15.905 Technology Strategy

Transitions and disruption

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Massachusetts Institute of Technology

# Agenda for today, Wednesday 11 April 2007

~12:45

~13:15

~14:15

- Transitions and disruption
- Apple in 2006 …and 2007
- End of class

Technological innovation and the diffusion of innovations cause transitions

- *Incremental* innovation involves relatively minor changes
- *Radical* innovation is based on different engineering and scientific principles

Performance

Incremental innovation

Incremental innovation

Dominant design

Ferment

Radical innovation

Ferment

Time
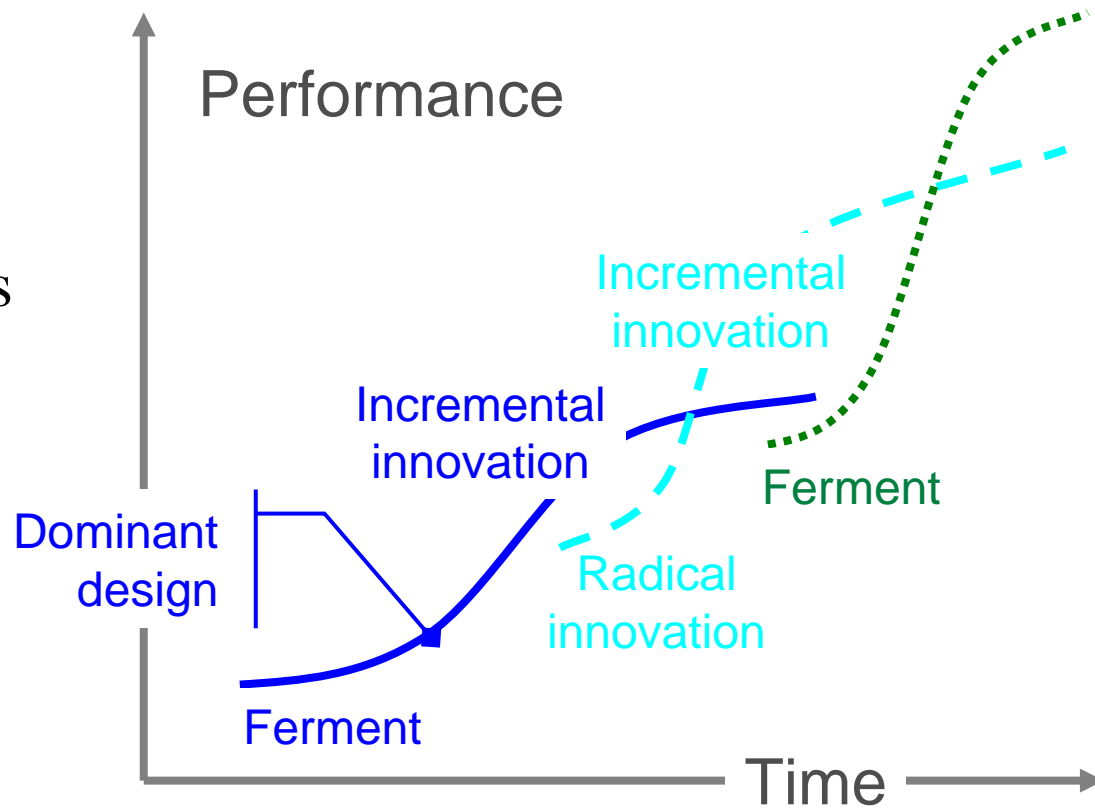
Incremental and radical innovations have very different competitive consequences

Incremental innovation

- Introduces relatively minor changes
- Happens once dominant design has been established
- Typically drives rapid performance improvement
- Exploits the potential of the established design
- Typically reinforces position of incumbents

Radical innovation

- Based on a different set of engineering principles
- May open up whole new markets and potential applications
- Often creates great difficulties for incumbent firms
- Can be basis for successful entry by insurgents

But sometimes, "…apparently modest changes…" have dramatic consequences

Xerox and Canon in small copiers

- Pioneers plain paper copiers
- In 1970's competitors win share with much smaller, more reliable copiers
- Little new scientific or engineering knowledge
- But Xerox takes ~8 years to launch competitive product
- …and it loses 50% of its market share

