

# **The Economics of E-commerce and Technology**

Innovation

# Impact of Innovation

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- ▶ **Enhance competitive advantage of incumbent.**
  - ▶ PlayStation3 (Sony)
  - ▶ Laserjet printer (Hewlett Packard)
- ▶ **Destroy the incumbent (creative destruction).**
  - ▶ MP3 player (Sony vs. Apple)
  - ▶ Computers (Microsoft and Intel vs. IBM)
  - ▶ Digital cameras (Kodak vs. Sony)
- ▶ **Create new markets.**
  - ▶ Children's TV (Disney vs. Nickelodian)
  - ▶ Light motorbikes (Triumph vs. Honda)

# Types of Innovations

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- ▶ **Value enhancement**

- ▶ Pneumatic tyres (1845)
- ▶ Cotton replaced by rayon (1938)
- ▶ Run flat tyres (1974)

- ▶ **Cost reductions**

- ▶ Banbury mixing (1916)
- ▶ Rayon replaced by nylon (1958)

- ▶ **Gradual vs. Drastic**

- ▶ Drastic can put competitor completely out of business.
- ▶ Not the same as “disruptive technology”.

# The Lifecycle of Innovation

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## ▶ Questions

- ▶ How does industry structure changes product life?
- ▶ When does entry occur?
- ▶ When are profits made?

## ▶ Difficulties:

- ▶ Products are all different.
- ▶ Analyze successful products, but most not successful.
- ▶ What's a new product?

## ▶ Four phases: Introduction, Growth, Maturity and Decline.

# Phase 1: Introduction

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- ▶ **Begins with few firms**
  - ▶ If successful, rapid entry.
  - ▶ Firms make loss.
  - ▶ 99% of ideas die.
- ▶ **Market is small**
  - ▶ First adopting customers are not typical.
- ▶ **Heavy promotion**
  - ▶ Market education. Free samples.
  - ▶ Low pricing.
- ▶ **Insure customers against product risk**
  - ▶ Money back guarantees.
  - ▶ Help implementation and servicing.

# Phase 2: Growth

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- ▶ **Market**
  - ▶ Growth keeps competition down
  - ▶ Falling costs
  - ▶ High cost and poor quality firms will die
  - ▶ Others make large profits
- ▶ **Product**
  - ▶ Products improve over time
  - ▶ Standardization: handful of major designs
- ▶ **Strategy**
  - ▶ Distribution becomes important
  - ▶ Cultivate brand name
  - ▶ Prepare for shakeout

# Phase 3: Maturity

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- ▶ **Market**
  - ▶ Demand stabilizes. Seek growth abroad.
  - ▶ Shakeout
- ▶ **Cost Strategy**
  - ▶ Minimize costs. Efficient Distribution
  - ▶ Basic model becomes a commodity (e.g.VCRs)
- ▶ **Value Strategy**
  - ▶ Focus on niche
  - ▶ Differentiate product



