Business Administration

Lecture No. 5: History of Product and Production System: With Focus on Automobile (2)

1.Characteristics of Automobile Industry
2.Automobile and Production System in Early Phase
3.Japanese Automobile Industry in Incunabula
4.Hypothesis on Product/Process Lifecycle

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1.Characteristics of Automobile Industry

Characteristics of Automobile as Product

High-priced durable consumption good (passenger car)

Requires multiple functions:

transportation means of individual control; means of self-expression;

"toy" function; function of alternative housing

Social good: traffic accident, fuel consumption, exhaust emission, noise, disposed car issue

Complicated mechanical product: number of parts at 20-to-30 thousand;

Having an enormous ancillary base

Iron steel remaining major material as yet

Closed integrated architecture: requires parts of interrelated optimum-design works

Gasoline internal-combustion engine as base for passenger cars:

Few electricity-powered cars yet

Characteristics of Automobile Industry

One huge industry to represent the 20th century.

20-30 auto makers flourishing in the world, being stable in recent years: Oligopoly-ish, but severely competitive, especially in terms of "capabilitybuilding competition"

Industry of national pride: Feature of "state capital" when it comes to the push.

Running complex games of competition, collaboration, and conflict.

No big revolution to overturn existing companies in recent years, and a cumulative evolution as base.

Down-to-earth "industrial marathon" continuing on.

Positions of Automobile Industry in Japan's Economy

Item.	Location.
Number of employed people.	10 percent of number of employed people.
Amount of production of major manufactures.	10 percent of amount of production.
It is sales amount during the year of the retail trade.	10 percent of amount of retail.
It is exports during year.	10 percent of exports (four-wheeled vehicle).
Amount of capital investment of major manufactures.	20 percent of amount of capital investment.
Research and development spending of manufacturing.	10 percent of research and development spending.
Tax revenue.	Car implication various taxes are 10 percent of the tax revenue.
Domestic traveler transportation allotment rate.	2/3 of domestic traveler.
Domestic freight transportation allotment rate.	50 percent of domestic freight.

Share of World-wide Automobile Production: Europe→ USA→USA/Europe/Japan

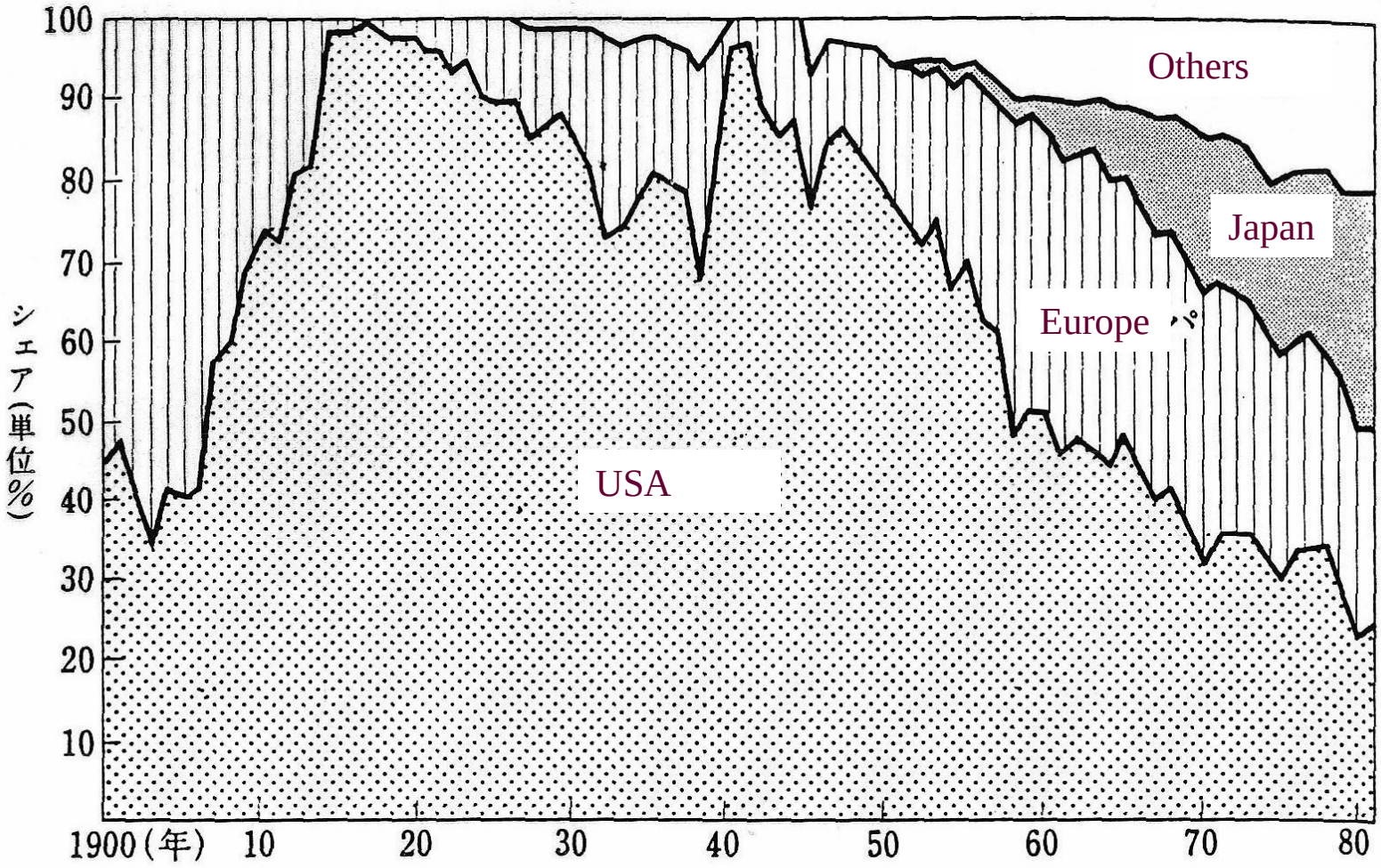


図２－１　地域別自動車生産シェア（1900～80年）　(MIT,「自動車の将来」)

注：自動車産業の初期については乗用車だけのデータがないので，この図のデータは乗用車・トラック・バスすべてを含む。

出典：*World Motor Vehicle Data Book*, 1983 edition, Detroit: MVMA, 1983から計算。

2.Automobile and Production System in Early Phase

Cars of gasoline-driven engine were borne in Germany (Daimler/Benz in 1886)

“Big automobile country” in the 19th century was France.

Competitions from electricity-powered cars and steam-powered cars (no change in mainstream)

Auto makers in the era of small-lot production: Benz, P & L, Peugeot

Automobile Production, 1891-1895

	1891	1892	1893	1894	1895
Benz	(7)	(12)	(45)	67	135
P&L	6	16	37	39	72
Peugeot	4	29	24	40	72

Sources:

Benz--Siebertz, Karl Benz, pp. 170-72, and the author's estimates in parentheses;

P&L--company archives; Peugeot--company archives.

Bardou, Chanaron, Fridenson & Laux "The Automobile Revolution"

Making Automobiles in Early Phase

Big parts makers, and small assembly makers

Collecting multipurpose parts and assembling a small quantity: Primitive open architecture

Assembling at fixed position, not using a conveyer assembly line:

car fixed at a spot, and parts being carried over

(some testing this system even now, including Volvo)

Flexible, but a work site of low productivity

Many minor makers made entries in USA, but were shaken out afterward.

From the Fixed-Position Assembly to the “Assembly Conveyer System”: Ford Production System

