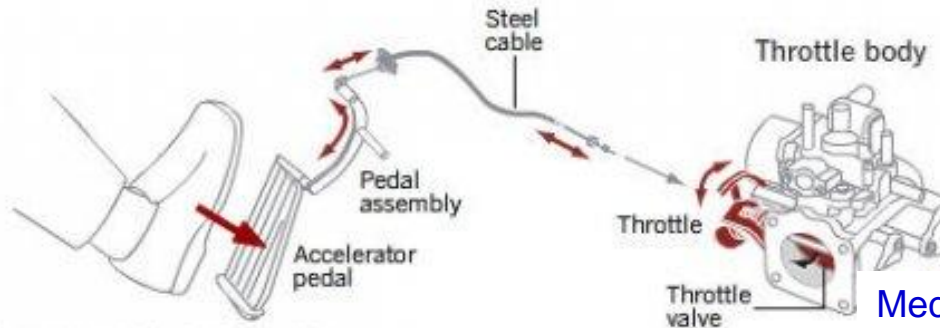


The problem is unintentional acceleration but its root cause is not known exactly: *“Toyota ... put a hold on sales in response to growing concerns that possible defects may cause the vehicles to accelerate unintentionally, but many questions remain about the cause of the problem”*, according to Toyota Nears Repair for Accelerator, by K. Linebaugh and M. Sanchanta, WSJ January 28, 2010.

Yet, Toyota shares dropped 15% in 3-4 days; CTS Corp (pedal supplier in Indiana) shares dropped 16% over the same time span in January 2010.

# Accelerator Pedals: Mechanic or Electronic Control

**Steel cable:** When the driver presses down on the accelerator pedal, it pulls a cable that physically opens the throttle valve, thereby regulating the intake of air and gasoline to the engine.

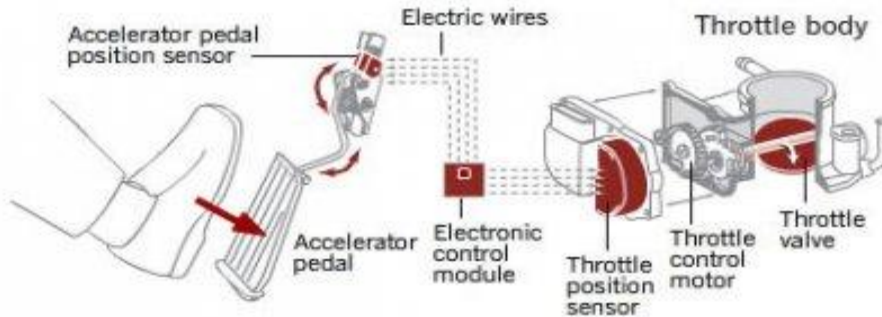


Note: Drawings are representational and not to scale.

Sources: Toyota, National Highway Traffic Safety Administration, Times research, Graphics reporting by WIL RAMIREZ

Mechanic control  
of gas and air inflow  
Into the engine

**Signals:** An electronic sensor detects the position of the accelerator pedal and sends a signal to the vehicle's computer, or electronic control module (ECM). The module then signals the throttle to regulate air intake.



Sources: Toyota, National Highway Traffic Safety Administration, Times research, Graphics reporting by WIL RAMIREZ

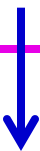
Electronic control  
of gas and air inflow  
Into the engine

2002

Later



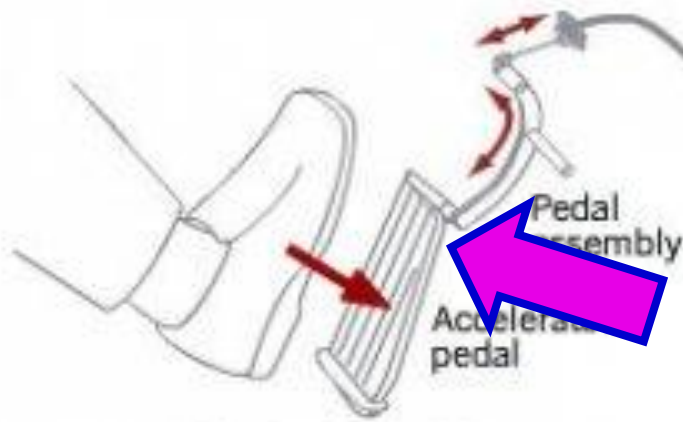
Camry



Lexus ES

# Fixing Accelerator Pedal: Spacer

**Steel cable:** When the driver presses down on the accelerator pedal, it pulls a cable that physically opens the throttle valve, thereby regulating the intake of air and gasoline to the engine.



Note: Drawings are representational and not to scale.

Sources: Toyota, National Highway Traffic Safety Administration, Times Graphics reporting by WIL RAMIREZ.

