Defining Automotive Technology

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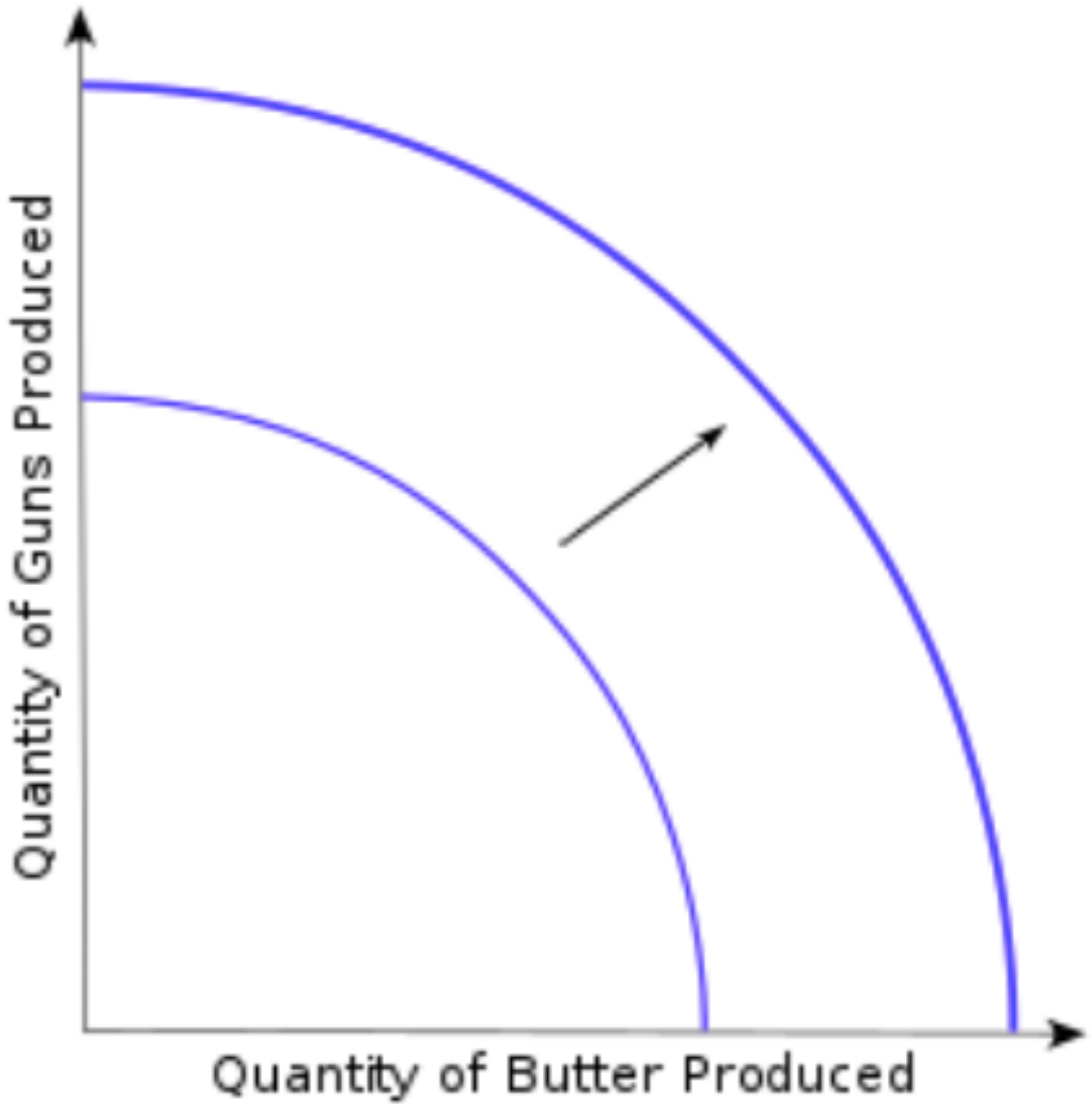
What is technology?

- Anything that shifts out production possibilities
  - Includes better management methods
  - And better production equipment
- But that's only meaningful if it's ACTUAL output
  - Patents are NOT technology
  - Intellectual property not central to auto industry
- If "China" is stealing, then...
  - It hasn't helped them



Technology is People not Blueprints

- Or patents
  - So “stealing” technology is not straightforward
  - Nor is learning how to make or sell vehicles or components
- Implications
  - Building organizations matters
  - Personal relationships matter
  - Geography matters
    - But less than in the past
  - Today’s leaders are tomorrow’s leaders
- Industry heterogeneity: what is true of autos is not true of every industry

Distinguishing “science”

- Science
- Invention
- Commercialization
- Refinement

Distinguishing “science”

Level	Risk	
• **Science**	Very High	**Dead ends normal = very risky**
		Most discoveries unfruitful
• **Invention**	High	**Most inventions never used**
• **Commercialization**	Moderate	**May not pan out in marketplace**
• **Refinement**	Low	**Can do repeatedly**
		“Management” possible

Distinguishing "science"

Level	Cost	
• **Science**	Low	**sometimes pencil and paper**
• **Invention**	Moderate	**need prove workable**
• **Commercialization**	Substantial	**need prove makeable**
• **Refinement**	Very high	**need tweak design**
		add features
		remove features
		improve production methods

Distinguishing “science”