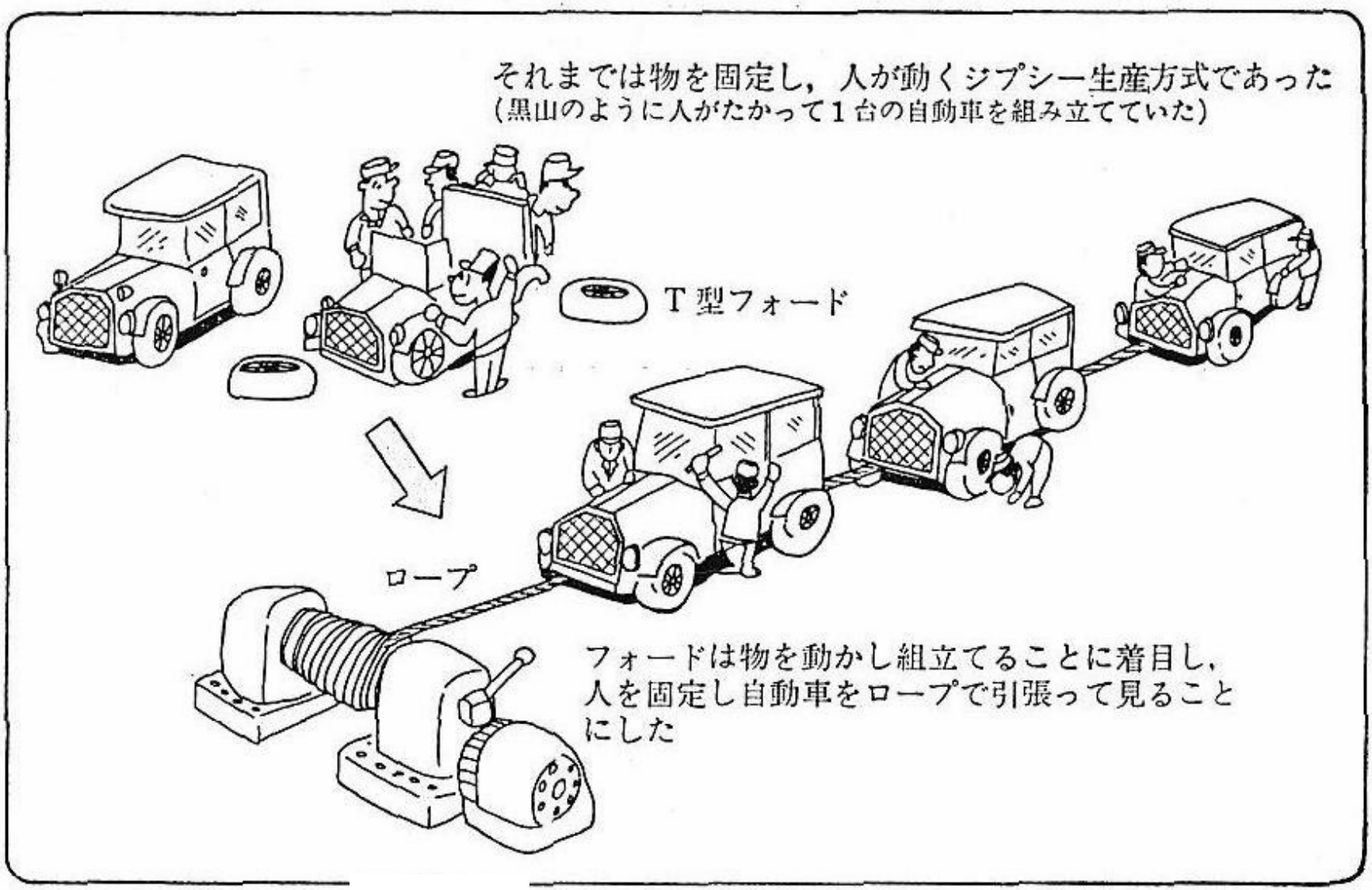


図 12·1　フォードの１個流し誕生の図

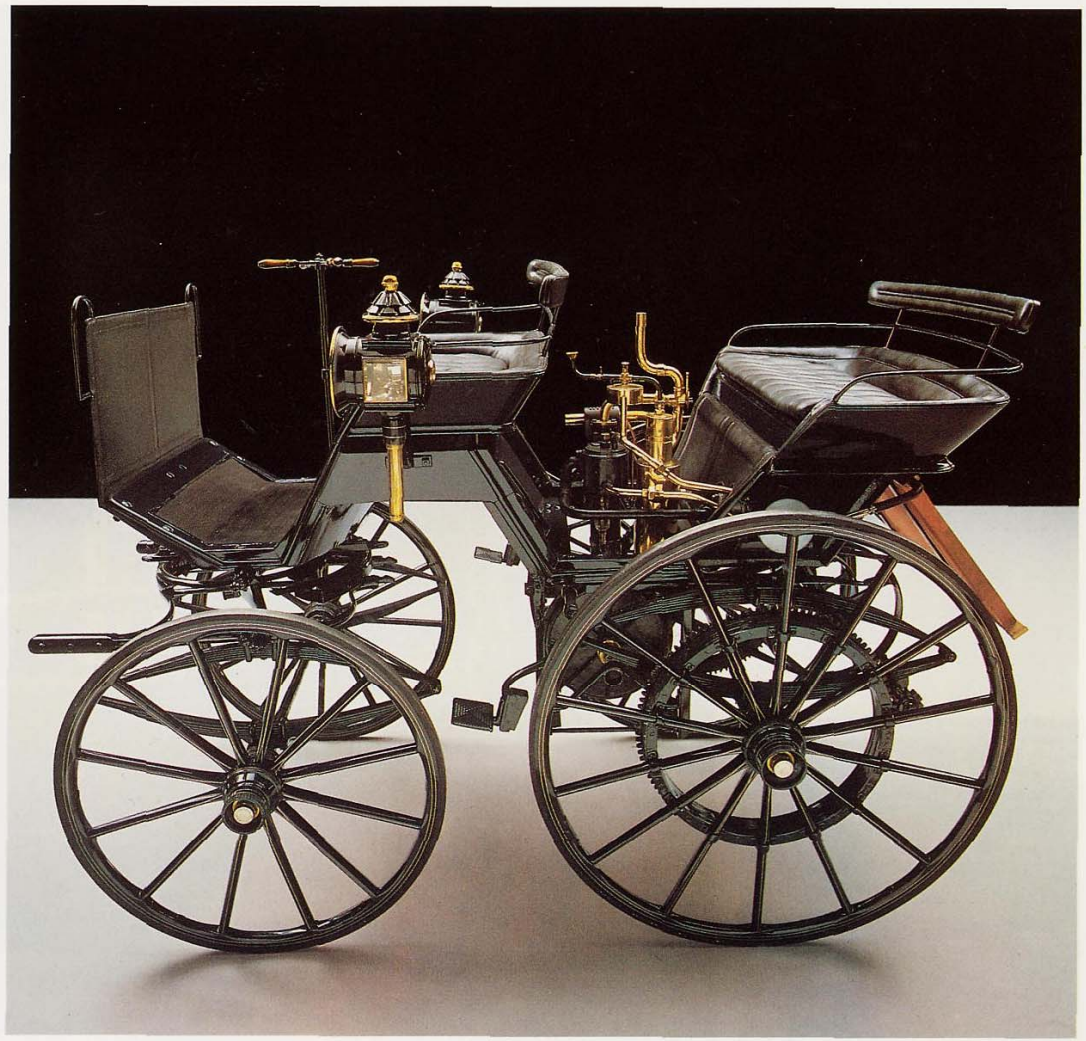
1886

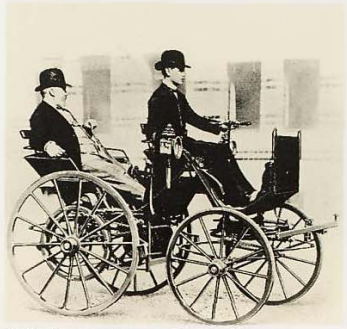
DAIMLER MOTOR CARRIAGE

History of Daimler Cars: First gasoline-driven car in 1886

1 cylinder
Bore: 70 mm, Stroke: 120 mm
Displacement: 462 cc
Output at 700 rpm:
0.8 kW (1.1 hp)
Top speed: 16 km/h

This vehicle – a carriage without horses, propelled by an invisible energy source – marked *the beginning of a revolution in* transport. The power came from the new small engine developed by Gottlieb Daimler and Wilhelm Maybach. Following the motorcycle and a motorboat, the motorization of the carriage provided *further proof of the versatility of* this invention.





Daimler motor carriage with G. Daimler in the rear and his son Adolf at the wheel