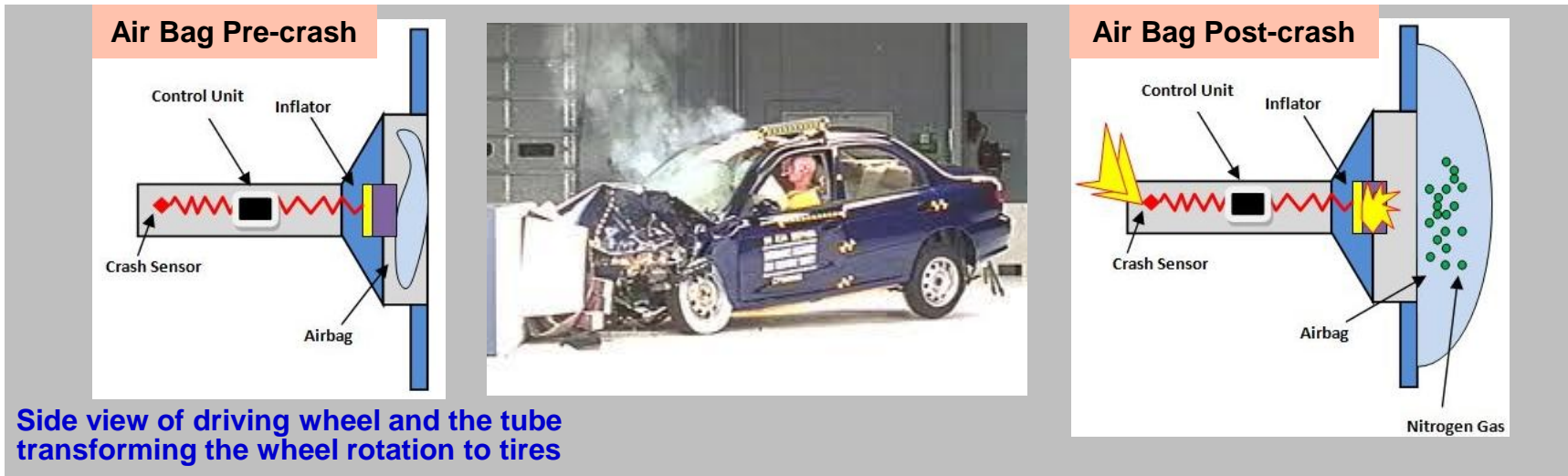
- ❑ The problem could be that accelerator pedal, once pushed forward to accelerate, remains in the “pushed forward” position even when the driver is not pushing anymore.
- ❑ This can cause unintentional acceleration.
- ❑ The pedal should ideally return to its natural position when the driver pulls his/her foot.
- ❑ To fix this problem, a spring mechanism can be inserted into the pedal assembly to “push back” the pedal into its natural position.
- ❑ Toyota and CTS announced a solution called “spacer” on Jan 28, 2010 to enforce this “push back” mechanism.
- ❑ “Spacer” production started immediately at CTS.

# E<sup>x</sup>ponent Exonerates Electronic Controls

---

- E<sup>x</sup>ponent is an engineering and consulting company; based in Menlo Park, Ca; see [www.exponent.com](http://www.exponent.com).
  - Toyota hires E<sup>x</sup>ponent to investigate unintended acceleration in Dec 2009.
  - 6 Toyota and Lexus vehicles, all with electronic gas (throttle) controls, were tested in Dec 2009 and Jan 2010.
- The result of the investigation is put in a Feb 4, 2010 report. The report is to be shared with the Congress. According to “*Toyota-Funded Study Finds No Problem With Electronics*” by K. Linebaugh on WSJ Feb 13, 2010, the report says:
  - ❖ "Exponent has so far been **unable to induce, through electrical disturbances to the system, either unintended acceleration or behavior that might be a precursor** to such an event, despite concerted efforts [stress situations] toward this goal”
  - ❖ "Imposing perturbations [stress situations] resulted in a significant drop in power rather than an increase. **In all cases, when a fault was imposed, the vehicle entered a fail-safe mode.**"

# Faulty Air Bag Inflators Force Japanese Automakers Recall Vehicles



**Toyota 1.73 million**  
Corolla, Corolla Matrix, Sequoia, Tundra, Lexus SC 430, others

**Honda 1.13 million**  
Civic, CR-V, Odyssey, others

**Nissan 0.48 million**  
Maxima, X-Trail, others

**Mazda 0.045 million**  
Limited models

**Toyota, Honda, Nissan, Mazda recalled more than 3 million vehicles on April 11, 2013.**



# Back to Case: What is Doug Friesen's problem?

---

# A Test of Japanese

---

- ◆ Andon
- ◆ Heijunka
- ◆ Ikko-nagashi
- ◆ Jidoka
- ◆ Kaizen
- ◆ Kanban
- ◆ Muda
- ◆ Poka-yoke
- ◆ Takotei-mochi
- ◆ Tsukurikomi

What is violated at TMM?

# 1. Line stoppage

---

## 2. Crowding in the overflow area

---

# 3. Assembly area

---

# 4. Supplier

---

# 5. Seat Mismatches

---

How much of TPS is culture?  
How much of it is science?

---



# Toyota from an Ex-Toyota Design Engineer

---

Darius Mehri, author of "Notes from Toyota-land", Cornell University Press, 2005, spent 3 years as a design engineer in Toyota, Japan. Below, you will find excerpts from [www.gembapantarei.com/2006/05/interview\\_with\\_darius\\_mehri\\_author\\_of\\_notes\\_from\\_toyotaland.html](http://www.gembapantarei.com/2006/05/interview_with_darius_mehri_author_of_notes_from_toyotaland.html) and his article in WSJ Opinion Asia Feb 13, 2010, titled "Kaizen Goes Kaput".

He has been impressed with some aspects of TPS:

➤ Kaizen: "It is rare ... to design products that are flawless the first time around. ... I was impressed when a lead engineer in my section was flown to Pakistan on short notice to gather information on a new engine that was failing due to desert sand wearing out the ... components. When he returned, his team ran an analysis and within a few months the problem was fixed. **Very few companies have the inclination or the ability to redesign and retool the manufacturing of a product in such a short time.**"

➤ Long-term profits: "... **managers in Japan** ... aren't concerned about short term profits. They don't have to worry about stock market values. They **think long-term**. Their whole focus is on designing good products. There are limitations on owning stock if you are a manager in your company."

# Toyota from an Ex-Toyota Design Engineer

---

Mehri has not been impressed with other aspects of TPS:

➤ ... “**respect for workers [is] a myth.** ... I experienced very long working hours. One of the things I observed was that Lean [manufacturing or JIT] also means cutting back on personnel and overloading workers. ... I think a lot of people, particularly **academics** who write about Lean, are either unaware of the problems or are aware of this but **don't write about it.** ... I joined some foreign worker professional organizations with people working in various Japanese companies and they had all very similar stories. They had very long working hours. For example the academics don't talk about **service overtime.** That is a rule in Japanese companies for workers to work overtime, ... staying in their office late ... for free.”