Sony and RCA in portable radios

- Mid-1950's RCA develops prototype portable radio
- Sony- small new insurgent - uses transistorized radio to enter US market
- Sony's radios produced with technology licensed from RCA
- But RCA doomed as a follower, can't match Sony

Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

Two different sorts of knowledge: component or modular; architectural or integrative

Component

- Knowledge about each of the core design concepts
- How they are implemented in a particular component within a product
- Specialized and focused, can be mastered by an individual or a small team
- Constant focus once dominant design established
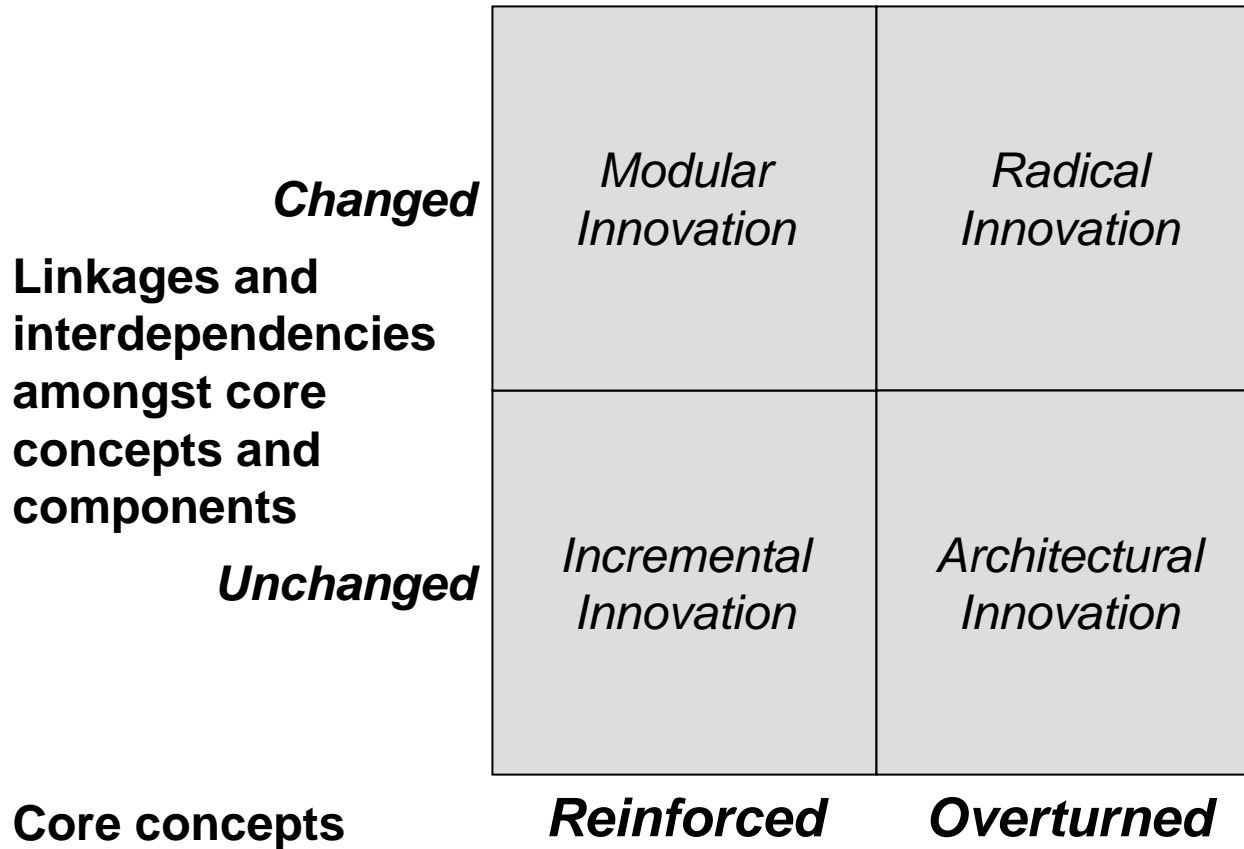- Radical change obvious

Architectural

- Knowledge about ways in which components link together into coherent whole and are interdependent
- Tends to become embedded as tacit knowledge
- Communication channels, information filters and problem-solving strategies
- Shift may not be apparent

Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

A framework for thinking about different types of innovation and the resulting transitions

	Reinforced	**Overturned**
Changed	*Modular Innovation*	*Radical Innovation*
Unchanged	*Incremental Innovation*	*Architectural Innovation*

Linkages and interdependencies amongst core concepts and components

Core concepts

Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

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Architectural innovation and the consequences of transitions in semiconductor capital equipment

Generation

Firm	1 Contact	2 Proximity	3 Scanner	4 Step and Repeat (1)	5 Step and Repeat (2)
Nikon					**70**
GCA				**55**	12
Perkin-Elmer			**78**	10	<1
Canon		**67**	21	9	
Kasper	17	8			
Cobilt	**44**				

Rebecca Henderson and Kim Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms", Administrative Science Quarterly, March 1990, pages 9-30

Difficult transitions also happen when technological innovation outstrips the demand opportunity
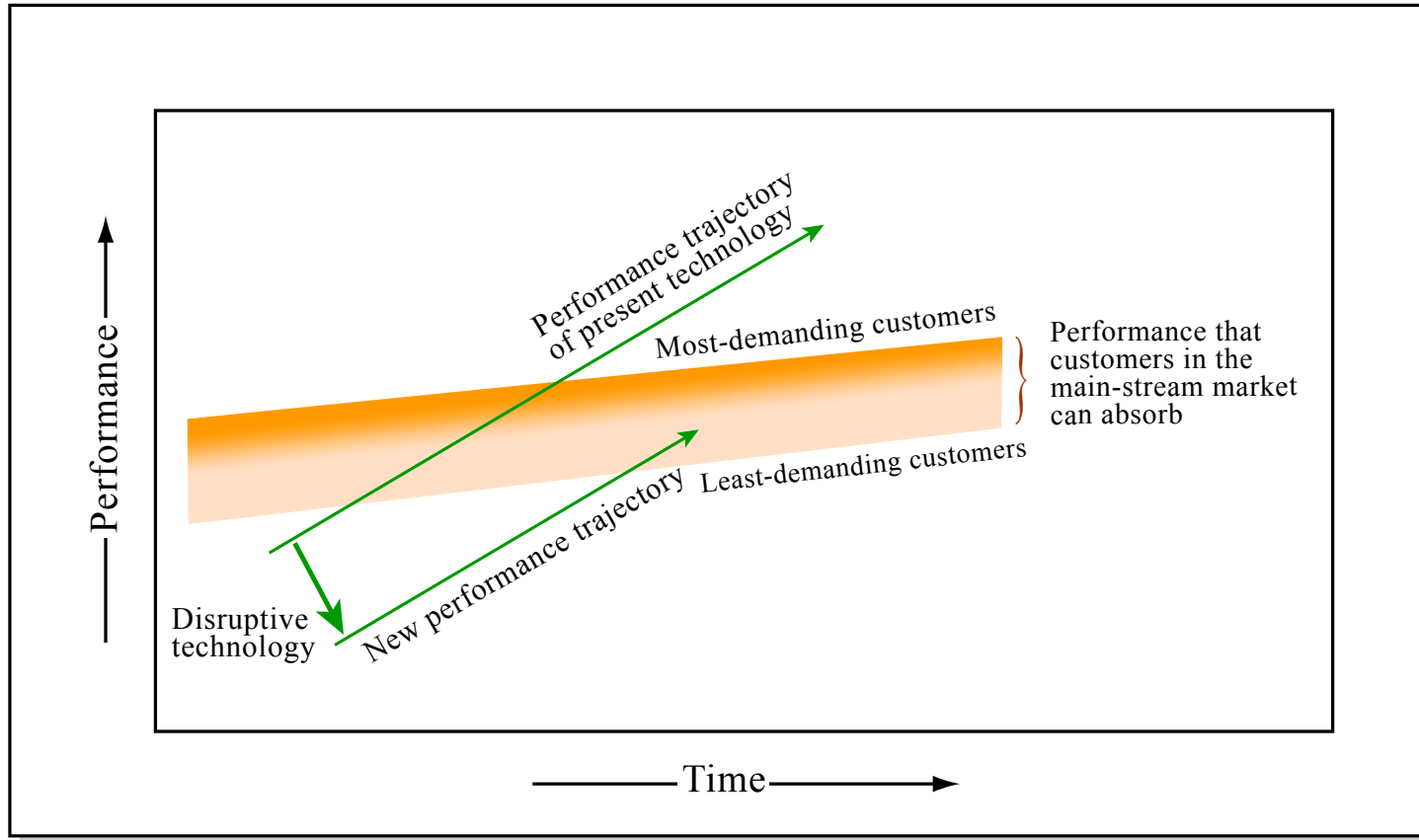