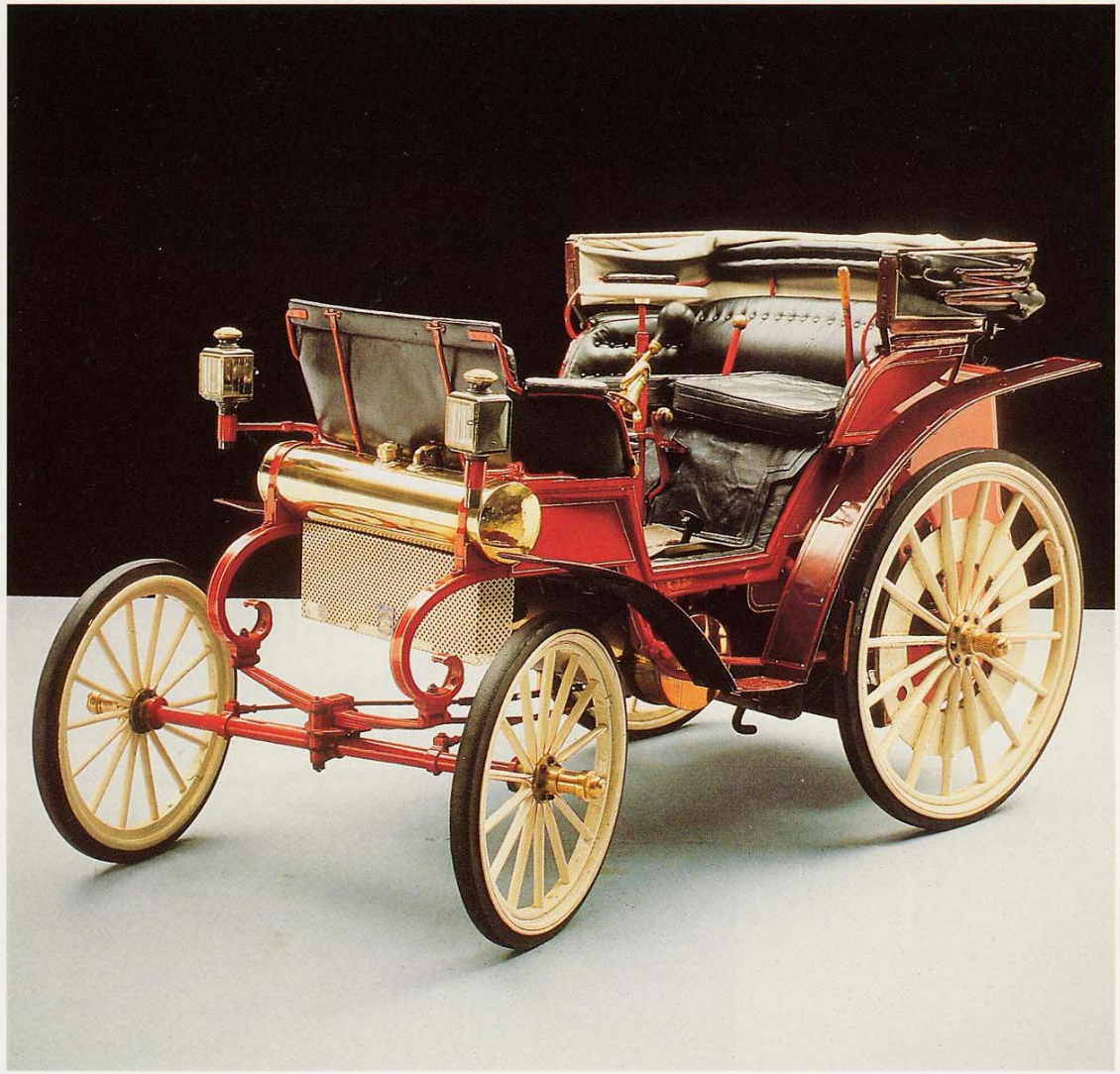
1894

Daimler Belt-Driven Car

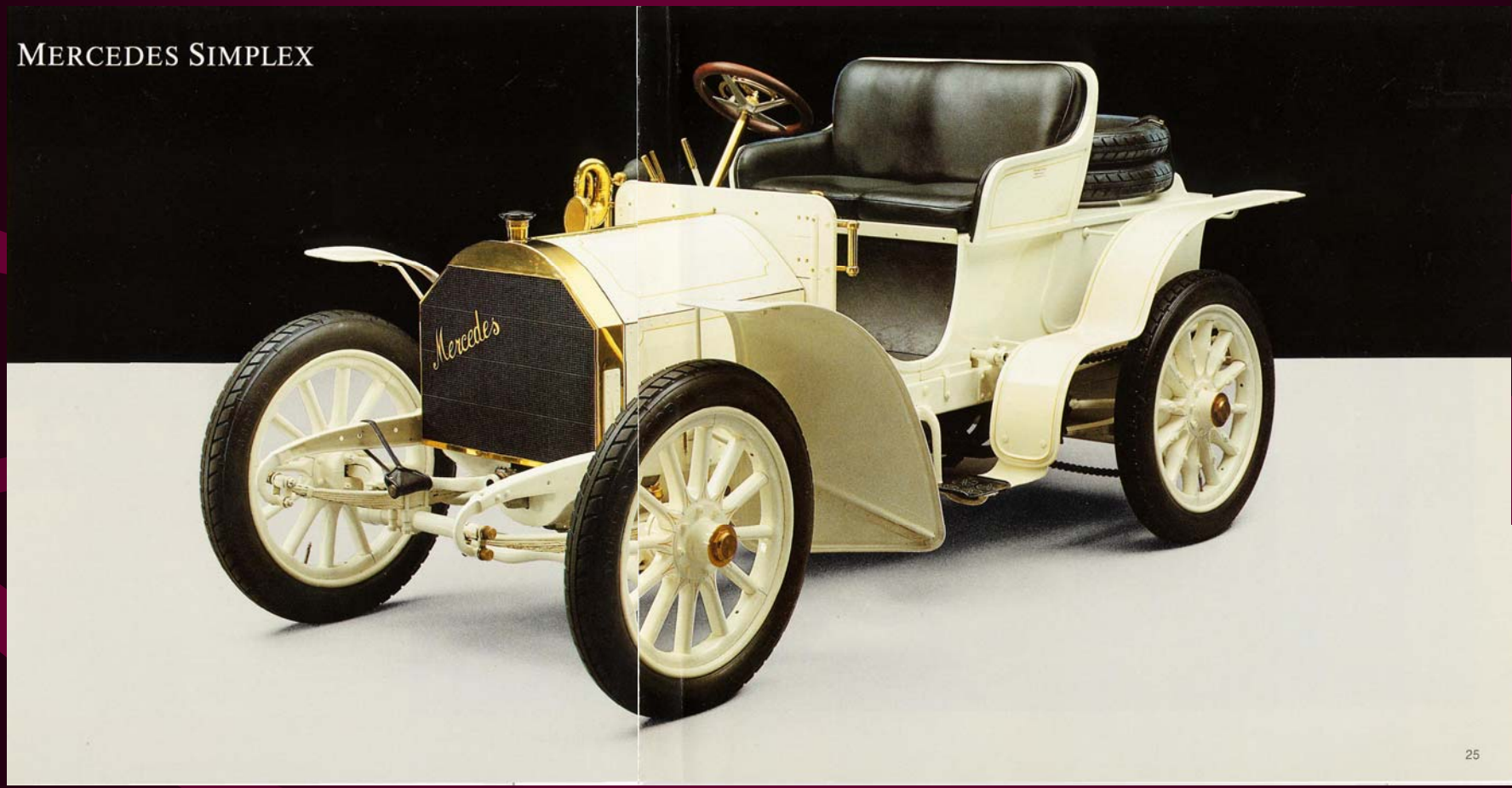
History of Daimler Cars: Era of “horseless buggy”

2 cylinders
Bore: 67 mm, Stroke: 108 mm
Displacement: 762 cc
Output at 700 rpm:
1.8 kW (2.5 hp)
Top speed: 20 km/h

The engine of the “belt-driven car” was connected to the rear wheels by a 4-speed belt transmission, which permitted smooth gear-changing.



1902 History of Daimler Cars: P&L system (engine at the front)



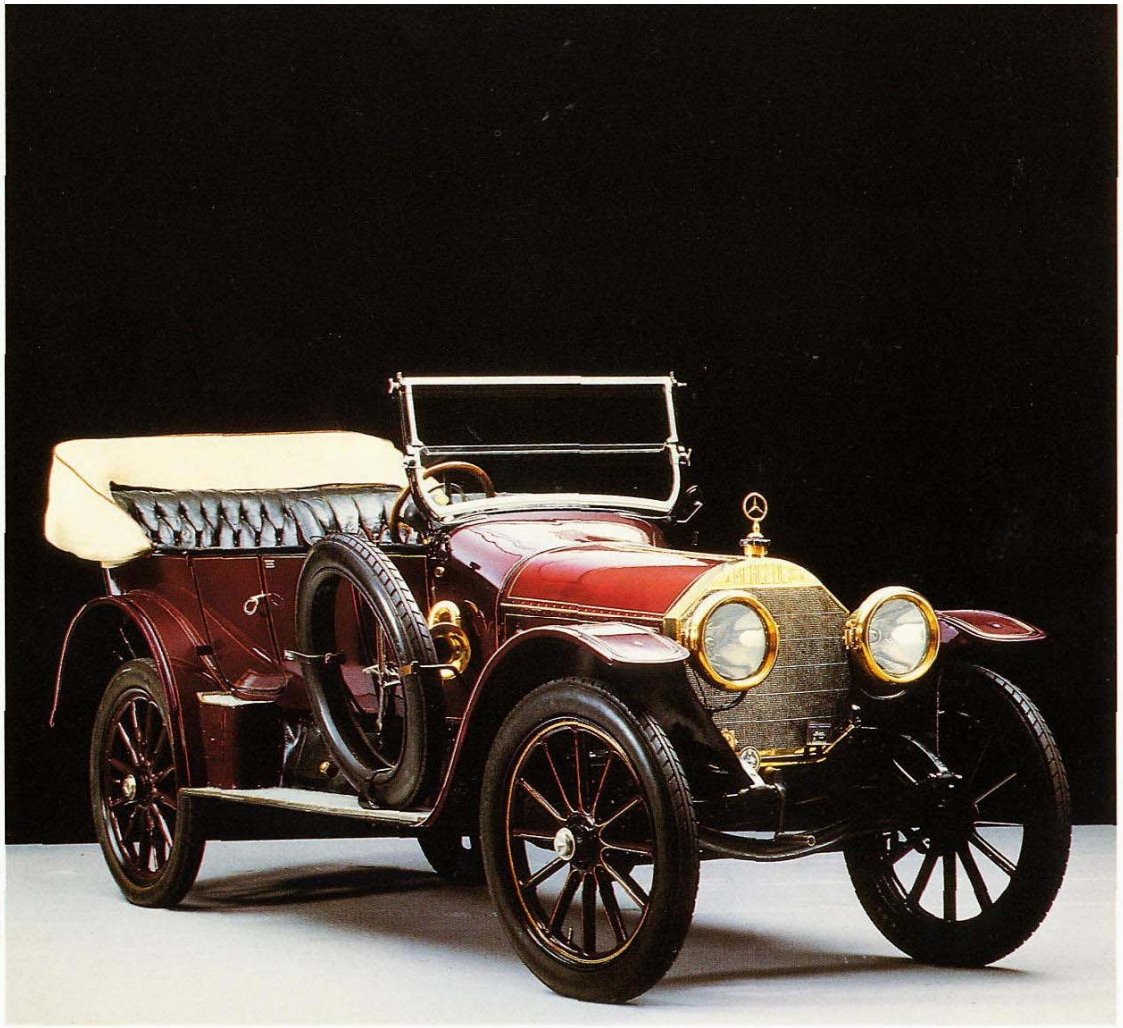
SIMPLEX

1910

MERCEDES 22/40 HP
TOURER

4 cylinders
Bore: 110 mm, Stroke: 148 mm
Displacement: 5626 cc
Output at 1230 rpm:
29 kW (40 hp)
Top speed: 80 km/h

History of Daimler Cars: Era of Ford's Model T



1929

Mercedes-Benz 460 "Nürburg", 18/80 HP Saloon

8 cylinders
Bore: 80 mm, Stroke: 115 mm
Displacement: 4624 cc
Output at 3200 rpm:
59 kW (80 hp)
Top speed: 100 km/h

The "Nürburg" was the first Daimler-Benz apart from the racing cars with an in-line eight-cylinder engine under the bonnet. The name recalls the memorable occasion when one of these models was driven 20,000 km in thirteen days on the Nürburgring.

History of Daimler Cars: Toward a sealed steel body

1955

MERCEDES-BENZ 180 SALOON

History of Daimler Cars: Toward contemporary cars

4 cylinders
Bore: 75 mm, Stroke: 100 mm
Displacement: 1767 cc
Output at 4000 rpm:
38 kW (52 hp)
Top speed: 126 km/h

The first Mercedes with the modern three-box body appeared in 1953. This year marked a watershed between traditional and modern designs. The 180 has all the typical features of the self-stabilising body, clearly divided into engine compartment, passenger cell and luggage compartment. This was the first vehicle to embody the safety bodywork patented by Daimler-Benz in 1951, comprising a rigid passenger cell and "crumple zones" front and rear.

The integration of the wings in the body also meant that the passenger compartment and boot could be considerably enlarged, as well as giving the driver a better view of the corners of the vehicle and lowering drag. For these reasons, the new design quickly became popular with customers.