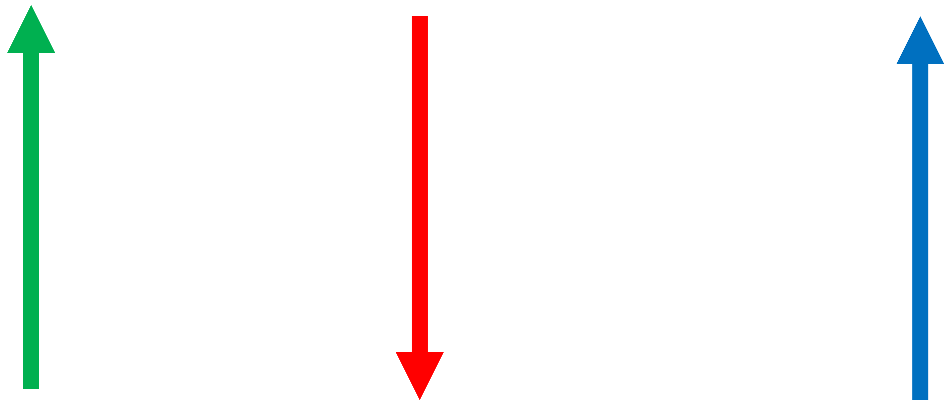
Level	Appropriability	
• **Science**	Very High	**Goal / mandate to publish details!**
• **Invention**	High	**Patents / limited detail, creates IPR**
• **Commercialization**	Moderate	**Can often “invent around” patents**
• **Refinement**	Low	**Trade secrets, plus lead time**

Summary: Distinguishing “science”

Level

- Science
- Invention
- Commercialization
- Refinement

Risk Cost Appropriability



Photoelectric example

- 1839, Alexandre Edmond Becquerel noted interaction light and electrical properties
- 1887 Heinrich Hertz experiments with photoelectric effect
- 1905 Albert Einstein. source of his Nobel prize, gave birth quantum mechanics
- 1938 invention by Chester Carlson (1942 patent)
- 1944 Battelle Institute prototype, 1947 development contract with Haloid Corp
- 1949 Model A first commercial product; improved version; 1955 Copyflow
- 1959 Xerox 914 first rotary drum machine
- 1963 first plain paper copier

- 50 years: initial observations to final science
- 51 years: initial science to first invention
- 11 years: first invention to first product
- 10 years: Generation I to Generation II (with intermediate steps)
- 4 years: Gen II to Gen III [understates: work on Gen III began prior to launch of Gen II, with pieces going back to the initial work by Carlson and Batelle]

Implications

- Gen II development $160 million = cost of developing US Air Force fighter plane
- Needed lots of feed-in change: powders, paper, lots more
- First-to-market gave long period of highly profitable dominance

Gentex = automotive example

- Photochemical technology, not photoelectric

SmartBeam

Photobit Equity Stake in 1998

HomeLink

Licensed in 1999

Acquired from JCI in 2013

ITM

Partnership with Transcore in 2015

Biometrics

Delta ID Partnership in 2016

CMS

Co-development with Ambarella in 2016

History

- 1974: started in Zeeland, Michigan
  - manufactured residential smoke detectors.
- 1982: auto-dimming electromechanical mirror
  - minimal market uptake
  - patents show founder also played around with helmets
- 1987: electrochromic autodimming mirror
  - EC technology known for 50 years
  - first successful commercialization
  - Battelle Institute assisted (cf. Xerox story)
- Sample electrochromic patent: Patent #5928572

Gentex example

- Patent long expired (1984 → 2001
- Largest competitor (Magna Donnelly) is literally down the street
  - In Zeeland Michigan
- But Gentext still has 90% of market
  - And it’s now a big market

Partial list of Customers
– now also Boeing –

BMW
- -BMW
- -Rolls Royce

Chrysler
- -Chrysler
- -Dodge
- -Jeep

Daimler
- -Mercedes-Benz

Fiat
- -Alfa Romeo
- -Fiat
- -Lancia
- -Maserati

Fisker

Ford
- -Ford
- -Lincoln

Geely
- -Emgrand
- -Volvo

General Motors
- -Buick
- -Cadillac
- -Chevrolet
- -GMC
- -Holden
- -Opel

Honda
- -Acura
- -Honda

Hongqi

Hyundai
- -Hyundai
- -Kia

Mazda

Mitsubishi

Nissan
- -Infiniti
- -Nissan

PSA
- -Citroen
- -Peugeot

Renault
- -Renault
- -Samsung

SAIC
- -MG
- -Roewe

Ssangyong

Subaru

Suzuki

Tata
- -Jaguar
- -Land Rover

Toyota
- -Lexus
- -Toyota

Volkswagen
- -Audi
- -Bentley
- -SEAT
- -Skoda
- -Volkswagen

Auto industry: lessons from Levin et al

- Intellectual property not important
- **Lead time**
  - Not not unusual that a customer will mandate licensing to a second supplier!
- **Ability to adapt for customer needs**
  - Most components not standardized modules
- **Ancillary contributions**
  - Global supply capabilities for global products: one plant not sufficient
  - Sales engineering
  - Upstream supply stream management
  - Ability to meet industry norms (PPAP, validation standards)
- **Process innovations 🡸 🡺 trade secrets**

Technology = teams

- “Stealing” designs puts a firm one full design cycle behind
- Designs don’t lead to engineering teams
  - Only time can do that
- Modern tools: Computer Aided Engineering
  - Not available for purchase: firms develop internally
- Studies of Nam on Chinese assemblers
  - 20 years of learning from joint venture partners
    - Chinese firms still have minority of market
    - Despite government support
    - Challenges include product planning, distribution

Making empirical

- Internal firm data
  - However hard to use in “academic” papers as under non-disclosure agreements
- Non-compete clauses
  - But becoming routine, even in restaurant industry!!
- Durability of technical lead
  - Turnover of top firms not quick: “disruption” is highly unusual
- Aftermarket should look different