Image by MIT OCW.

Disruptive technologies have two key characteristics

- Products and services that embody these technologies in their early stages have **attributes that make them unattractive to incumbents' current mainstream customers**, and typically appeal only to small and emerging markets or segments, and offer inferior returns

BUT

- These technologies have the **potential for rapid innovation** along trajectories that will in future enable products and services that are attractive to incumbents' mainstream customers, allowing insurgents to later invade established markets and displace the incumbent

Three things are needed for these technologies to empower insurgents and threaten incumbents

Investment

- Even though products and services that embody these technologies are unattractive to incumbents' current mainstream customers at the outset, insurgents perceive sufficient demand opportunity to fuel investment and innovation

Innovation trajectory

- The innovation trajectory for these technologies evolves in the right direction and fast enough to meet the evolving requirements of the incumbents' current mainstream customers

Indifference

- The demand opportunity represented by incumbents' mainstream customers is evolving along a different trajectory than can best continue to be met using incumbents' sustaining technologies

Disruptive innovations in disk drives

- An alternative explanation
  - could have mastered the architectural transition
  - but novel technologies did not meet needs of current customers
- Response to transition depends on technical knowledge **and** on the perceived demand opportunity, business model and capabilities
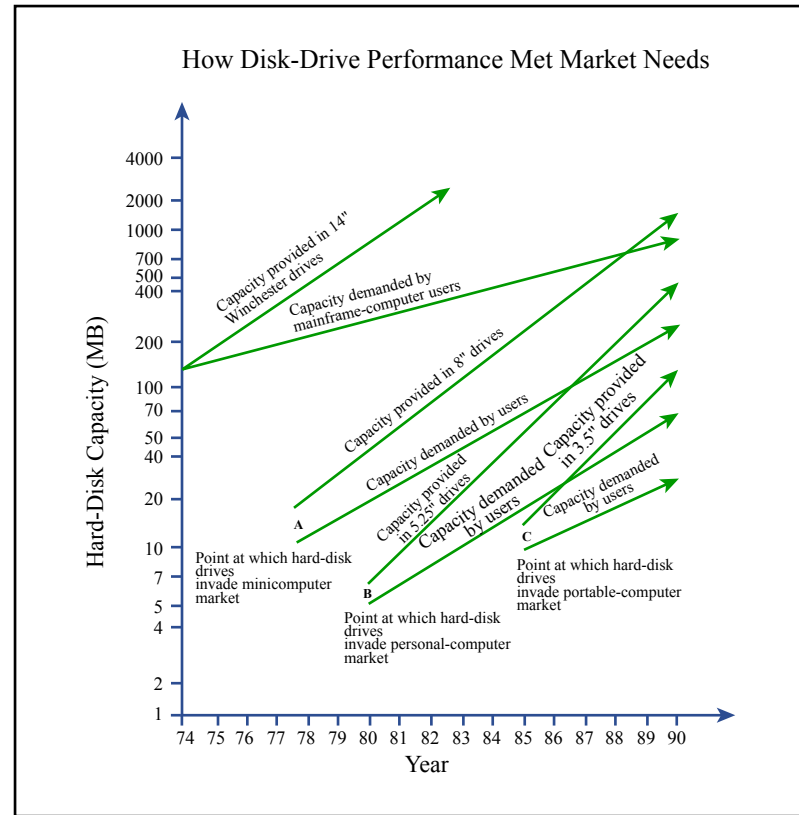

Image by MIT OCW.