1955

Automobile Technologies in Early Phase

Competition from electricity-/steam- powered cars (no change in mainstream)

Technological effects from bicycles/horse carts (called "horseless buggy")

P&L (Panhard et Levassor) system, a turning point for automobile evolution

Victory of gasoline-powered cars (year 1900 or thereabout)

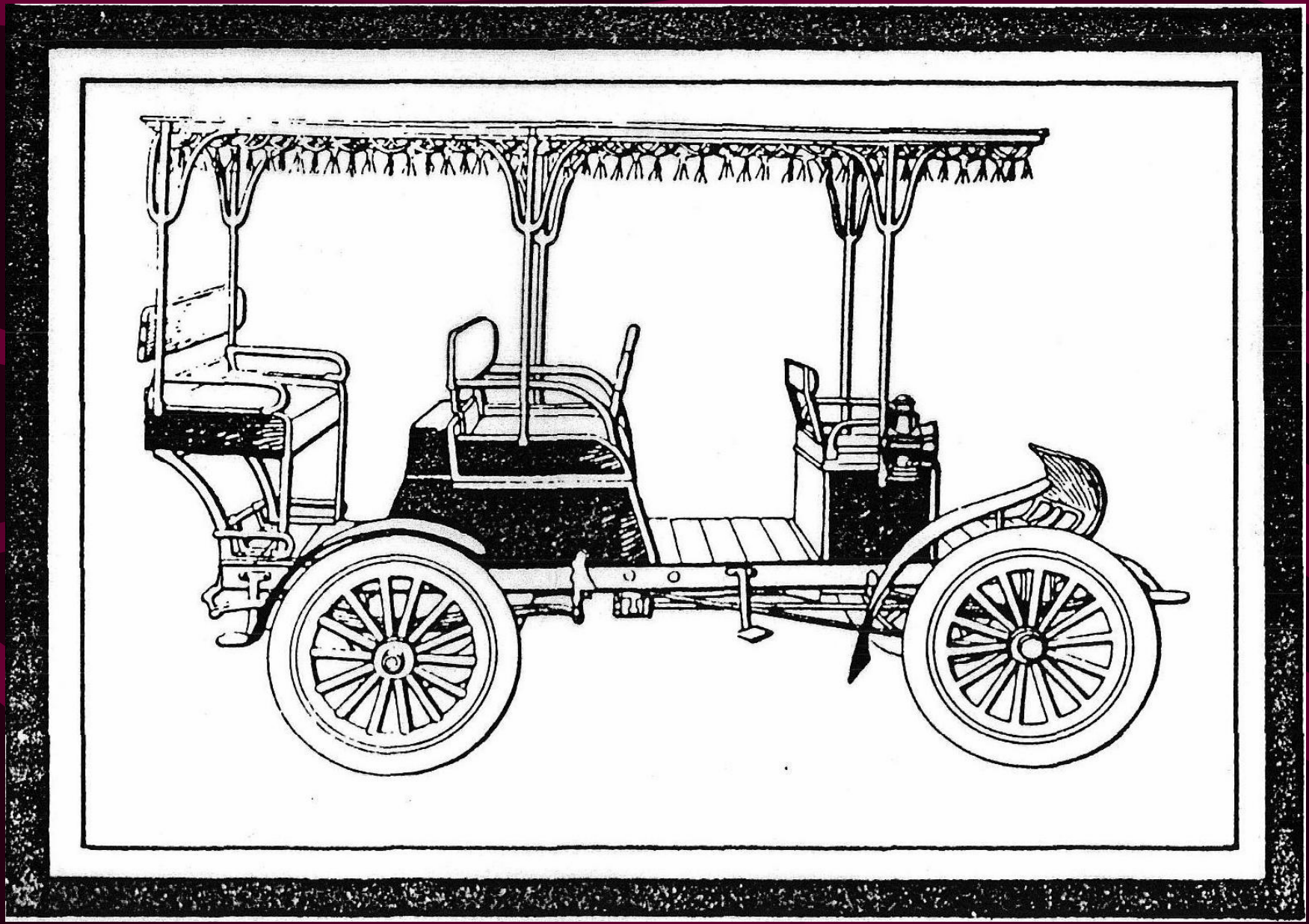
Innovation of automobile technologies concentrated in the first 30 years

Rise of many minor car makers in USA

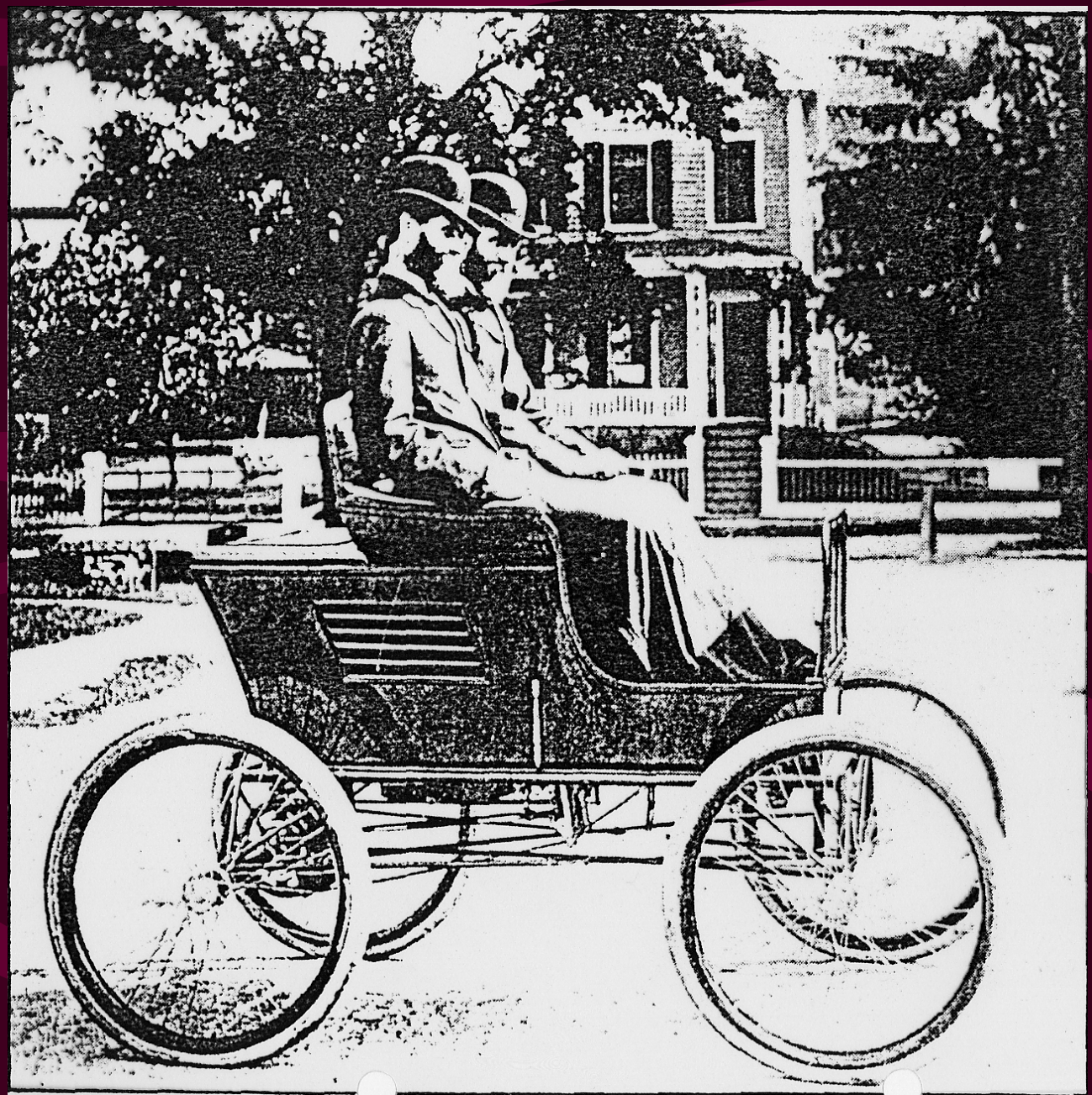
Emergence of Ford's Model T (Ford production system)

GM's flexible mass production system

American Automobile in the Cradle (Duryea) Sudden rise of many minor makers



Stanley Steamer　1897　・・・Steam-powered cars being active then

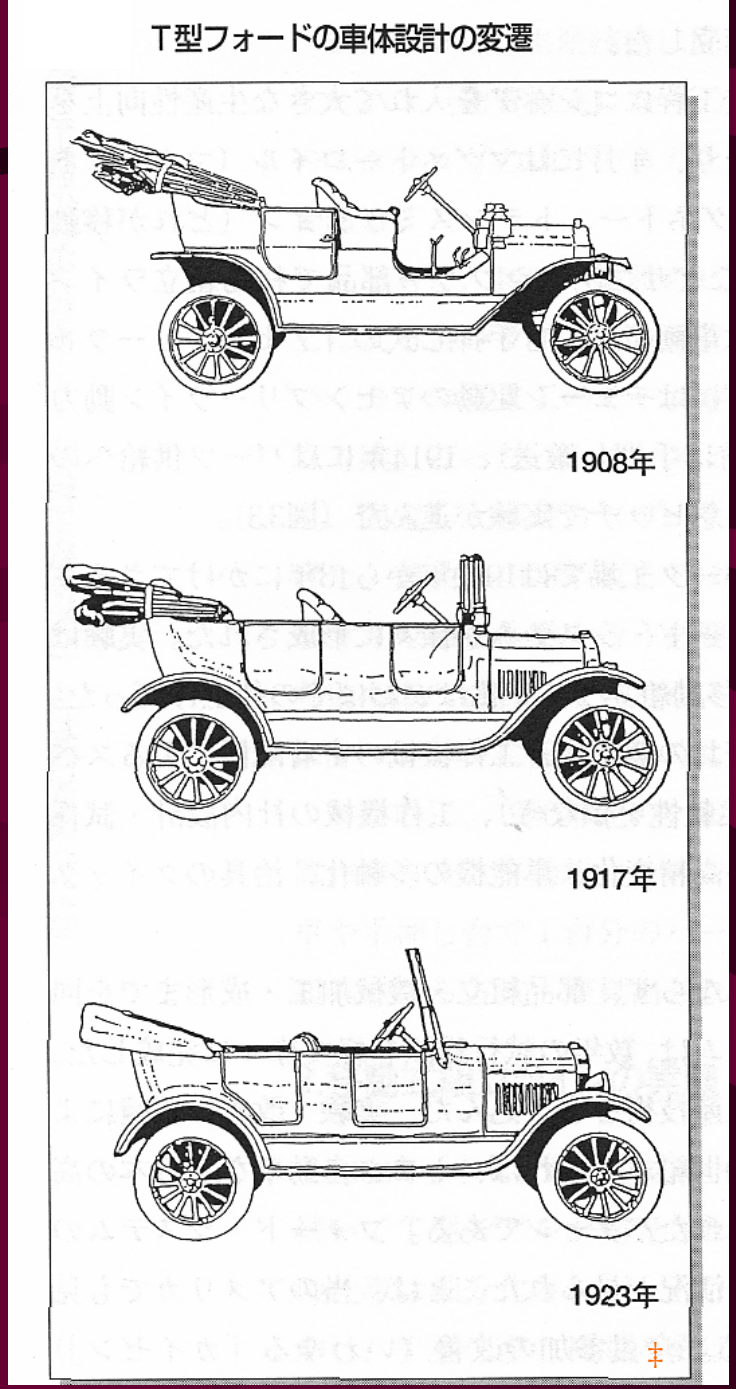


Ford's Model T

15 million cars over 20 years

Little design change in undercarriages

(but significant changers in the body)



