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15.912 Technology Strategy  
Fall 2008

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# 15.912

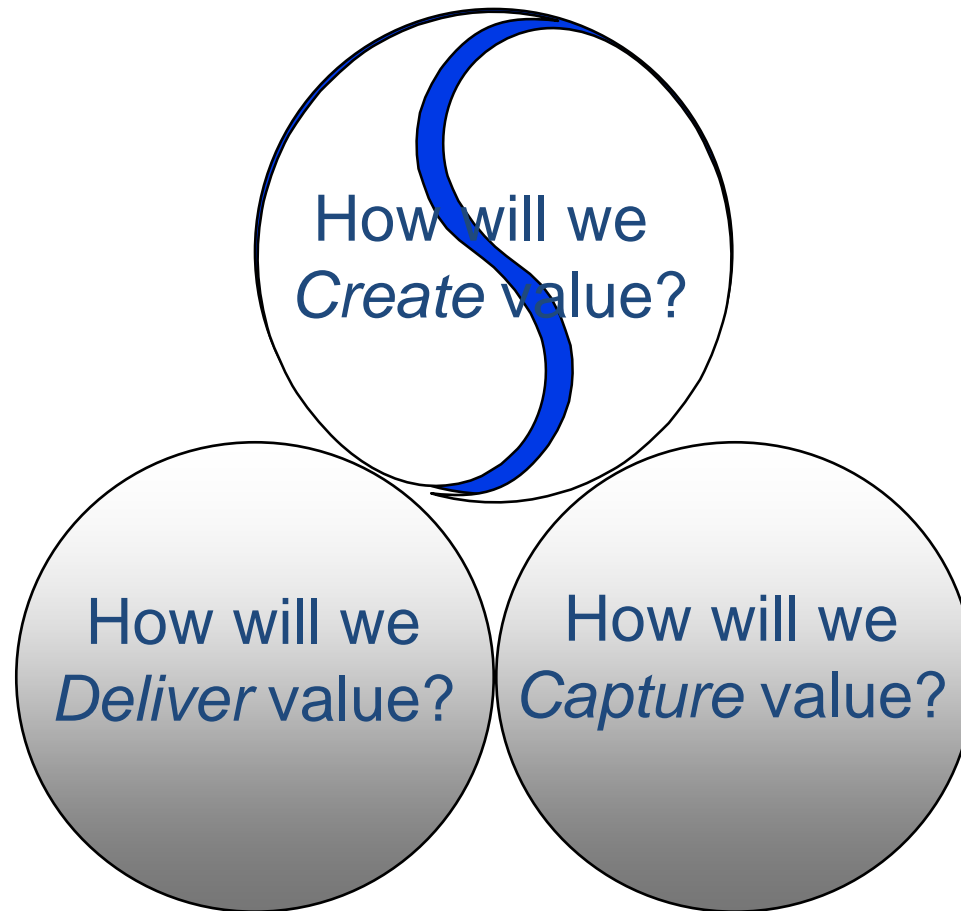
# Technology Strategy

**Professor Jason Davis**

MIT Sloan School of Management



# Effective strategies address three key problems:



## Effective strategies address 3 key problems:

- How will we create value?
  - How will the technology evolve?
  - How will the market change?
  - How do we organize effectively?
- How will we capture value?
  - How do we compete to gain sustainable competitive advantage?
  - How should we compete if standards are important?
- How will we deliver value?
  - How should we execute the strategy?
  - How do we make strategic decisions and take decisive action?

Why have a strategy?