Each of these generations involved innovation along a new and different trajectory

Generation

	1	2	3	4	5
	14"	8"	5.25"	3.5"	2.5"
Demand opportunity	Mainframe	Mini-computers	Desktop computers	Portable computers	iPods
Leader(s)	CDC	Shugart	Seagate	Conner Quantum	
New attributes		Internal power supplies Smaller	Higher density Lower unit cost	Rugged Lightweight Low-power	Tiny

Clayton Christensen, "Exploring the Limits of the Technology S-Curve - Part I: Architectural Technologies", Production and Operations Management, Fall 1992, pages 358-366

Even where incumbents pursue radical innovations, cognitive limitations may doom them

- Polaroid was the leader in instant photography
- Technology-driven company
  – long-term, large-scale research
- Believed in consumables
  – *"What's the business model? It's the razor/blade … so we make money with the film"*

- Commits to digital imaging
  – '86 Microelectronics Lab
  – by '89, 42% of budget
  – superior imaging technology
- Did not invest in other areas
  – low cost electronics manufacturing
  – rapid product development
  – new marketing and sales
- Takes long time, capabilities erode, people leave

Mary Tripsas and Giovannit Gavetti "Capabilities, Cognition and Inertia: Evidence from Digital Imaging", Strategic Management Journal, 2000, pages 1147-1161

SDM **system** DESIGN AND MANAGEMENT

The evolution of capabilities and beliefs at Polaroid

1980
- Instant film technology
- Manufacturing: Thin film coating and precision electronics
- Mass market distribution

1990
- Instant film technology
- Manufacturing: Thin film coating and precision electronics
- Mass market distribution
- Leading edge digital imaging technologies
    - microelectronics
    - lasers

1998
- Instant film technology
- Manufacturing: Thin film coating and precision electronics
- Mass market distribution
- Diminshed digital imaging technological capability

Pre-1980
- Instant camera product and process innovation

1981-1990
- Instant camera product and process innovation
- Large investments in exploring digital imaging technologies
- "Printer in the Field" digital camera development
- Helios medical imaging system
- Image recorders and scanners

1991-1998
- Instant camera product and process innovation
- Smaller investments in exploring DI technologies
    - sale of microelectronics lab & Helios
- Digital camera (without printer) development
- Image recorders and scanners

1980
- Technology-driven product development
- Value of large-scale invention
- Value of an *instant* print
- Value of "photographic" quality
- Razor/blade business model

1990
- Market-driven product development
- Value of large-scale invention
- Value of an *instant* print
- Value of "photographic" quality
- Razor/blade business model

1998
- Market-driven product development
- No value in large-scale invention
- Value of an *instant* print
- Value of "photographic" quality
- Razor/blade business model

Image by MIT OCW.

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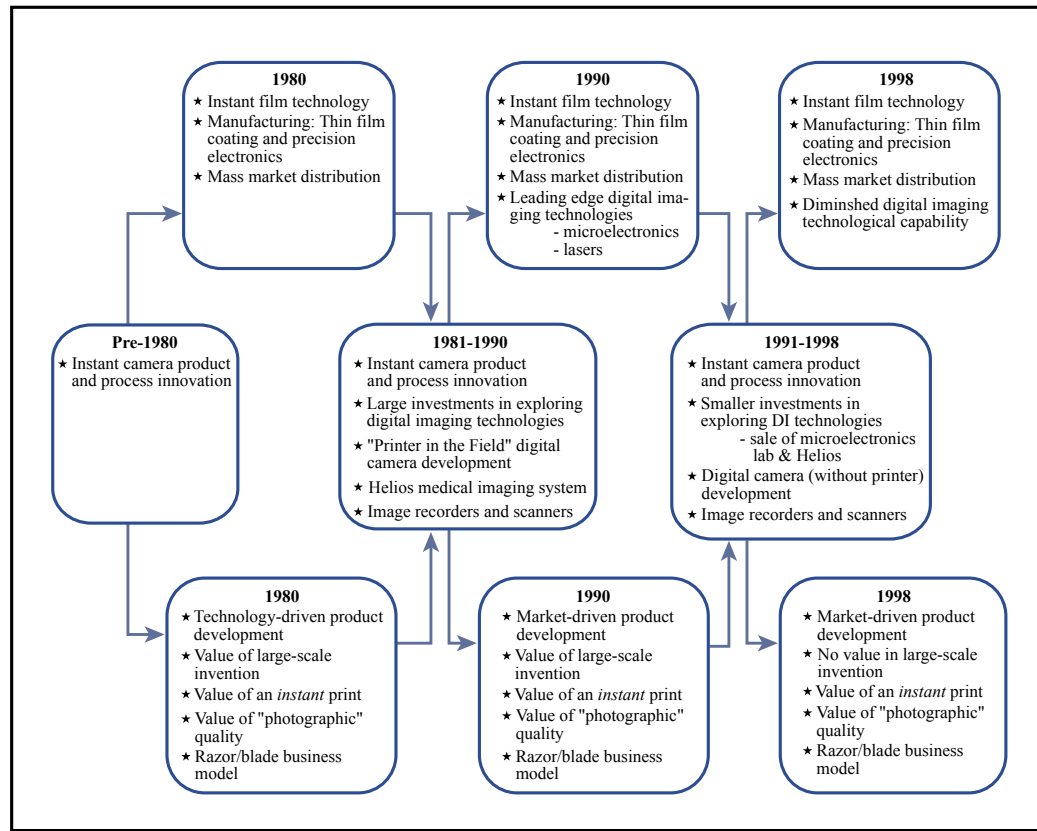
Innovation and transitions