Ford and Chevrolet

In the end, the one

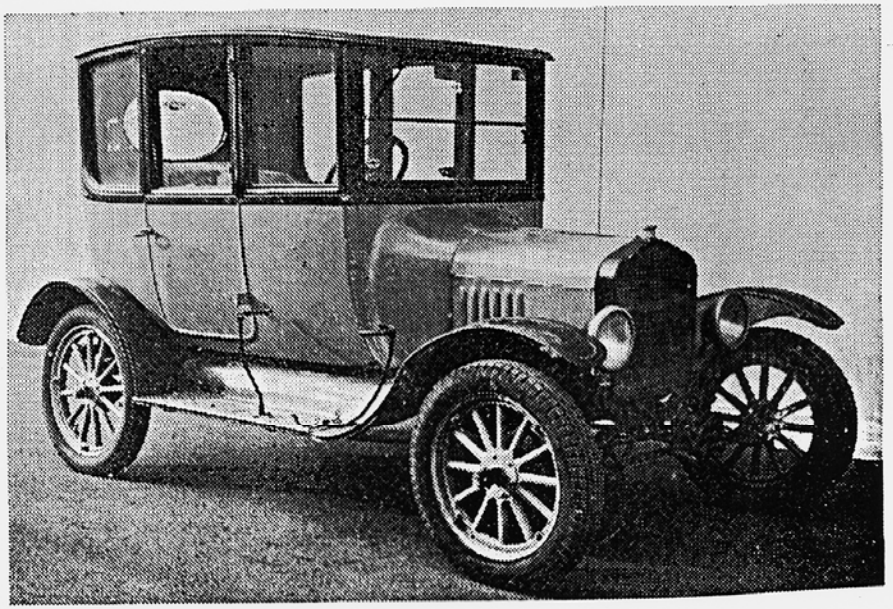
that took the top position

from Model T was GM/Chevrolet

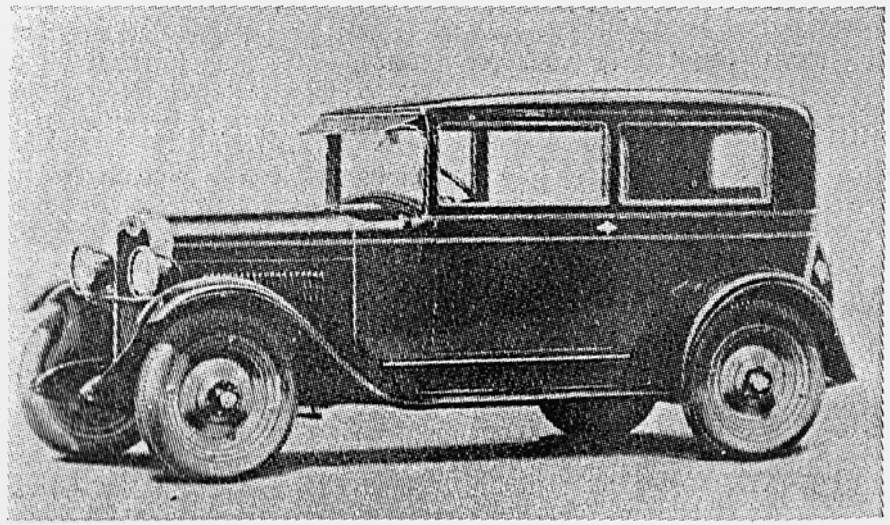
equipped with “flexible mass production”

and sealed bodies of steel.

(1927)



1920 年 T 型フォード・センター・ドア・セダン



T 型フォードから首位の座を奪った 1927 年シボレー・2 ドア

Comparison of Ford System in Early Phase and GM System (flexible mass production)

	Ford System in Infancy (era of Ford's Model T)	GM's Sloan Method (flexible mass production system)
Response capability to minor changes	Fit (renewed Model T's body and parts technology without altering undercarriage)	Fit (model change every year without altering undercarriage)
Response capability to major changes	Low (took about one year to switch Model T to Model A	Rather high (2 weeks to switch engine from 4 cylinders to 6 cylinders
Machine tool	Exclusive use (exclusive to T-shape cars)	Versatile
Process layout	By product (machines laid out with extreme density)	By product (basically same with Ford's)
Vertical integration	Vertical integration in extreme degree (Rouge Plant)	Relatively high share of outsourced parts
Product development capability	Rather weak. Too much dependence on past data; confusion in start-off production due to skipping pilot production	Relatively strong. Reinforced design function. Structure aligned for product improvements resulting from planned model changes

3.Japanese Automobile Industry in Incunabula

1910s: Car was no more than a trial product by "mechanic in town".

1923: Great Kanto Earthquake brought about a formation of the car market.

1925-35: Ford and GM dominated Japan's market having local assembly factories.

1936: Foreign makers were kicked out by "Automated Manufacturing Business Law".→ Time for Toyota, Nissan, etc.

Three-wheelers were popular as "low cost vehicles" (from the pre-War period to 1960s)

1950: Annual production at 50,000 cars. Labor dispute(s) with Toyota

1950s: Period of "reinforcing competitiveness without mass production"

1960s: Domestic market led the industry to drive building of mass production factories.

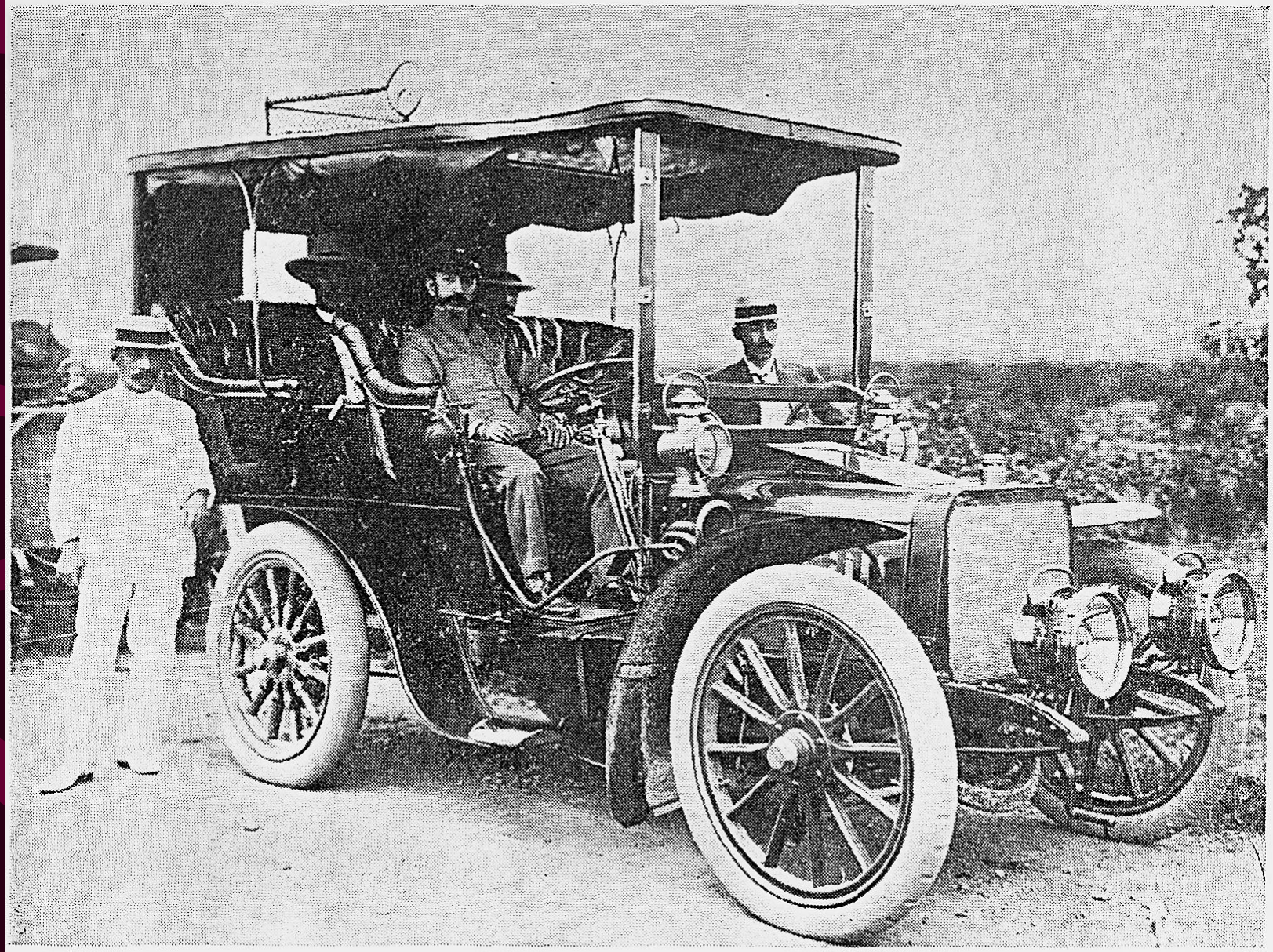
1970s: Exports expanded.

1980s: Overseas productions expanded.

1990: Annual production reached to 13,500,000 cars, resulting from the continued growth to date, which was the peak.

1990s: Production fluctuated around 10 million cars; to strengthen competitiveness in costs without relying on a quantity increase

Incunabula: Cars were no more than a hobby of rich people.