➤ Effectiveness of Japanese companies:

➤ I don't think most Americans could survive in ... that. ... I think the Japanese don't have the choice. There's **very limited labor mobility for the Japanese worker.** ... so the management isn't incentivized to try to keep you ... by improving the work environment.

➤ Japanese managers don't close factories as readily as in the U.S. ... . They see their national security directly correlated to industrial strength where in [U.S.] we view [ours] ... directly correlated to military strength.”

# Toyota is worried of its culture being diluted with fast overseas growth

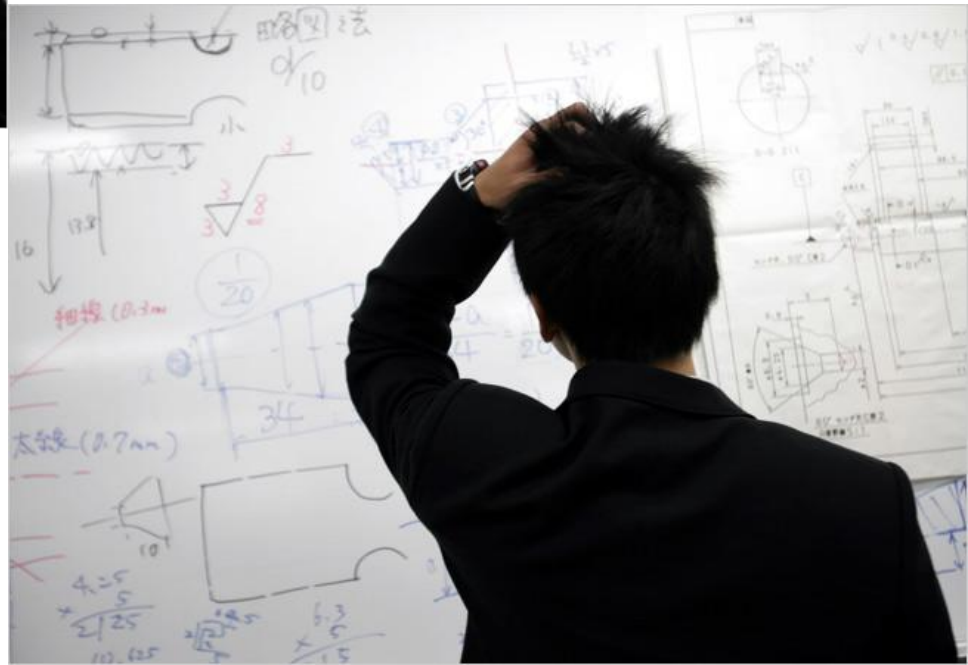


“... the hardest thing for Toyota’s new American employees to accept: those colored bar **[performance] charts** against a white bulletin board, in plain view for **all to see.**”

Latondra Newton, Toyota Employee in Erlanger, KY  
New York Times Business Feb 15, 2007.

Aspiring Toyota factory leaders attend Toyota Technical Skills Academy (high school) in Toyota City, Japan. They study mechanical drawing/design .

A separate institution, Toyota Institute, prepares executives for Toyota Way. The institute sends off its executives to offices around the world as missionaries.



# Toyota from an Ex-Toyota Design Engineer

---

Mehri continues in WSJ Opinion Asia Feb 13, 2010, titled “Kaizen Goes Kaput”.

For over two decades, Toyota's management strove toward the day the company would unseat GM as the world's No. 1 automaker. The ... consistent ability to produce high-quality vehicles and sense trends to break into a wide variety of market niches enabled its eventual rise to the **top spot, [which] ... looks like a poisoned chalice.**

**[Kaizen]** was mainly used **to tweak designs** to improve product performance. These techniques **ensured increased market share** for the company because buyers could immediately see the results of the improvements in new models. But some of the **most complex engineering design processes—and the ones that tend to fail—are under the hood and out of sight of most owners.**

TPS involved a punishing amount of work for its employees .... Projects required meeting strict design and quality goals with unyielding deadlines. It was not unusual for engineers to put in 16-hour days for several months. I remember one engineer who frequently dozed off at his computer while working on an engine analysis. ... **Under ... unrelenting overwork, it is simply too hard for engineers to produce products without design flaws and too easy for managers to hide those flaws.**

# Samurai Principles for Success

---

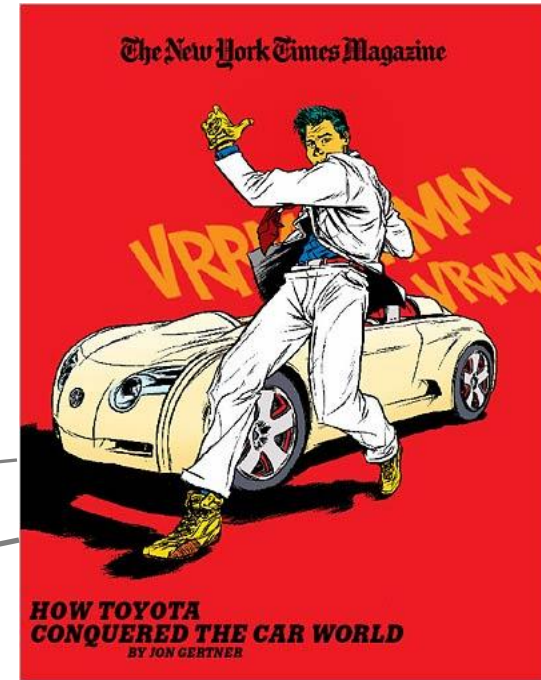
- ❖ **Develop yourself** to the benefit of the world around you.
- ❖ If you encounter a problem: change it, accept it or leave it.
- ❖ Take a **close view of distant things** and a **distant view of close things**.
- ❖ Look fear in the eyes while doing what you think is right and necessary.
- ❖ Inspire people and **celebrate successes with gratitude, not arrogance**.
- ❖ **Be helpful and generous**, yet choose the people around you wisely.
- ❖ **Dedicate yourself to a purpose beyond power, control or earning money**.
- ❖ **Balance** careful planning with creative / flexible execution.
- ❖ **Stay connected to yourself** and the environment.
- ❖ **Take care of yourself** and those around you.
- ❖ **Don't fight inevitable** developments.
- ❖ **Be respectful, yet clear and sharp**.
- ❖ **Reflect without judging**.