# Phase 4: Decline and Replacement

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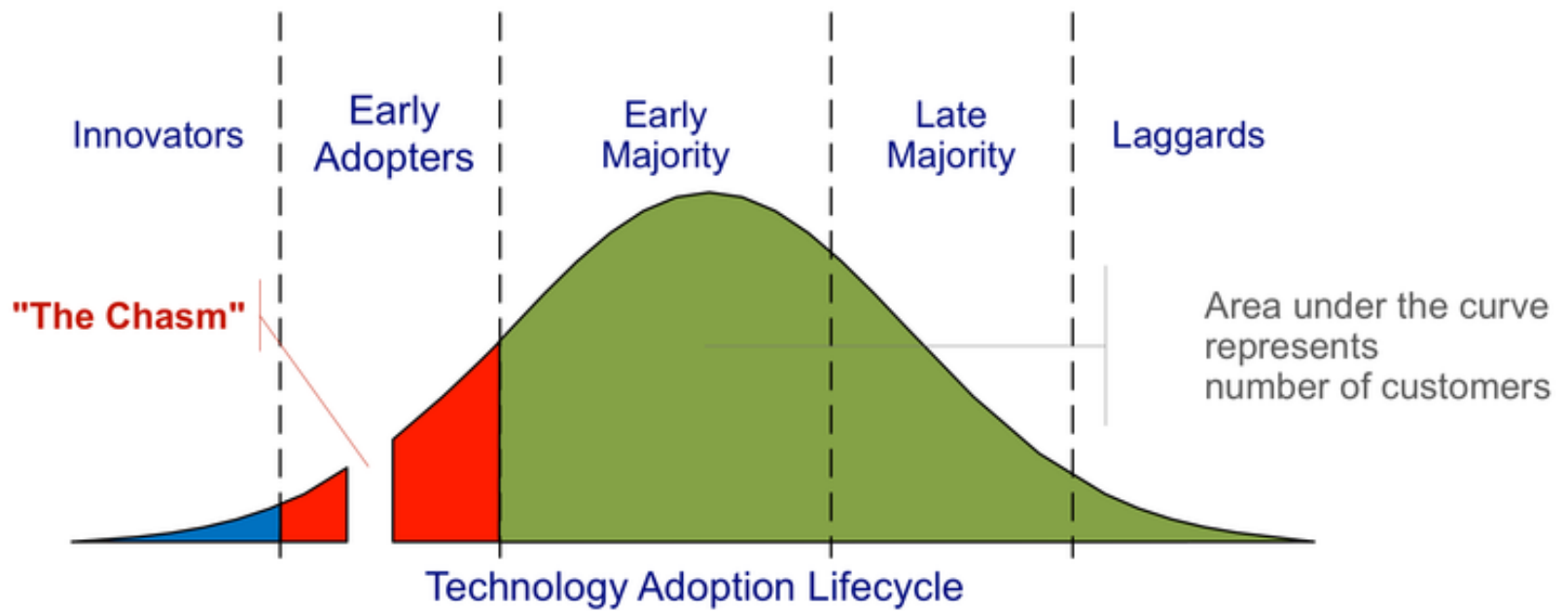
- ▶ **Reasons for declines**
  - ▶ Technological progress (e.g. B&W TVs)
  - ▶ Changing tastes and new info (e.g. fashion or CFCs)
- ▶ **Strategy 1: Focus on profitable segments**
  - ▶ Market changes (e.g. B&W TVs as security monitors).
- ▶ **Strategy 2: Harvesting.**
  - ▶ Don't replace capital. Exit when  $p \leq MC$ .
- ▶ **Strategy 3: Industry consolidation**
  - ▶ Importance of coordination
  - ▶ Excess capacity leads to ruinous price wars.
  - ▶ Strategies 1–3 compliment each other.
- ▶ **Complain to government.**

# Product Diffusion

# Roger's Diffusion Model

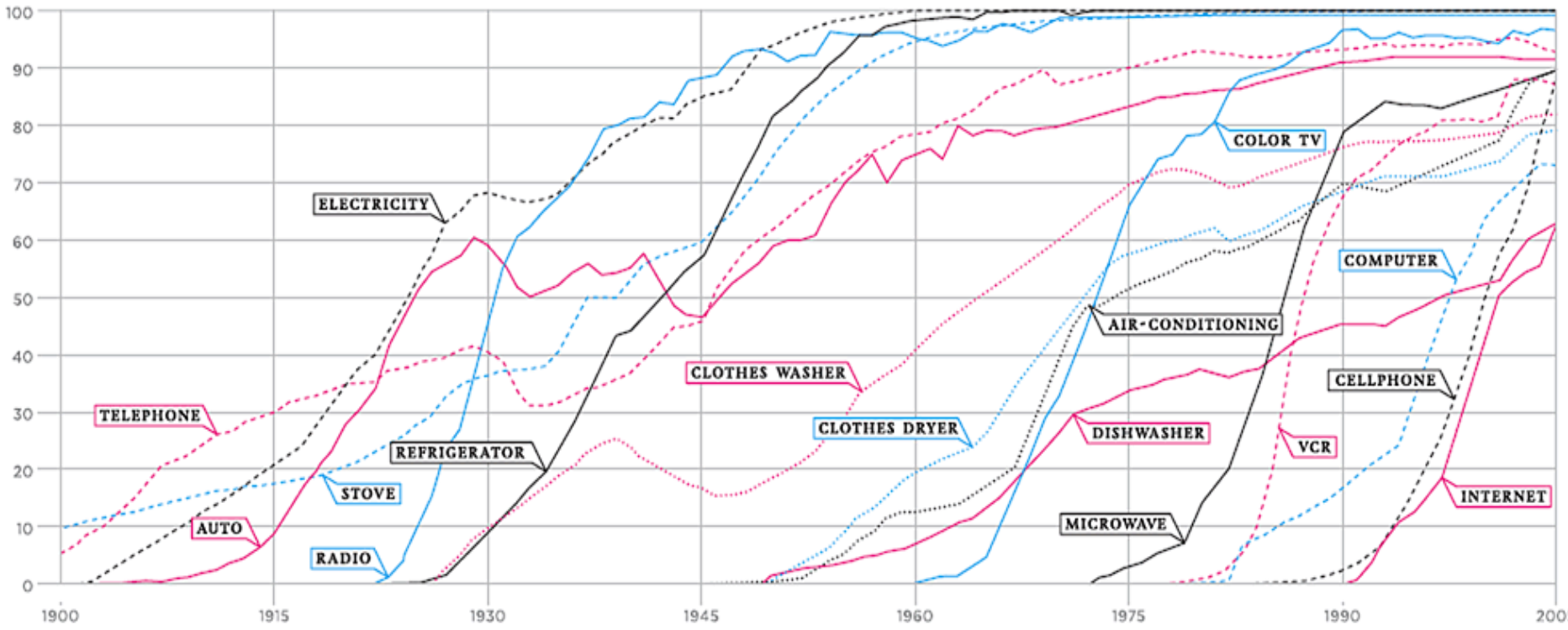
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- ▶ Diffusion is process through which new idea or product spreads.
- ▶ Questions:
  - ▶ How fast will product be adopted?
  - ▶ What factors affect technology adoption?
  - ▶ What strategies can we adopt
- ▶ We can broadly divide people into
  - ▶ Innovators – who experiment with product
  - ▶ Imitators – who learn from experience of others