（写真46）　有栖川宮殿下のダラック号

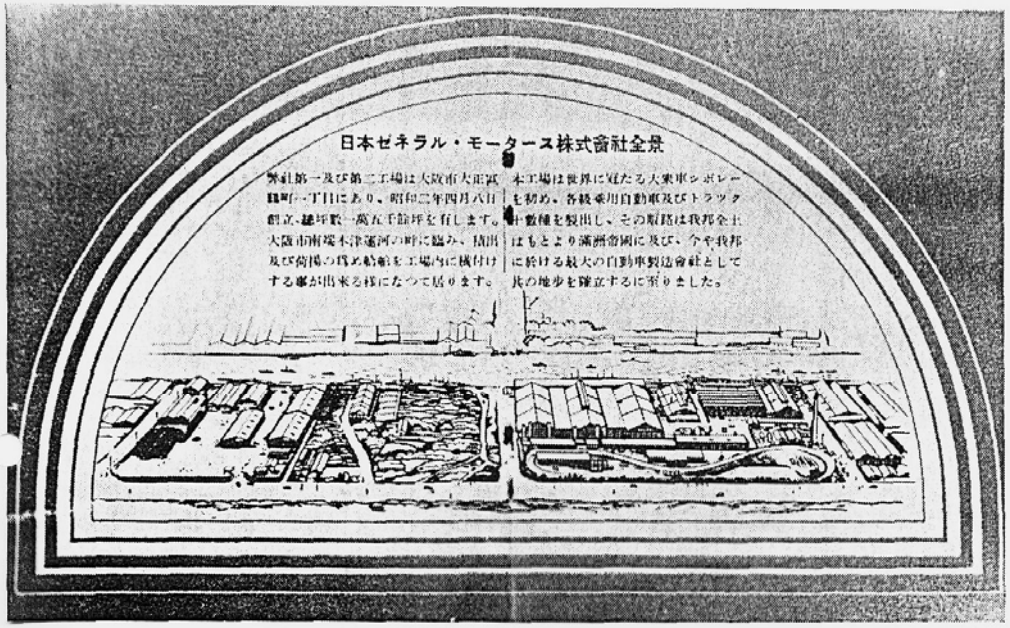
1920s ---

GM Oosaka Factory

Ford Yokohama Factory

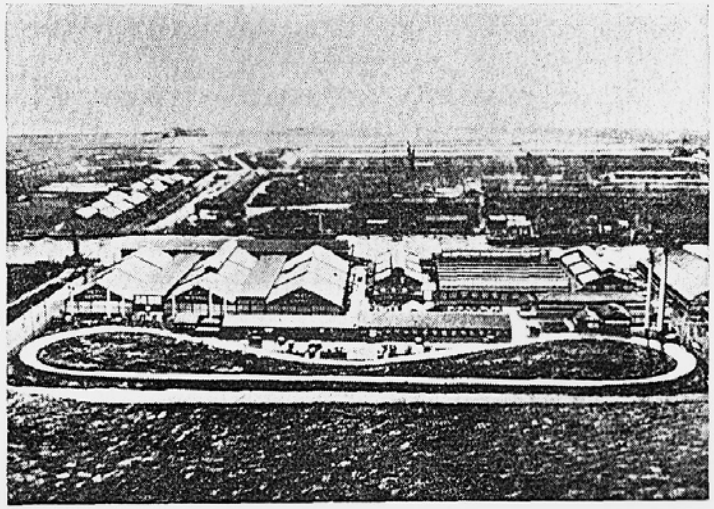
Reign of Japanese market by the foreign capitals