- Incremental versus radical
  - minor changes within established dominant design
  - different set of engineering or scientific principles
- Modular versus architectural
  - component knowledge, localized
  - architectural knowledge, about interdependence amongst concepts and components, often tacit and embedded within organization
- Sustaining versus disruptive
  - fits customers, business model and capabilities
  - does not fit well with current customers, business model or capabilities, initially irrelevant but eclipses

Some terminology for timelines and transitions

Epoch applies to the beginning of a new period marked by radical changes and new developments - while *era* applies to the entire period

| Era | Era |

| Epoch | Epoch |

| Episode | Episode | Episode |

Event   Event
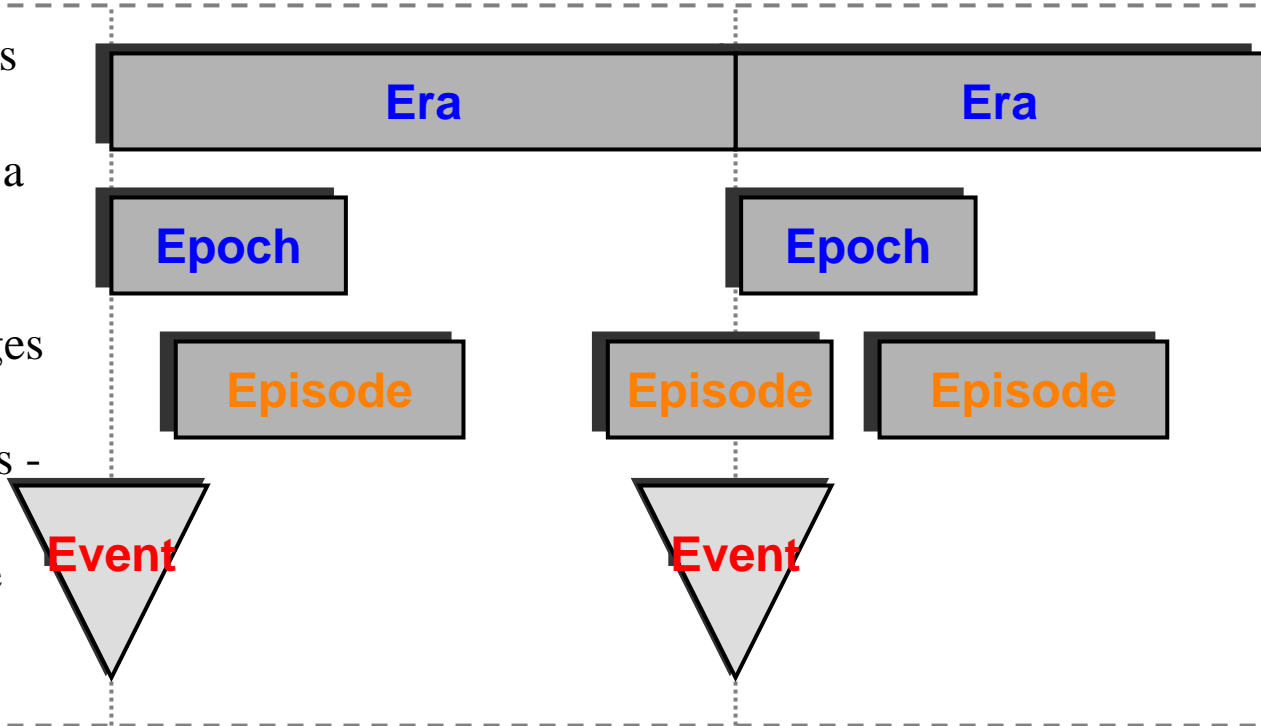
Time →

Roget's New Millennium™ Thesaurus, First Edition (v 1.3.1) © 2007

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Era
noun

1. a period of time marked by distinctive character, events and so on[1]
2. the period of time to which anything belongs or is to be assigned[1]
3. a period of time as reckoned from a specific date serving as the basis of its chronological system[2]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: American Heritage® Dictionary, © 2000 Houghton Mifflin

Epoch
noun

1. a period of time marked by distinctive character, events and so on[1]
2. the **beginning** of a distinctive period in the history of anything[1]
3. a **point of time** distinguished by a particular event or state of affairs[1]
4. a notable event that marks the **beginning** of a period of history, especially one considered remarkable or noteworthy[2]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: American Heritage® Dictionary, © 2000 Houghton Mifflin

Episode
noun

1. a portion of a narrative that relates an event or a series of connected events and forms a coherent story in anf of itself[1]
2. an incident in the course of a series of events[2]

1: American Heritage® Dictionary, © 2000 Houghton Mifflin