PERCENT OF  
U.S. HOUSEHOLDS

# CONSUMPTION SPREADS FASTER TODAY



# Innovators (Techies)

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- ▶ Technology enthusiasts
- ▶ Willing to learn
- ▶ Appreciate technology for its own sake
- ▶ Motivated by idea of being change agent
- ▶ Willing to tolerate initial problems
- ▶ Venturesome, educated
- ▶ How to sell to these
  - ▶ Product should be technologically interesting
  - ▶ Product should be novel in some dimension
  - ▶ Advertise in specialist outlets

# Early Adopters (Visionaries)

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- ▶ Want new technology to improve function.
- ▶ Want discontinuous breakthrough improvement
- ▶ Social leaders
- ▶ Attracted by high-risk, high-reward
- ▶ Anxious, champions
- ▶ Selling to these
  - ▶ Sell “dreams” that are clearly defined
  - ▶ Relate directly to objective
  - ▶ Demand personalized solutions
  - ▶ Reference other visionaries
  - ▶ Price is secondary; they want it right, complete, quickly, on time

# The Early Majority

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- ▶ Want incremental improvement
- ▶ Evolutionary, not revolutionary products
- ▶ Want proven, established products
- ▶ Don't sell dreams; sell reality
- ▶ Deliberate; less risk seeking
- ▶ Selling to these
  - ▶ Proven product
  - ▶ They want to know many satisfied customers
  - ▶ Buy whole products
  - ▶ Want lower prices



# Finally...

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- ▶ **Late majority (conservatives)**
  - ▶ Skeptical, traditional
  - ▶ Price sensitive
  - ▶ Want product mature, preassembled, with clear solutions
  - ▶ Don't like change
- ▶ **Laggards (skeptics)**
  - ▶ Only buy technology if necessary
  - ▶ Only now thinking about buying a cell phone
  - ▶ A hard sell

# Moore's Chasm

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## ▶ Visionaries

- ▶ Willing to take risks to obtain radical improvements
- ▶ Change agents

## ▶ Pragmatists

- ▶ Want incremental improvements
- ▶ Want comparisons, and solid references
- ▶ Price sensitive; more steps in sales strategy

## ▶ The chasm

- ▶ Tech firms must first sell to visionaries; then need to change
- ▶ Requires significant changes in marketing/sales strategy
- ▶ Many firms never overcome this leap

# What Determines Speed of Diffusion?

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- ▶ **Relative Advantage**
  - ▶ Improvement over old products
- ▶ **Switching costs**
  - ▶ Compatibility with previous systems and skills.
  - ▶ Complexity of learning new product
- ▶ **Network effects**
  - ▶ Degree to which my value depends on no. of users.
- ▶ **Trialability**
  - ▶ Ease of experimentation (cell phone vs. fridge)
- ▶ **Observability**
  - ▶ Visibility to others (iPhone vs. home computer)

# Bass Model of Diffusion

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- ▶ Let  $f(t)$  be the probability an agent first adopts at time  $t$ .
- ▶ Suppose hazard obeys

$$f(t) / [1 - F(t)] = p + qF(t)$$

so the no. of new adopters is linear in the no of users.