日本ゼネラル・モータース株式会社



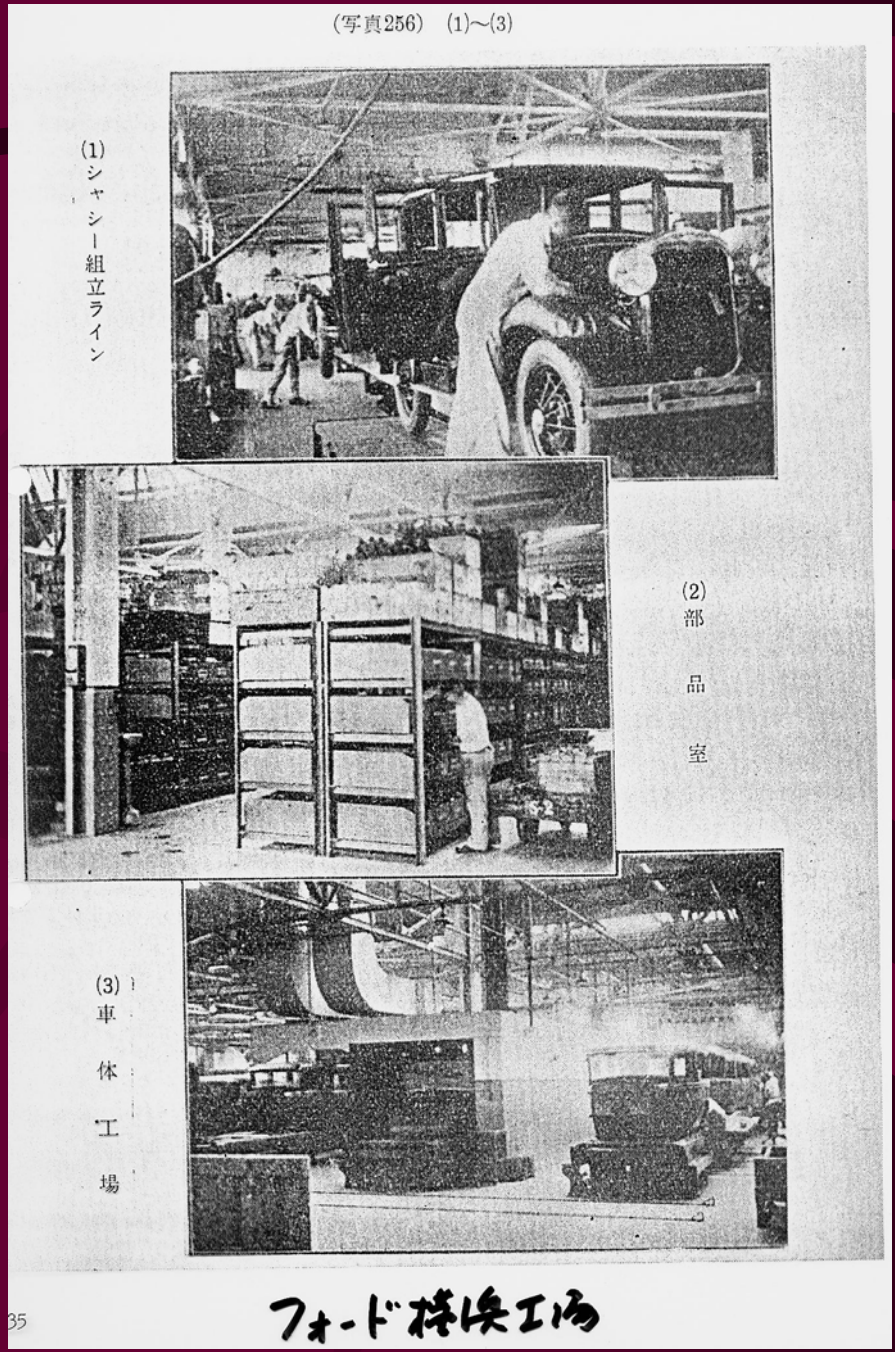
（写真262）　同社大阪工場の全景

（写真263）
飛行機上からみた同工場の一部

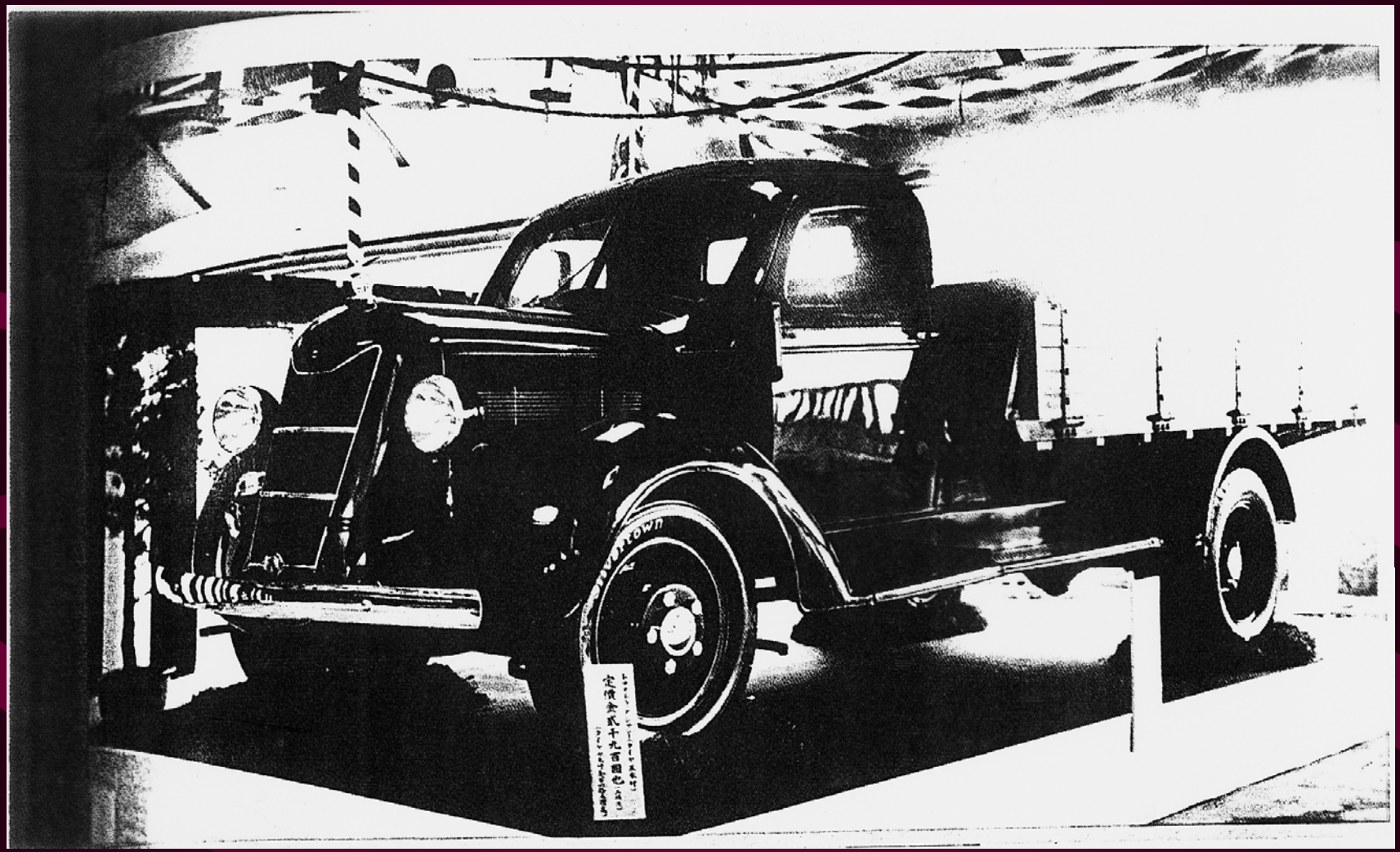


Ford Yokohama Factory

Assembly line, albeit small

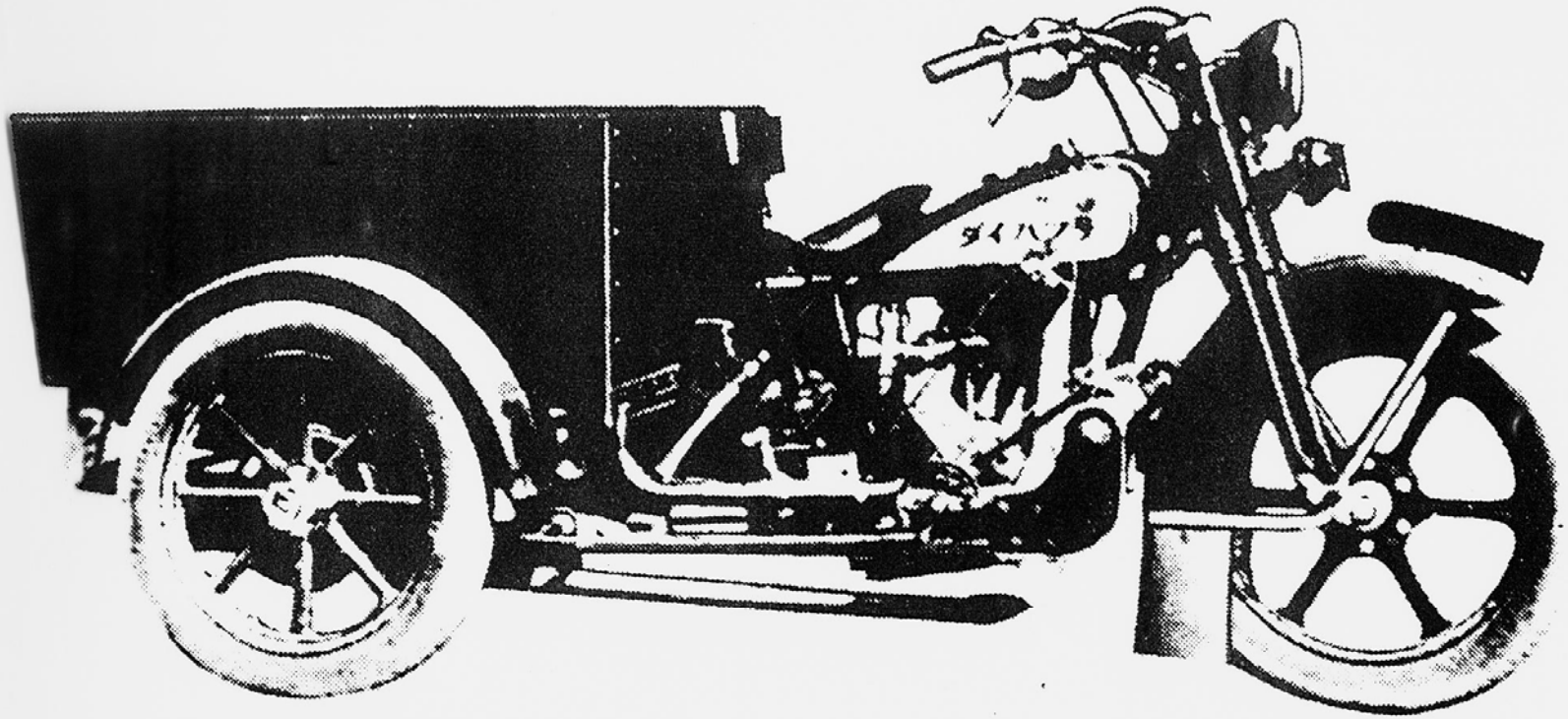


Toyota Automated Loom (→ Toyota Automobile) made its entry with trucks. (mid ‘30s)



Nearly copies and jumbles of Ford’s and GM’s cars when started

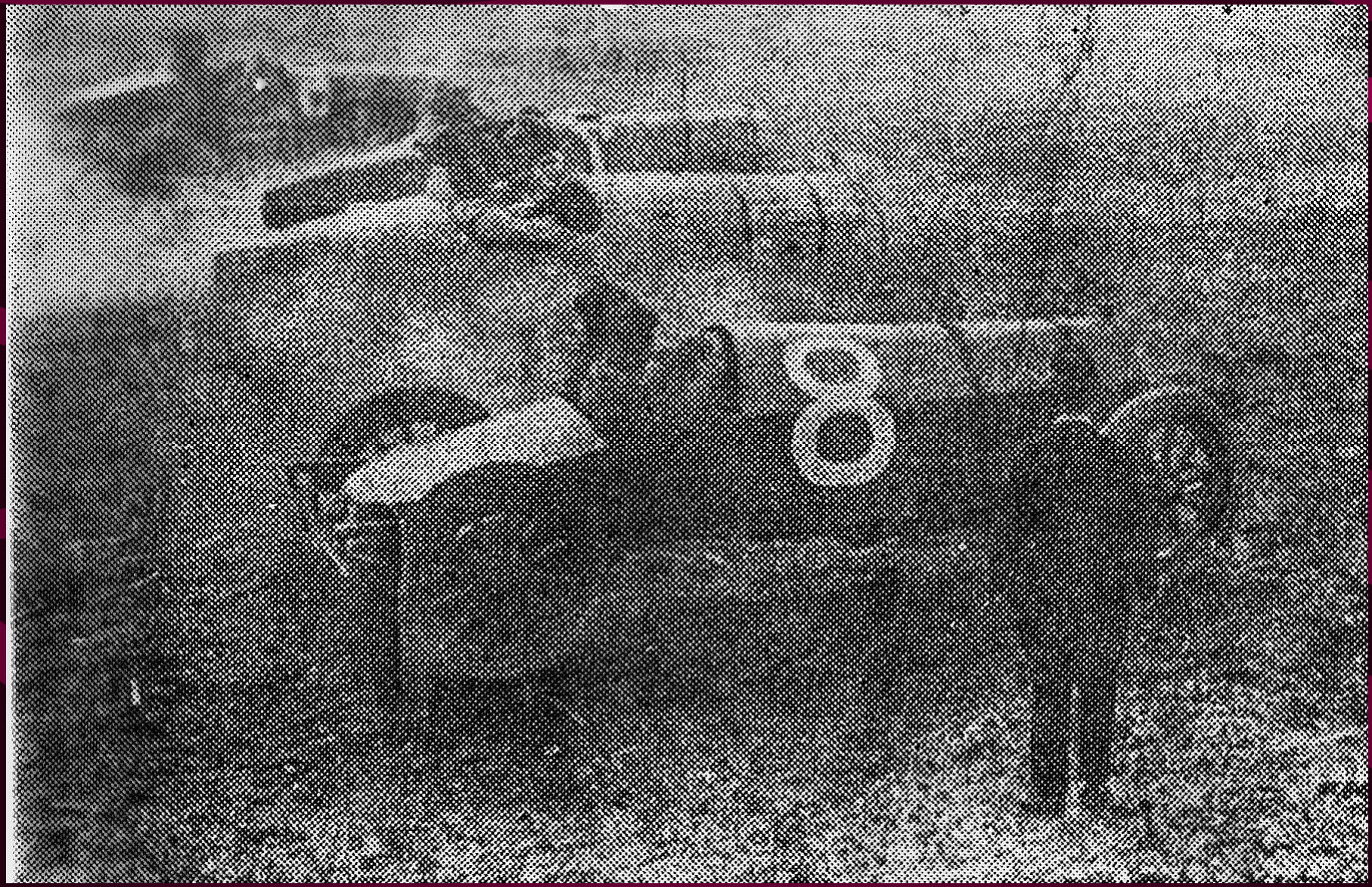
Meanwhile, the three-wheeled cars were popular as “low cost vehicles”.