2: Random House Unabridged Dictionary, © Random House Inc. 2006

Organization response to transition ultimately depends on four key factors

Demand opportunity - who your customers are and what they want

Business ecosystem - your chosen niche, its business model and hence how you make money

Technological infrastructure - explicit and tacit component and architectural knowledge
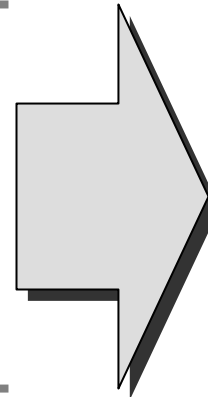
Your mental models - beliefs about the future, about how to make money, communication channels, information filters and problem-solving strategies

Domains, players and pattern recognition

- Digital displays: E Ink
- USB flash: Lexar Media, SanDisk, msystems and Sony
- Digital photography: Kodak, Polaroid, Sony, Canon and Nikon
- Portable radios: Sony and RCA
- Semiconductor capital equipment: Cobilt, Canon, Perkin Elmer and Nikon
- Disk drives: CDC, Fujitsu, IBM, Seagate, Conner and Quantum
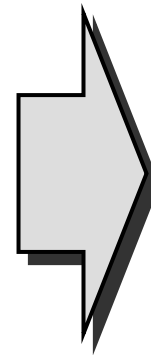
- Technologies and innovation trajectories
- Demand opportunity, adoption and diffusion
- Life cycles, transitions and disruption

Nine key concepts

✓ Technological infrastructure, technologies, innovation, parameters and trajectories

✓ Demand opportunity, adoption and diffusion

3 Business ecosystems, niches and co-opetition

✓ Co-evolution, life-cycles, epochs and transitions

5 Value creation, value capture and inimitability

6 Systems, architecture, modules, interfaces, standards, platforms, portfolios and pipelines

7 Activities, tasks, competences and capabilities

8 Ambiguity and scenarios, uncertainty and real options

9 Simple rules, prepared mind, active waiting, overload

A roadmap for the course

<u>A</u> Introduction	<u>B</u> Patterns of change	<u>C</u> Capturing Value	<u>D</u> Deciding and Delivering
Demand opportunity			
Business ecosystems, niches and co-opetition	Co-evolution, life-cycles, epochs and transitions	Value creation, value capture and inimitability	Ambiguity and scenarios, uncertainty and real options
Technological infrastructure			

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