## Why have a strategy?

1. To make choices and take actions

# Is This Your Project Pipeline? (A Log Jam)



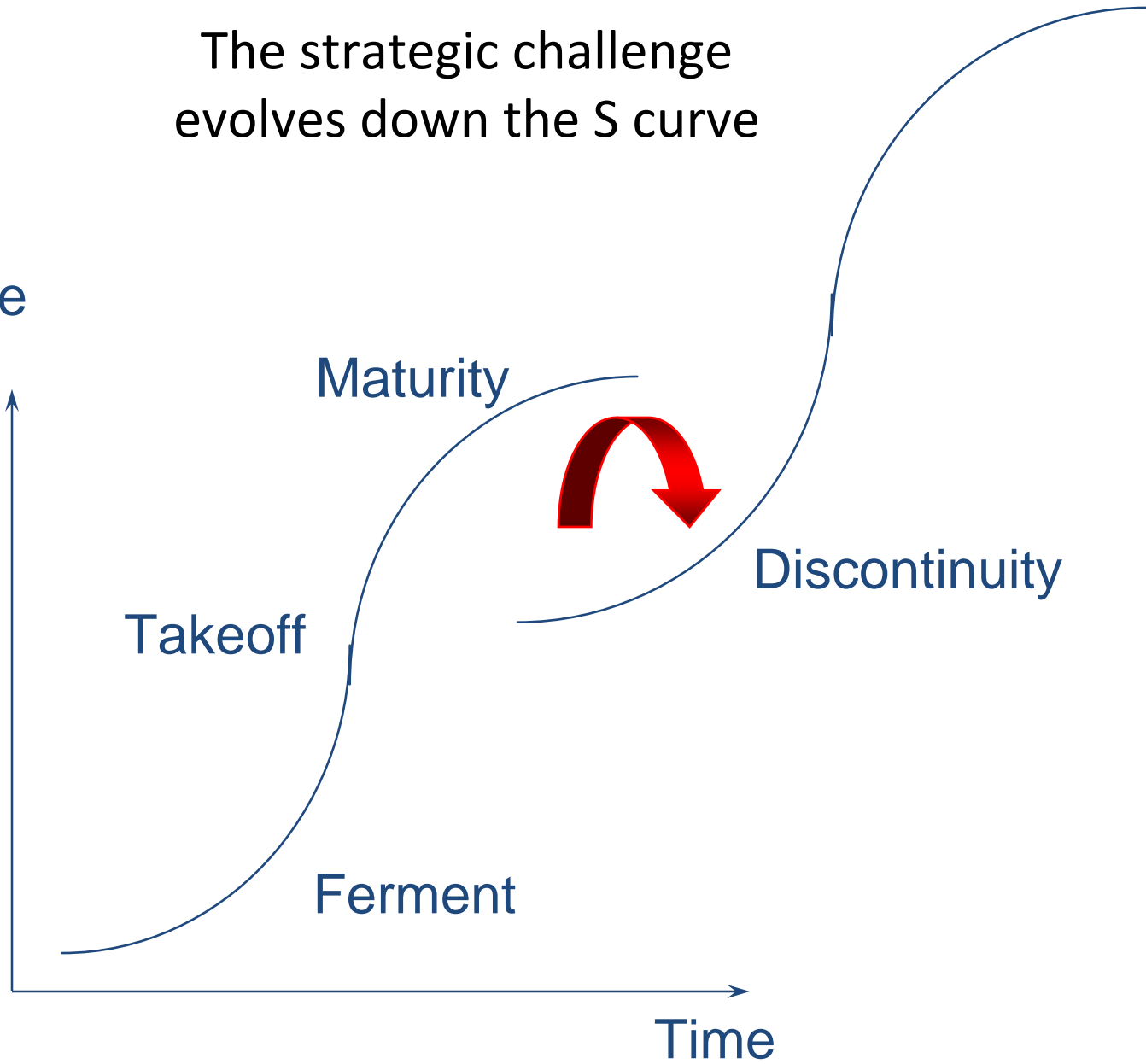
Why have a strategy?