ダイハツの１号車（昭和５年）

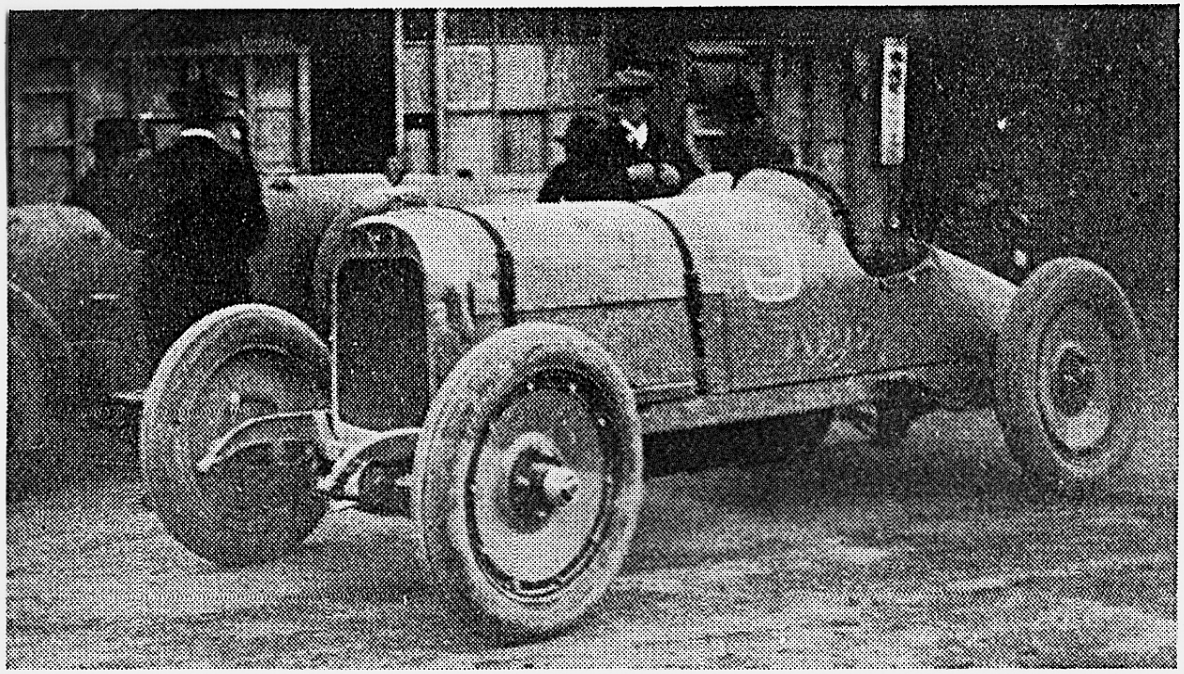
（大島・山岡『自動車』より）

Digression: Japan's Car Race in Incunabula



Jorge Fujimoto and Hudson (1920s)

自動車競走



ジョージ藤本氏が米国から持ち帰ったハドソンの純レーサー

4.Hypothesis on Product/Operation Lifecycle

Hypothesis by Professor Abernathy of Harvard University

(1)The beginning is the period of "product innovation".

(2) "Dominant design" (entry of a star performer--- e.g., Ford's Model T)

(3) This leads into the period of "process evolution"

(e.g., Ford production system)

(4) In due course, product/process technologies become standardized.

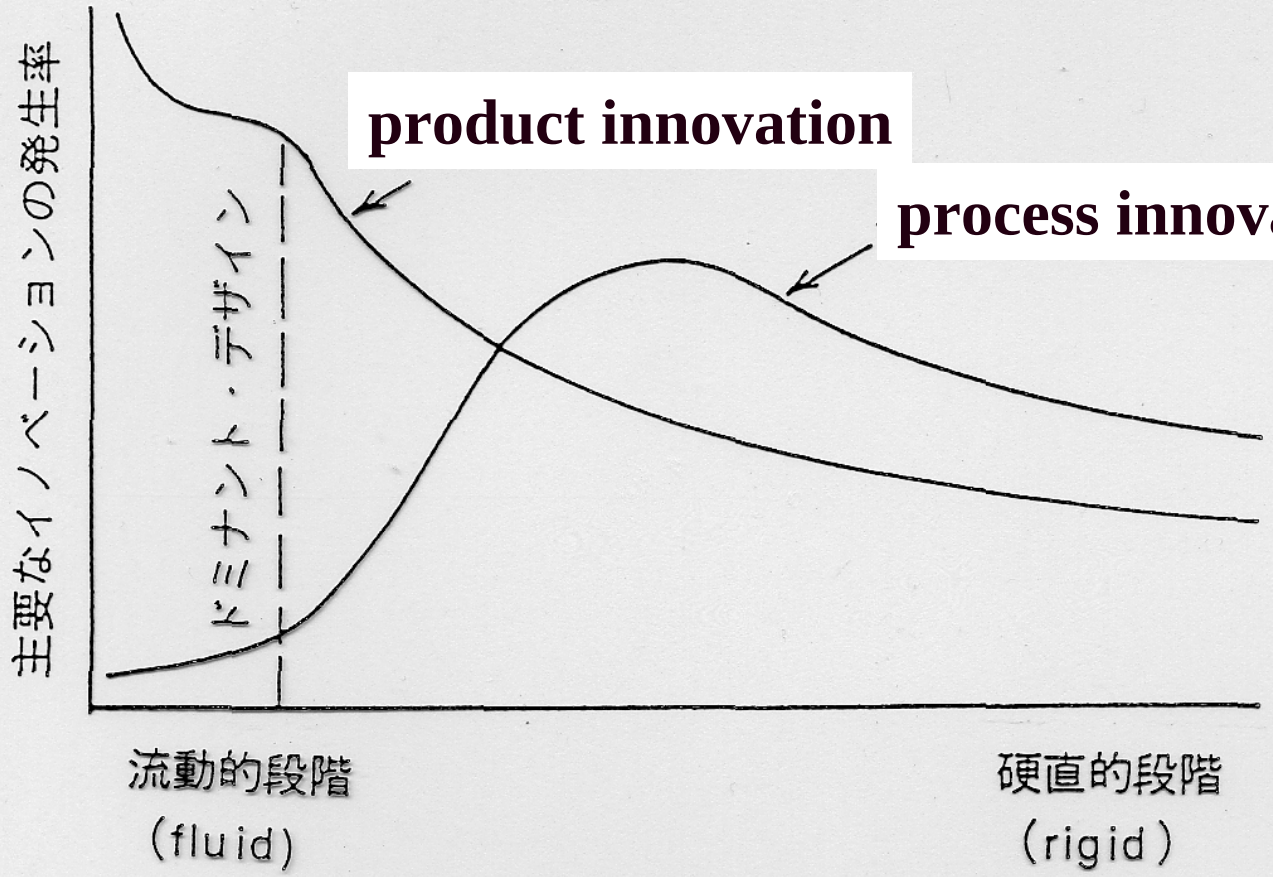
Cost goes down, and so does flexibility --- "dilemma of productivity"

Subsequently ---

Period of "flexible mass production" (many models in large quantity): e.g., GM

After the War, "Toyota's production formula" became conspicuous as an even more flexible system.

Product/Process Lifecycle

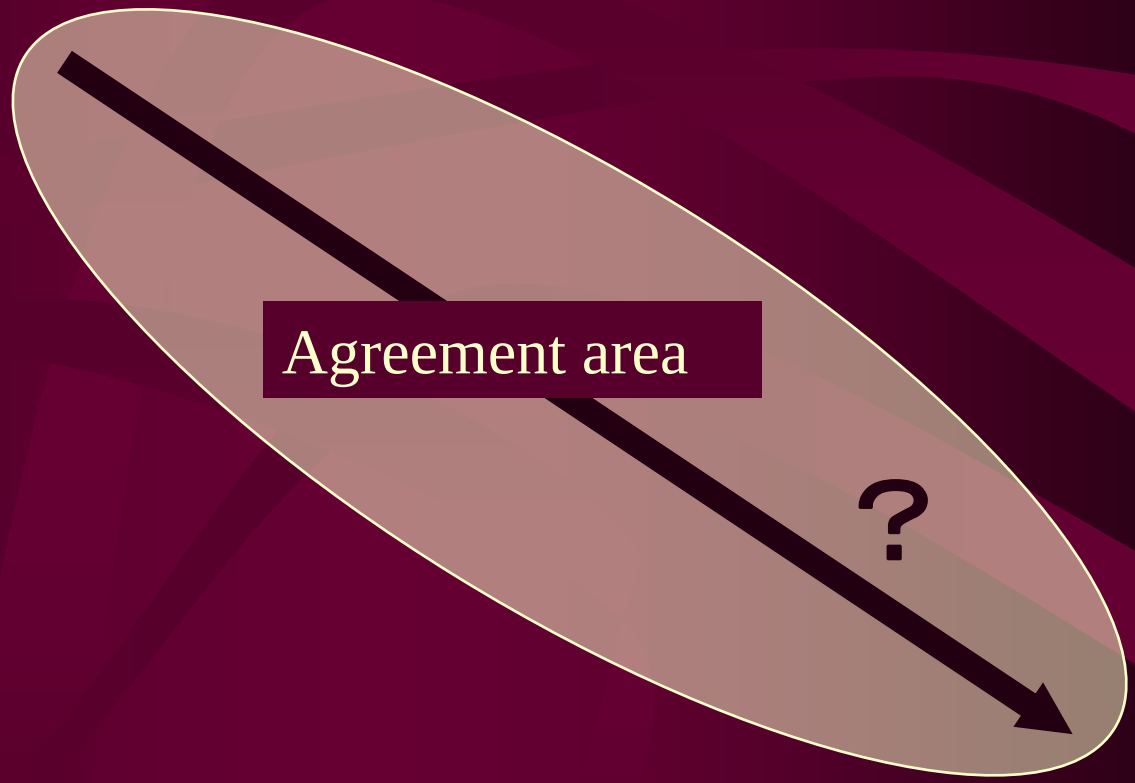


出所：W. Abernathy. Productivity Dilemma. Johns Hopkins University Press.

First, waves of product innovation → Next, waves of process innovation

Related to Product Process Matrix --- descending on diagonal line?

	Article kind	Many variety. A small amount.	Small kind. In large quantities.	Article kind. In large quantities.
Project				
Job Shop				
Patch flow				
Line flow				
Continuous flow				



Dematurity

Limitation of "hypothesis on product/process lifecycle" indicating the shift to just one direction.

Everything gets standardized in the end? ---- Not necessarily.

Rather, there is a possibility for a reversal or restart of lifecycle. ··· dematurity

(Abernathy, Clark and Kantrow, "Industrial Renaissance")

Will the Automobile Attain "Dematurity"?

(Fujimoto, Capability Building Competition, Chuko Shinsho)

Dematurity: "Restart" of product/process lifecycle
(another product evolution period)

A trigger will be an epoch-making innovation to turn over existing technologies and industrial structure.

Will the automobile attain "dematurity"?

"Automobile reinvention theory" in/around 1980 was, in effect, an air shot. (American type of misconception)

The era for gasoline-powered cars made of steel has continued. ---
The champion is tenacious.

Will a new propulsion technology be established in the next 20 years, taking advantage of the environment/energy issues?
Hybrid car? Electrifiable battery car? Fuel battery car?

However, high production costs (material cost, in particular) are the bottleneck: No easy job.