- ▶ Solving this differential equation,

$$f(t) = \frac{(p + q)^2 e^{-(p+q)t}}{\left( qe^{-(p+q)t} + p \right)^2}$$

- ▶ Bass (1969) estimated parameters  $p$  (no. of innovators) and  $q$  (importance of imitation) for different products.

# Innovation Incentives for Firms

# Incentive to Innovate: Replacement Effect

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- ▶ **Who innovates more: Incumbant or Entrant?**
  - ▶ Innovation reduces costs to  $c_L$
  - ▶ Let  $i$ 's profit with costs  $(c_i, c_j)$  be  $\Pi(c_i, c_j)$
  - ▶ Suppose opponent innovates (worst case scenario)
  - ▶ Suppose entrant enters if and only if she innovates.
- ▶ **WTP of incumbent,  $V_I = \Pi(c_L, c_L) - \Pi(c_H, c_L)$ .**
- ▶ **WTP of entrant,  $V_E = \Pi(c_L, c_L) - \Pi(\infty, c_L) > V_I$ .**
- ▶ **Entrant has higher willingness to pay.**
  - ▶ Incumbent cannibalizes herself (e.g. Nintendo vs. Sega).

# Incentive to Innovate: Efficiency Effect

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- ▶ Who innovates more: Incumbent or Entrant?
  - ▶ Suppose 3rd party sells patent.
  - ▶ Suppose entrant enters if and only if she innovates.
- ▶ WTP of incumbent,  $V_I = \Pi(c_L, \infty) - \Pi(c_H, c_L)$ .
- ▶ WTP of entrant,  $V_E = \Pi(c_L, c_H) - \Pi(\infty, c_L) < V_I$
- ▶ Incumbent usually has higher willingness to pay
  - ▶ Monopolist makes more profits than two duopolists
- ▶ Key: If I innovates, then E does not. For example,
  - ▶ I and E compete in patent race.
  - ▶ E only enters if strictly more efficient.

# Investment Timing: Pre-emption

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- ▶ A single firm considers *when* to acquire a new technology
  - ▶ E.g. A hospital considers buying and MRI
- ▶ Monopoly problem
  - ▶ At time  $t$ , innovation costs  $c(t)$ . Yields flow profits of  $V$ .
  - ▶ Firm solves:  $Max_T \Pi(T) := \left[ \int_T^\infty e^{-rt} V dt - e^{-rT} c(T) \right]$
  - ▶ Yielding FOC,  $r\Pi(T) = e^{-rT} [-c'(T)]$
- ▶ Duopoly problem
  - ▶ Suppose only demand for one firm in the market.
  - ▶ Not profitable for second firm to invest (e.g. Bertrand example).
  - ▶ Invest when  $\Pi(T) = 0$ .
  - ▶ Hence adopt early in order to steal market



# Intellectual Property Protection

# Trademark

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- ▶ A **trademark** is a phrase, symbol, or design that identifies a product, and distinguishes it from others.
  - ▶ Aim to stop customers from mixing up brands.
  - ▶ Strongest trademarks cover words that have no other meanings (Kodak), or are used in unusual way (Apple).
  - ▶ Not to prevent companies from stealing others' ideas.
- ▶ Trademarks established by
  - ▶ Use in the marketplace
  - ▶ Registrations with trademarks office



# “How” we use words matters

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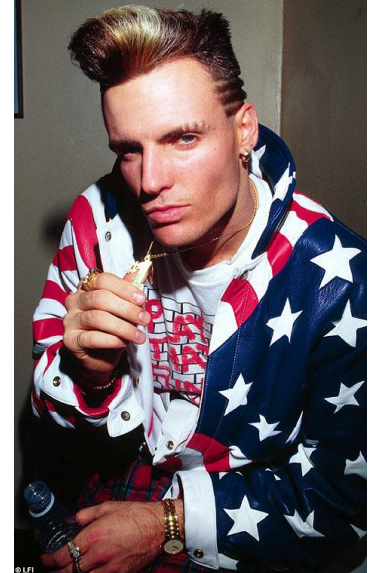


- ▶ Is “How” used in an unusual way?
- ▶ Could customers confuse these?