Principles are from “*Samurai Business: The way of the warrior for professionals in the digital century*” by J. Mepks.



# TOYOTA - the Largest Car Manufacturer

## Unintended Acceleration to Drink from a Poisoned Chalice



# Toyota Way of Finishing a Class: - *Sayonara!*



# NUMMI

---

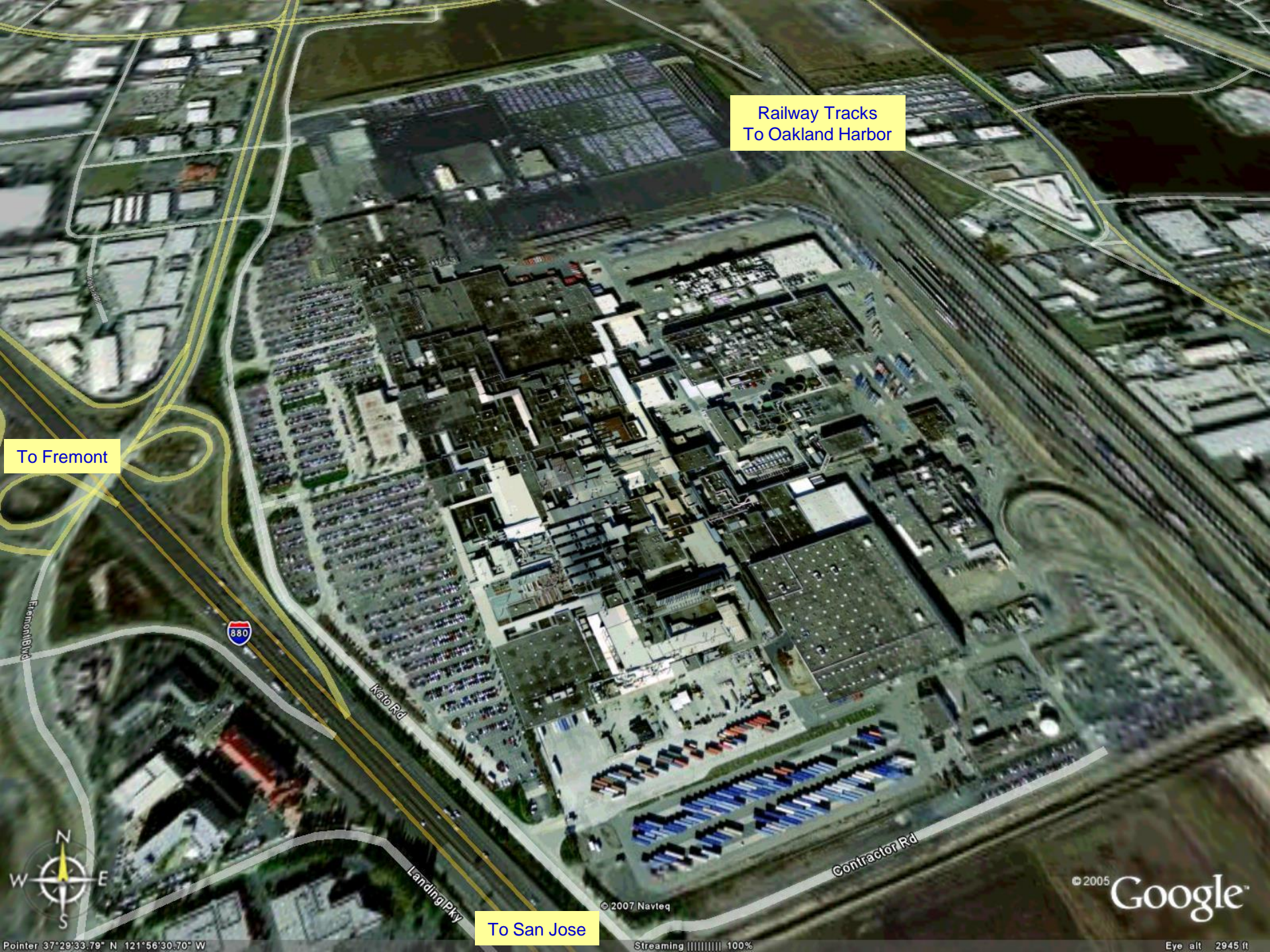
Based on a trip on Nov 19, 2002  
This plant is closed in the early 2010s



Railway Tracks  
To Oakland Harbor

To Fremont

To San Jose



Fremont Blvd

Kato Rd

Landing Pkwy

Contractor Rd



© 2007 Navteq

© 2005 Google

Pointer 37°29'33.79" N 121°56'30.70" W

Streaming 100%

Eye alt 2945 ft

# History/Products

---

- ◆ Late 70's oil crisis
- ◆ GM closes Fremont, CA plant firing 6000 in 1982
- ◆ Toyota approaches GM to set up Toyota production system at a GM plant, United Auto Workers accepts the deal
- ◆ GM and Toyota put together \$400M in 1984.
  - GM is the landlord, it owns the infrastructure
  - Toyota is the tenant
- ◆ Nummi = New United Motor Manufacturing, Inc is born in 1984 as the unique example of a Toyota – GM joint venture
- ◆ Products: Toyota Corolla, Tacoma Trucks, Pontiac Vibe (Toyota bottom, GM top) and Toyota Voltz (Toyota bottom, GM top, sold in Japan) , GM Prism until 13/12/01

# Workers

---

- ◆ Nummi has about 4500 unionized workers
- ◆ Workers are under two types:
  - Production, high school graduates
  - Maintenance
- ◆ Workers work in teams of 4-6
- ◆ Workers in a team rotate the tasks every 1-3 hours
- ◆ Team leader is responsible for the rotation.
- ◆ Team leader withdraws parts from the inventory (every 1-2 hours) and provides the tools as necessary
- ◆ Workers make \$17 per hour

# Capacity

---

- ◆ Nummi has a cycle time of
  - 60 seconds for Corolla, 1 body
  - 82 seconds for Tacoma, 3 bodies
    - » only cabin is produced at Nummi, the bottom and the back are bought from suppliers
- ◆ Nummi works in two shifts
  - I: 6:00-14:30, II: 16:30-1:00
  - Each shift has 1 hour lunch/dinner break
  - Starting the first shift at 6:00 workers avoid heavy morning traffic
  - Two hours between shifts I and II is to allow for overtime after the first shift when necessary



# Work Flow

---

- ◆ Stamping: Forming metal (side, back, front) panels with presses
- ◆ Body & Weld: Putting panels together
- ◆ Paint: Paint inspection is the current bottleneck
  - Primer body paint applied by robots (chemically hazardous task)
  - Door jambs painted manually
- ◆ Plastics: Making bumpers, inside panels
  
- ◆ Assembly: Putting in tires, engine, seats, bumpers, harnessing. Cars , trucks on 2 km , 0.8 km conveyors
- ◆ Cars contain Building manifest = BOM = Ingredients list at every step of these operations

# Just in time

---

- ◆ Kaizen: continuous improvement
- ◆ Kanban: replenishment every 1-2 hours
- ◆ Jidoka: Assure 100% quality. Otherwise pull the Andon chord
  - 1000 times per shift
  - 9% of line stops are longer than 30 seconds
  - Line stops longer than an hour once every month
- ◆ Muda: Waste to be eliminated
- ◆ Genchi Genbutsu: Go to the source to learn and to solve the problems
- ◆ This Japanese terminology is all over the boards in the plant

# Creative Tool / Work Place Design

---

- ◆ Die change at the stamping in 3 hours
- ◆ Tilted storage bins for ease of access
- ◆ Collapsing storage boxes when empty
  - To reduce the empty box storage requirements in trucks returning to suppliers, say in Indiana
  - These boxes save about \$10M annually
  - The worker who suggested the boxes earned several thousand points. 1 point = \$1.
- ◆ More info [www.nummi.com](http://www.nummi.com)