# Copyright ©

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- ▶ **Copyright** grants the creator of an original work exclusive rights to its use and distribution.
  - ▶ To incentivize people to create content.
  - ▶ Does not cover ideas and information themselves, only the form or manner in which they are expressed
  - ▶ Duration is life of the creator plus 50-100 years.
- ▶ **Justification: Obtaining a copyright**
  - ▶ Must meet minimal standard of originality
  - ▶ Copyright is automatically granted
  - ▶ Right based on originality rather than uniqueness
- ▶ **Exemptions for “fair use”**
  - ▶ Depends on % used; impact on copyrighted work



# Patents

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- ▶ A **patent** is exclusive right to inventor for a limited time in exchange for detailed public disclosure of an invention
  - ▶ Invention must be novel and non-obvious.
  - ▶ Patent allows one firm to block others.
  - ▶ Enforced via civil lawsuits; patent may be challenged.
  - ▶ Last 20 years from date of filing.
- ▶ Patent may cover
  - ▶ Business methods (e.g. Amazon's one-click)
  - ▶ Genetically modified organisms (e.g. Monsanto)
- ▶ Obtaining a patent
  - ▶ File with patent office. Cost \$10-30k.



# Patenting Strategy

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## ▶ Patents vs. Trade Secrets

- ▶ Obtain 17 yrs protection, but disclose details of innovation.

## ▶ Which is better?

- ▶ Can the competition use information in patent disclosure?
- ▶ Can they get around the patent?
- ▶ Can they see through trade secrets?
- ▶ Do you wish to license or sell the idea?
- ▶ Do you wish others to improve on the idea?
- ▶ How quickly will returns come?