To San Antonio by I-35

I-35 & I-410 Intersection  
Southwest of San Antonio

I-410 Loop

# Home of Tundra in San Antonio



Pointer 29°16'25.06" N 98°32'31.23" W elev 522 ft

Image © 2007 DigitalGlobe  
© 2007 Navteq

© 2007 Europa Technologies

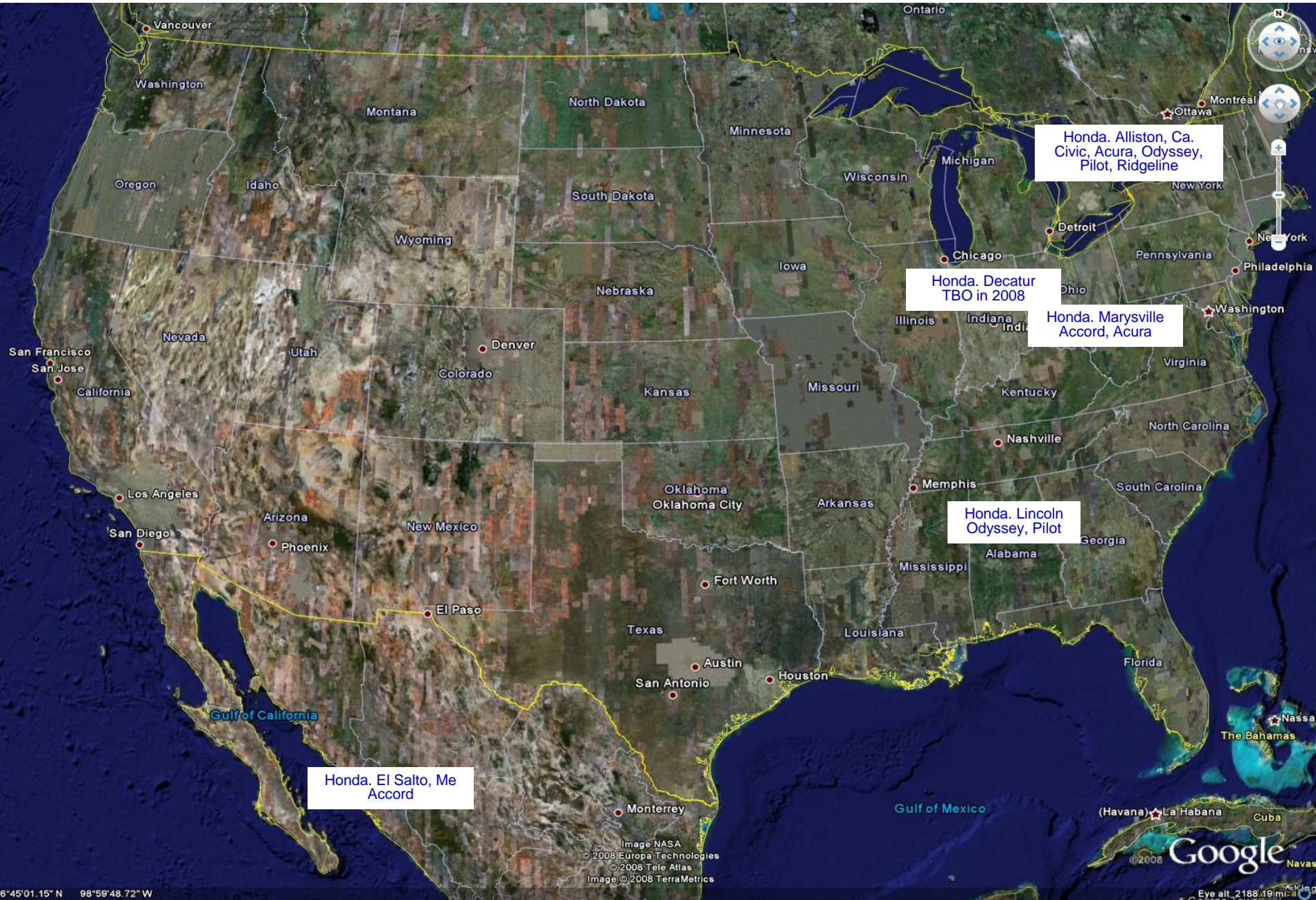
Streaming 100%

© 2005 Google™

Eve alt 14563 ft



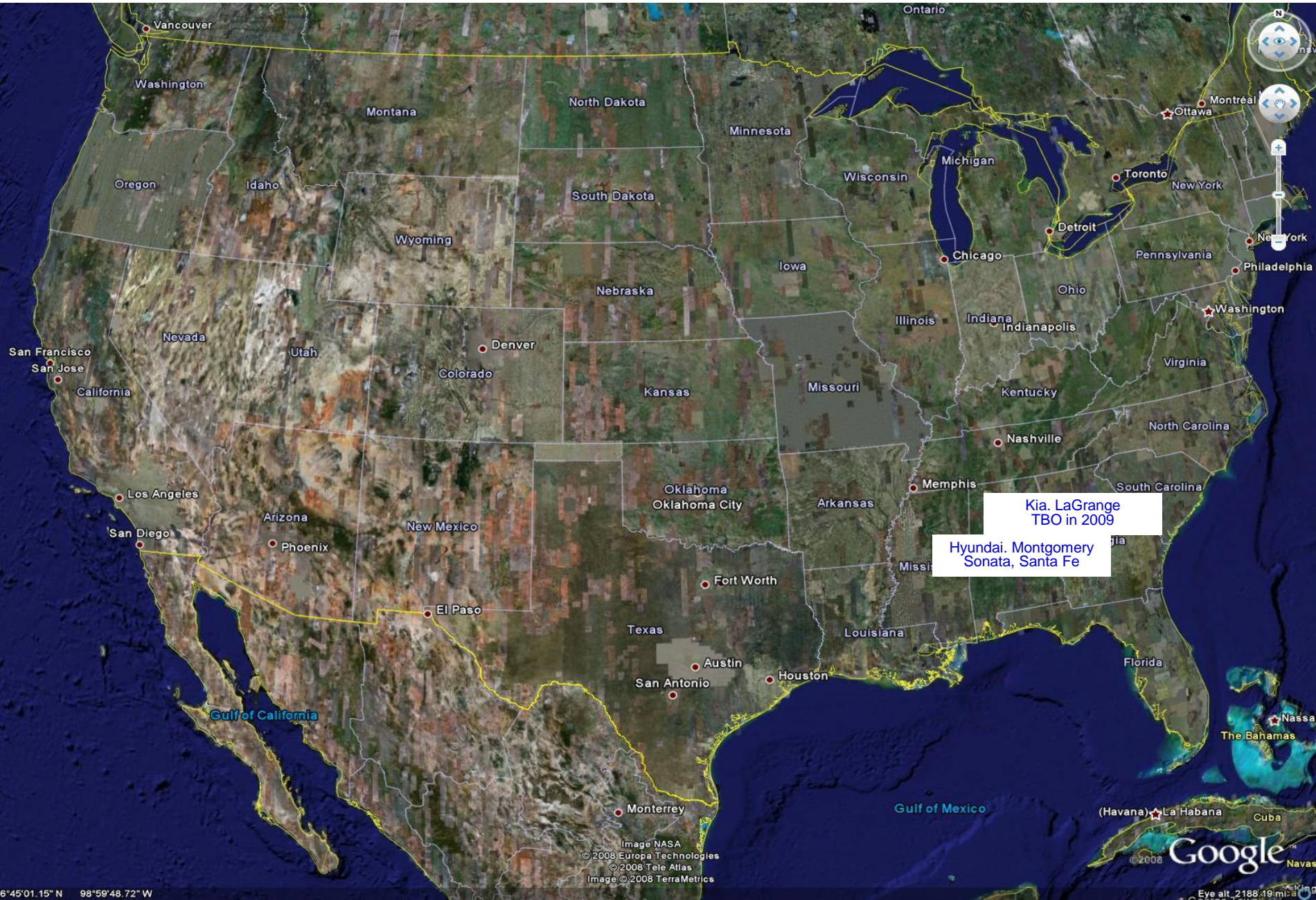
# All of Honda Plants in the North America in 2008



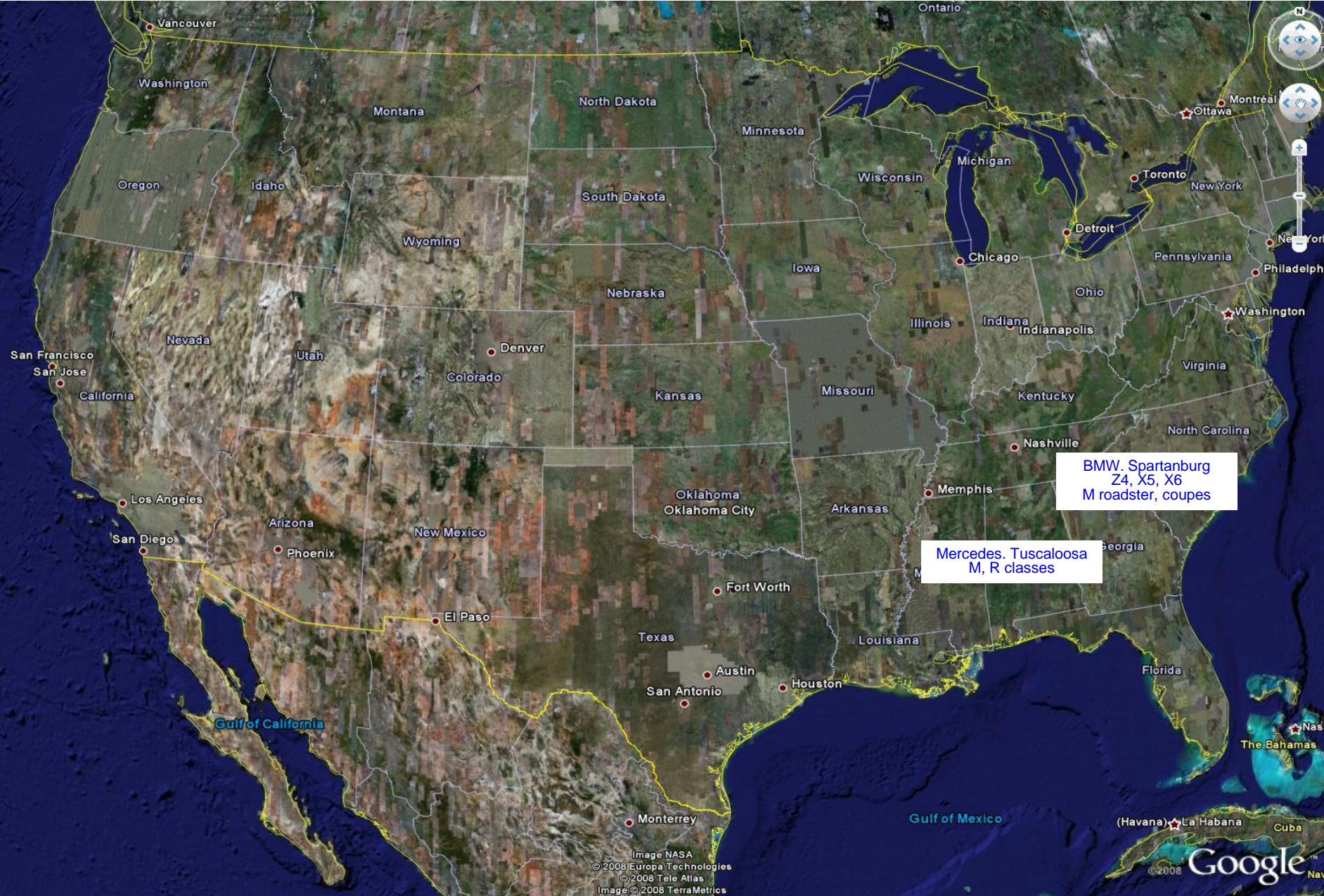
# All of Nissan Plants in the North America



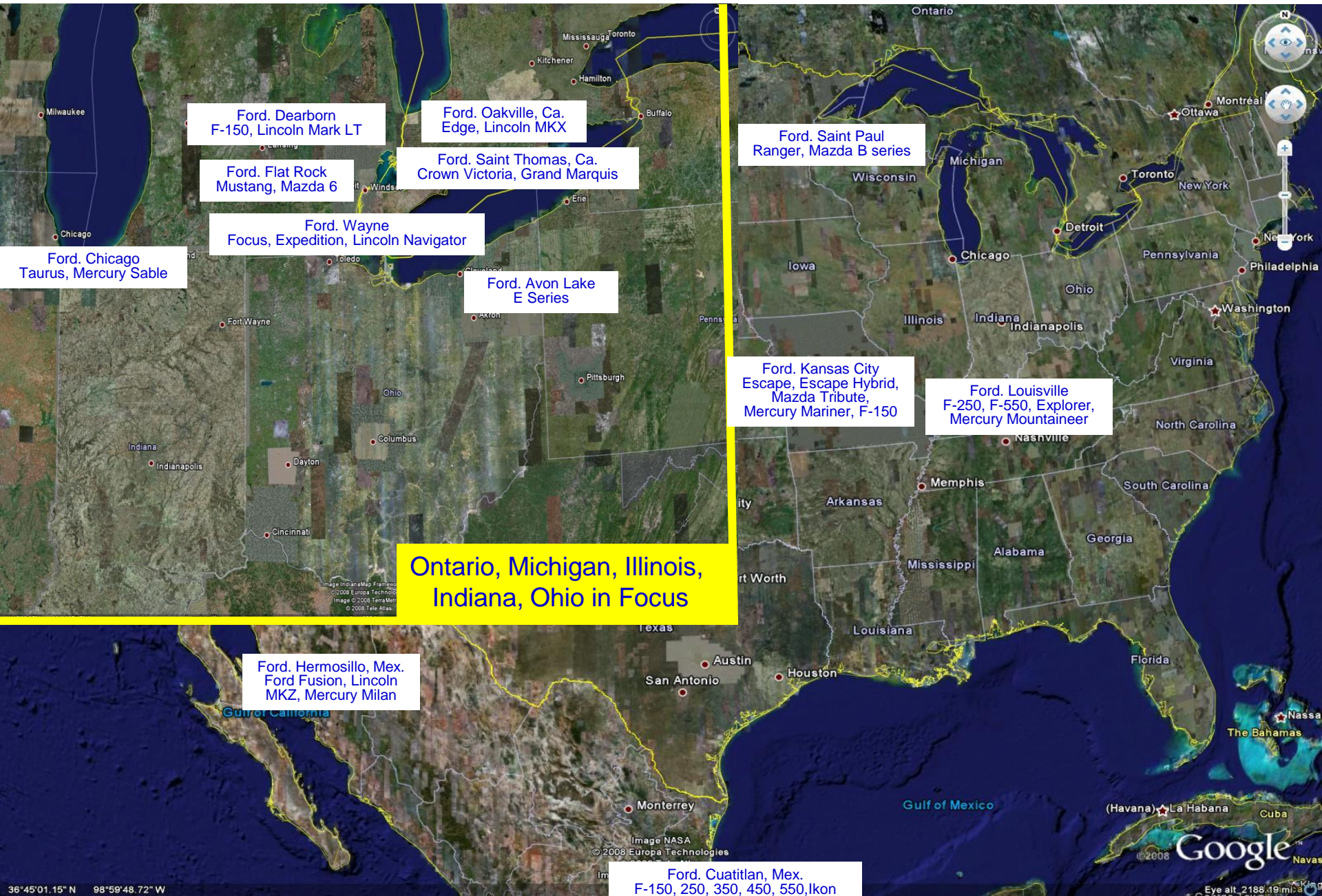
# All of Hyundai-Kia Plants in the North America