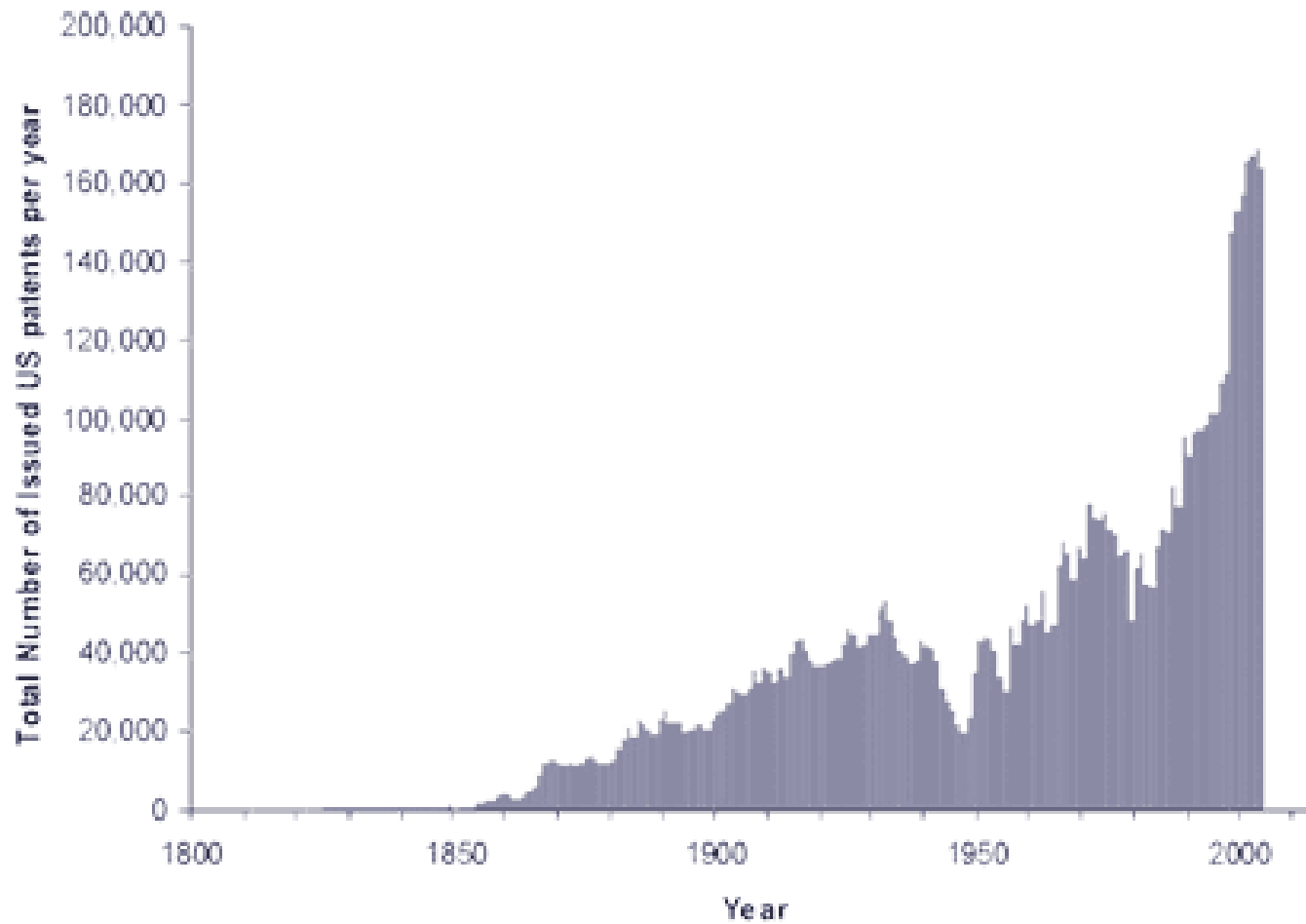
## ▶ Computer industry

- ▶ IBM invests \$5bn in R&D, while MS invests \$6bn.
- ▶ IBM obtained 3250 patents in 2004; licenses many.

- ▶ MS obtained 650. Relies on trade secrets

# Growth in patents

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# More Patenting Strategy

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- ▶ **Protective patents**
  - ▶ Patent all substitutes, including inferior technology.
  - ▶ Analogy: spatial preemption.
- ▶ **Defensive patents**
  - ▶ Patent holes in competitors process.
- ▶ **Timing of Patents**
  - ▶ Suppose two ideas are complements.
  - ▶ Then can wait to patent idea 2, extending effective patent.
  - ▶ Danger: someone patents before you do.



# Technology Transfer

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- ▶ Innovator may not have comparative advantage in using idea.
- ▶ **Licensing**
  - ▶ Buyer receives right to exploit innovation.
  - ▶ Receives technical assistance and pays fixed fee or royalty.
  - ▶ Example: In 2004, IBM earned \$1.2bn by licensing.
- ▶ **Acquisition of patent**
  - ▶ Seller forgoes independent commercialization.
  - ▶ Give away control rights (future sales, agreements)
  - ▶ Buyer can assemble complimentary patents.
- ▶ **Acquisition of innovator**
  - ▶ Buyer purchases idea and innovator's capabilities.

# Motivating Innovation

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- ▶ **How should a firm provide incentives to innovate?**
  - ▶ WHO provides incentive to develop AIDS drug.
  - ▶ DARPA provides incentives to develop cheap spaceship.
  - ▶ Large firms need to provide incentives internally
- ▶ **Push strategies - fund R&D directly.**
  - ▶ Who to fund?
  - ▶ What are their objectives?
- ▶ **Pull strategies - award winners.**
  - ▶ Give one prize or many? Prizes for incremental steps?
  - ▶ How define success?
  - ▶ Example: Lockheed–Martin makes divisions compete.

# Disruptive Innovation

# The problem of repeating success

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- ▶ Main frames – IBM
- ▶ Minicomputers – Digital Equip, Data General
- ▶ Desktop computers – Apple, Commodore, Tandy, IBM
- ▶ Engineering workstations - Apollo, Sun Microsystems
- ▶ Portable computers – Compaq, Zenith, Toshiba, Sharp
- ▶ Netbooks – Asus, Acer
- ▶ Tablets – Apple, Samsung

# Types of innovations

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- ▶ **Sustaining innovations**