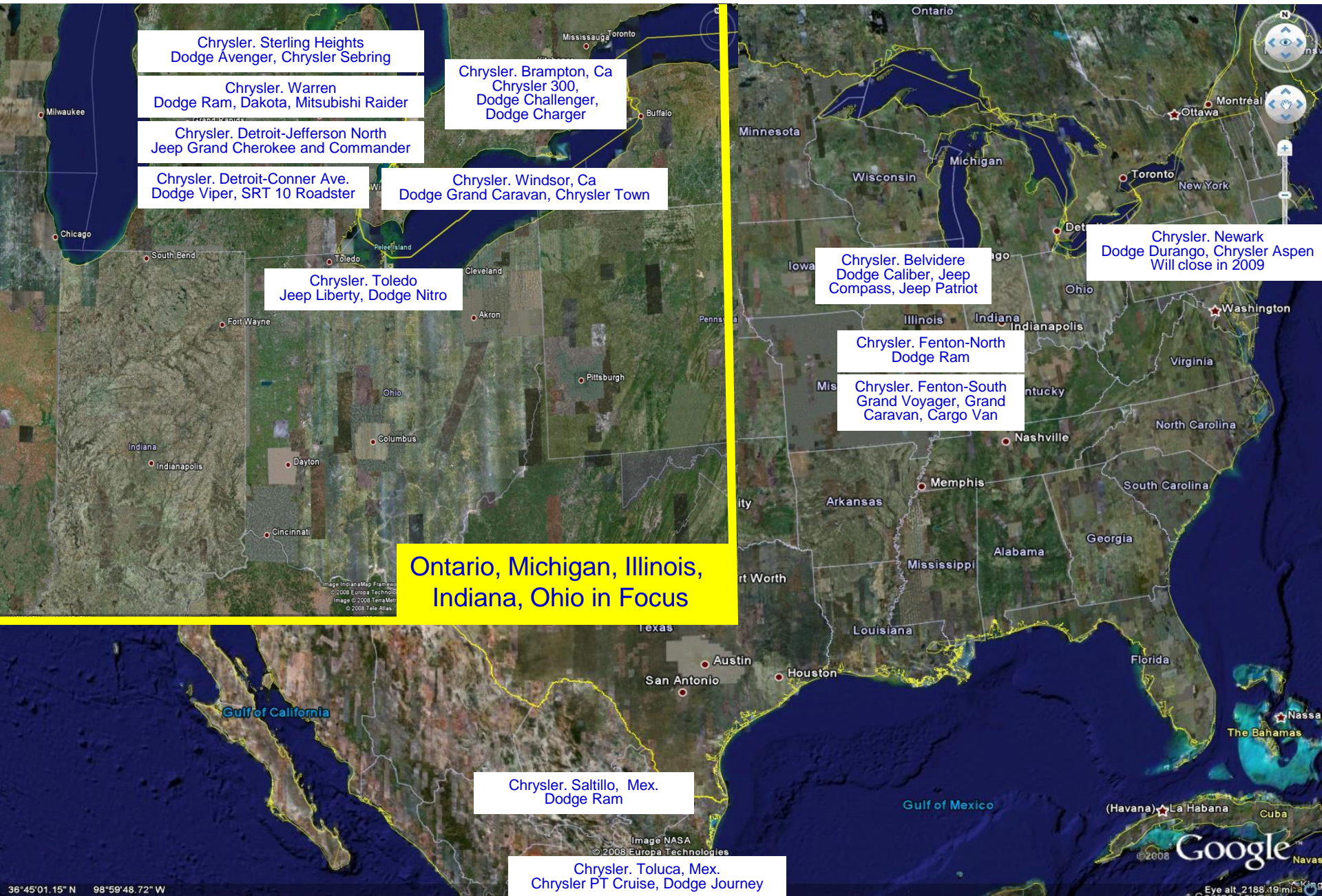
# All of Mercedes and BMW Plants in the North America



# All of Ford Plants in the North America



# All of Chrysler Plants in the North America



# All of GM Plants in the North America



Ontario, Michigan, Illinois, Indiana, Ohio in Focus