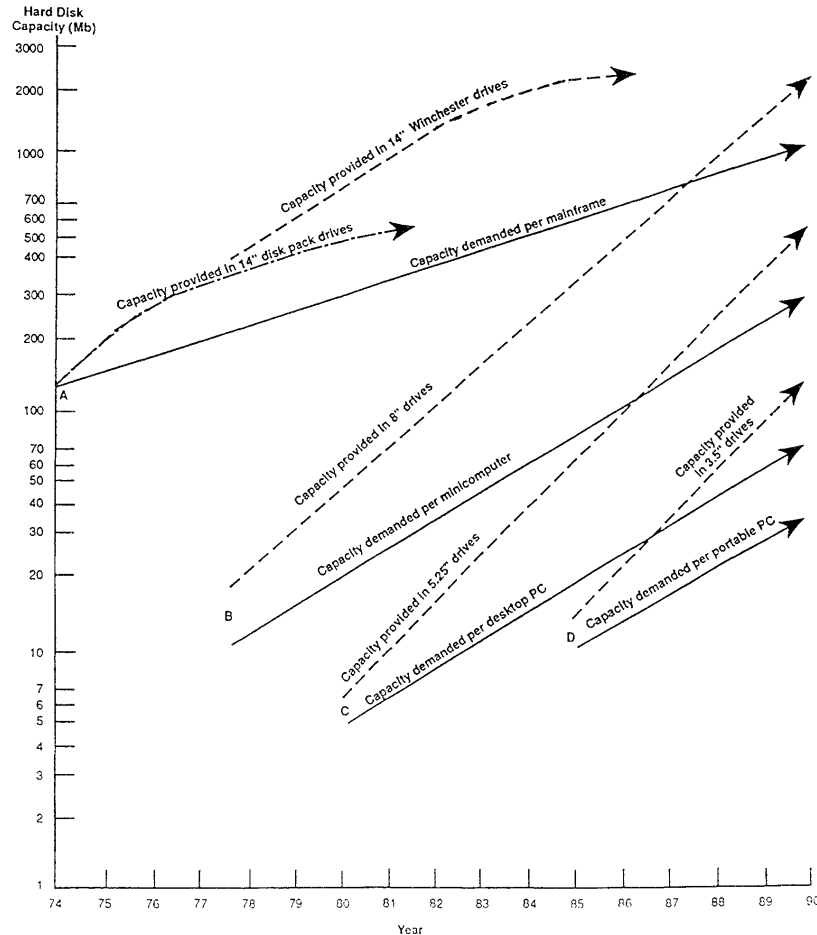
- ▶ Vertical improvements
- ▶ Doing the same, but better
- ▶ e.g. Thin film disks in Hard Drive industry.

- ▶ **Disruptive innovations**

- ▶ Different package of performance attributes
- ▶ e.g. Architectural innovations - 14", 8", 5.25" and 3.5" drives
- ▶ Low end disruptions – least profitable market segments
- ▶ New market disruptions – emerging market
- ▶ **The disruptive innovation can ultimately takeover**

# Disruptive technology takes over (1)

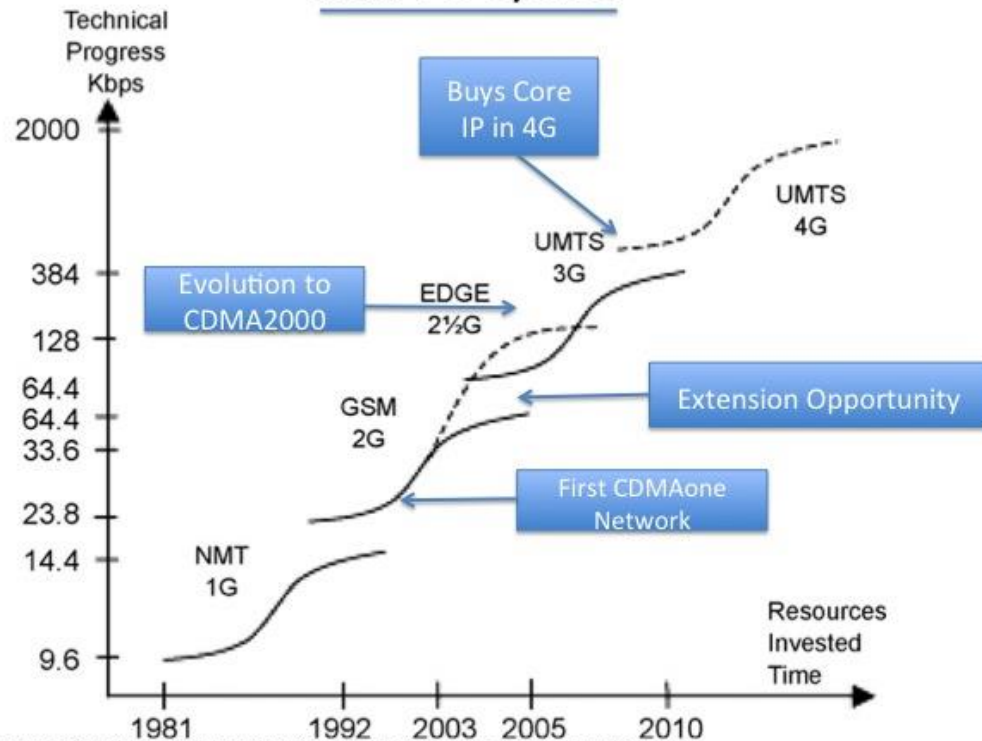
- ▶ Customer demand rises slower than technical progress



# Disruptive technology takes over (2)

- ▶ S-curves mean decreasing speed of innovation

## At the forefront of innovation through 2G, 3G and 4G cycles



Source: Inter-generational transitions in socio-technical systems: The case of mobile communications

# Leadership and Innovation

(a) Numbers of established and entrant firms introducing models employing selected trajectory-sustaining technologies

		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Thin-film heads	Entrants							1			1	2	1		1	4
	Established			1			1	1	3	5	6	8	12	15	17	22
RLL codes	Entrants											1	2	3	6	8
	Established											4	11	20	25	26
Winchester architecture	Entrants				1	4	9									
	Established	1		3	3	7	11									

(b) Numbers of established and entrant firms introducing models based upon disruptive architectural technologies

		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
8-inch	Entrants					1	4	6	8							
	Established					0	2	5	5							
5.25-inch	Entrants							1	8	8	13					
	Established							1	2	8	11					
3.5-inch	Entrants											1	2	3	4	
	Established											0	1	1	4	

- ▶ Sustaining innovations
  - ▶ Leaders continued to dominate across generations
- ▶ Disruptive innovation,
  - ▶ 1/2 to 3/4 of manufacturers failed to introduce new models
  - ▶ New wave of entrants



# Why?

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## ▶ Incumbent's dilemma

- ▶ Managers listen to what *current* customers want.
- ▶ Do what worked in the past.
- ▶ Overcome bureaucratic hurdles to launch new product.
- ▶ Don't want to go down-market.
- ▶ Henry Ford: "If I'd ask customers what they wanted, they would have told me 'a faster horse'".

## ▶ Example: Seagate

- ▶ Pioneered 5.25" drive, used by IBM for desktops.
- ▶ Developed 3.5" by 1985, but main customers not interested.
- ▶ Former employees founded Conner.
- ▶ New customers, e.g. Compaq, making small desktops
- ▶ Rapid improvement in technology.
- ▶ Seagate entered market in 1987, but then too late.

# Crowdfunding

# What is it?

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- ▶ **Examples**

- ▶ Kickstarter
- ▶ IndieGoGo

- ▶ **Crowdfunding increases efficiency of lending**

- ▶ Works in countries with limited banking
- ▶ Entrepreneurs can learn demand before undertaking project

- ▶ **Examples**

- ▶ Citizen star video game raised \$93m
- ▶ Pebble-time smart watch raised \$20m

- ▶ **Crowdfunding can be used to donate money**

- ▶ People can give to specific projects
- ▶ Can cut out middlemen

# How does it (roughly) work?

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## ▶ Rewards crowdfunding

- ▶ An entrepreneur posts price  $p = \$100$  and target  $T = \$10,000$ .
- ▶ If raise less than  $T$ , everyone gets money back.
- ▶ If raise more than  $T$ , everyone pays  $p$  and (hopefully) gets good.

## ▶ Debt crowdfunding

- ▶ Entrepreneur requests loan size  $T$  and interest rate  $r$ .
- ▶ Lenders can choose to give money.
- ▶ If raises  $R$ , then money is lent; otherwise get refund.

## ▶ Equity crowdfunding

- ▶ Entrepreneur willing to sell  $x\%$  of company for  $\$T$ .
- ▶ Lenders can buy shares, so  $1\%$  costs  $\$1/T$
- ▶ If raises  $T$ , then money is given; otherwise get refund

# Moral hazard problem

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- ▶ How ensure firm doesn't run away with the money?
  - ▶ Consider rewards-based product (e.g. video game)
- ▶ Solution 1: require prototype
  - ▶ Skarp raise \$4m on Kickstarter, but was suspended
  - ▶ Went over to Indigogo, where raised \$300k
- ▶ Solution 2: deferred payment (e.g. PledgeMusic)
  - ▶ Give firm target T immediately, so can build product.
  - ▶ Give all money raised after product finished.
- ▶ Solution 3: Buyers put down non-refundable deposit
  - ▶ Firm can use deposit money.
  - ▶ Can use future orders to get regular capital.
  - ▶ E.g. apartment buildings, which usually pre-sell 70%