2. To be able to change it



The strategic challenge evolves down the S curve

Performance



Maturity

Takeoff

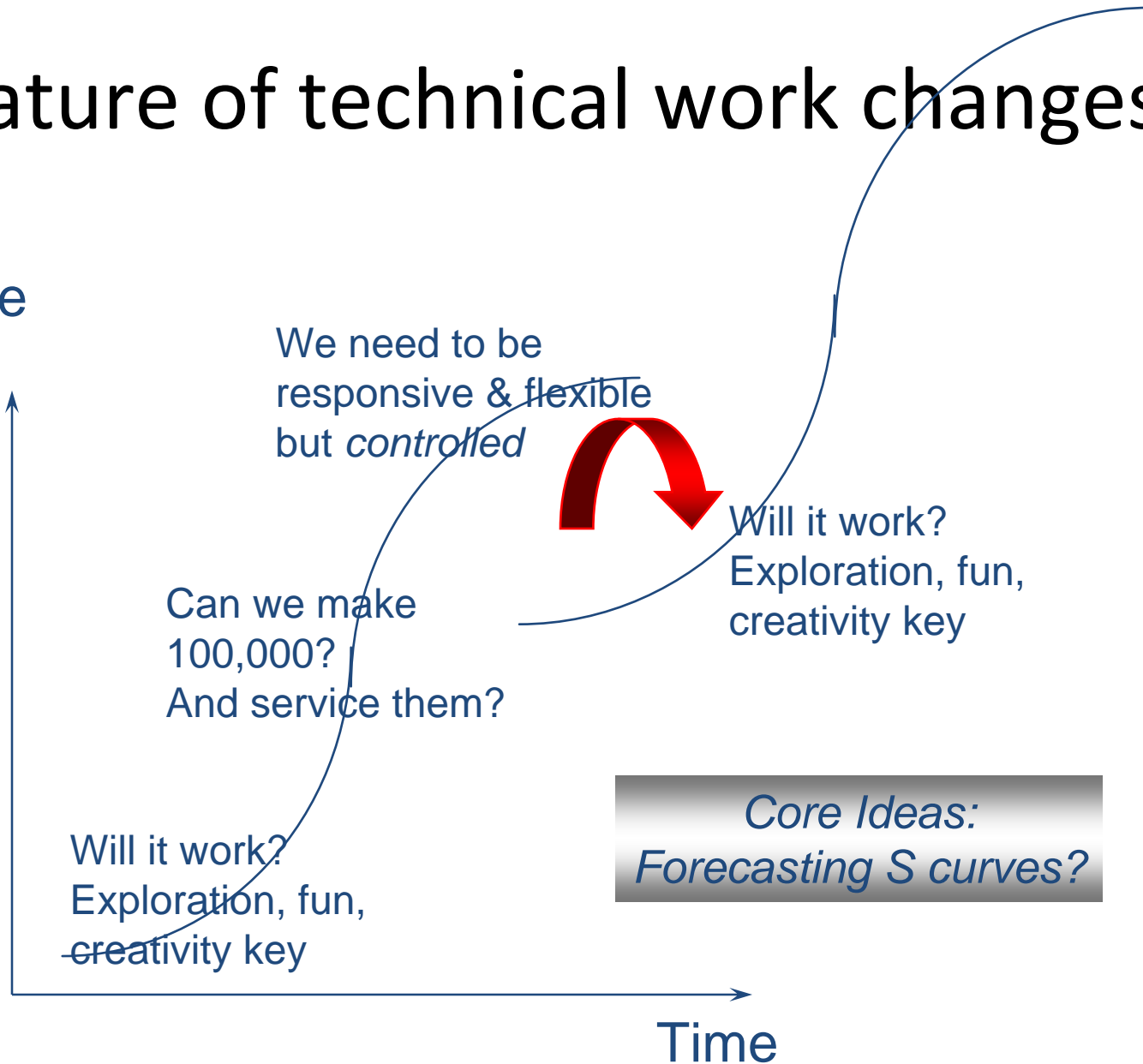
Ferment

Discontinuity

Time

# The nature of technical work changes

Performance



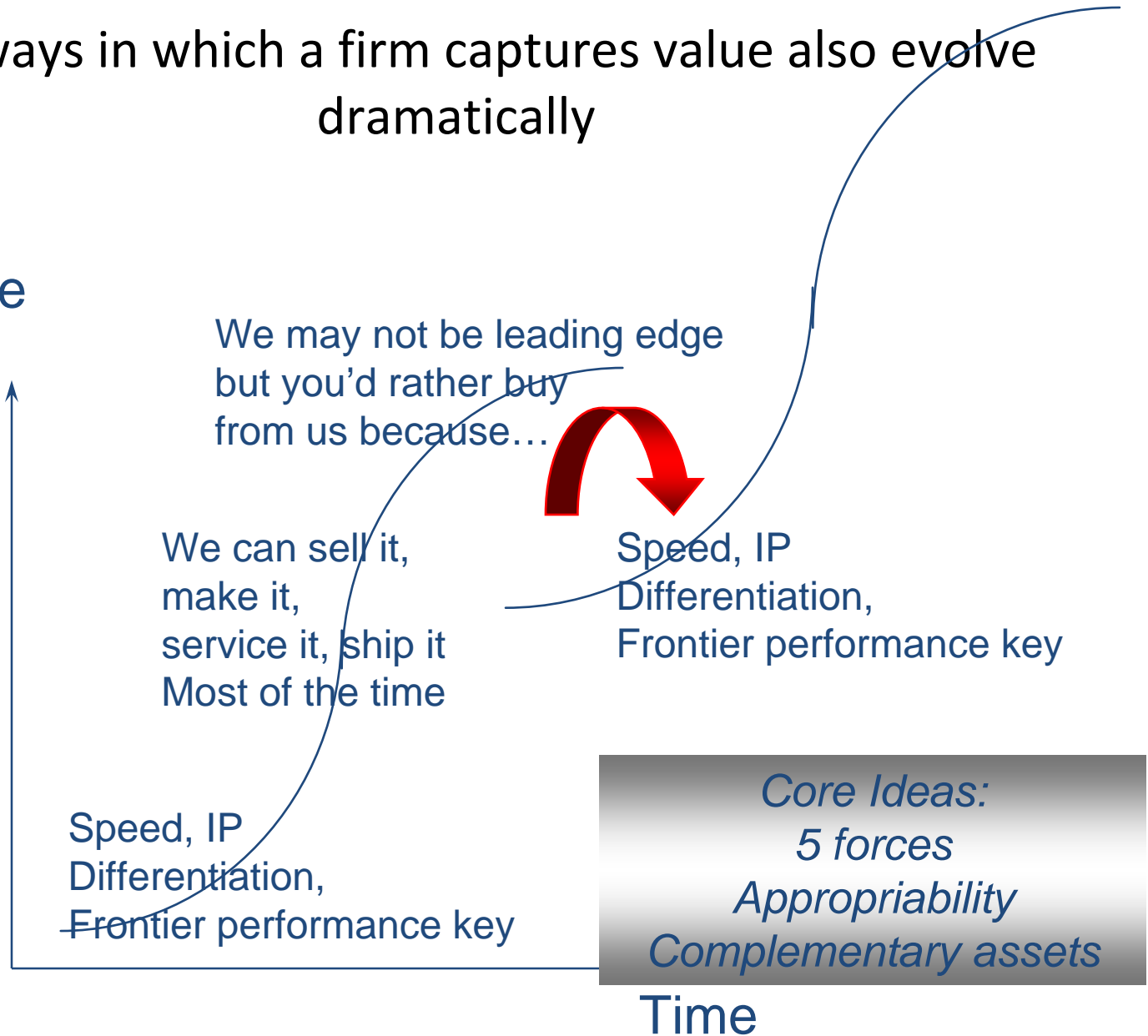
# The marketing challenge evolves

Performance



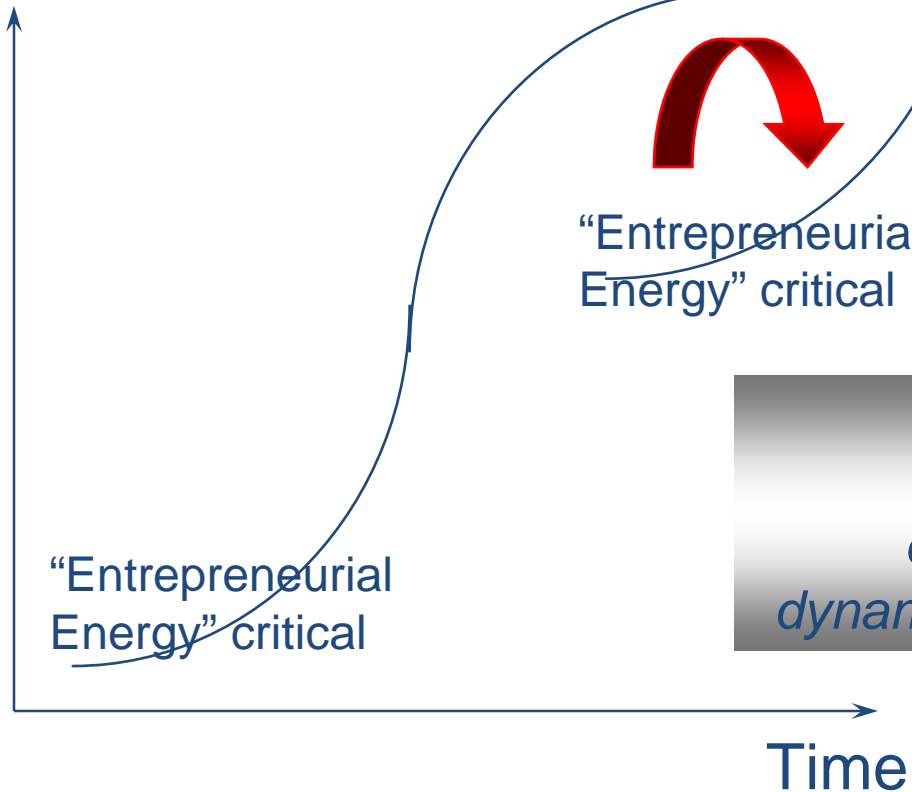
# The ways in which a firm captures value also evolve dramatically

Performance



The organizational challenge changes significantly

Performance



*Core Ideas:  
Managing the  
organizational  
dynamics of discontinuity*

That is, Technology Strategy is hard because it involves doing strategy in highly dynamic environments:

- high velocity
- high complexity
- high ambiguity
- high unpredictability

# Strategic Challenge of Technology Markets: Unpredictability and Ambiguity

## SOURCES

- Future S-curves and market evolution are hard to predict!
- Blurred timing and paths
- Shifting competitive basis, from products to business models
- Lack of control over key technology resources

## IMPLICATIONS

- Planning is limited
- Reacting is insufficient
- Traditional strategies of “defend a position” and “leverage core competence” are incomplete
- Shift from “closed” internal innovation to “open” innovation with partners

How shall we create value?



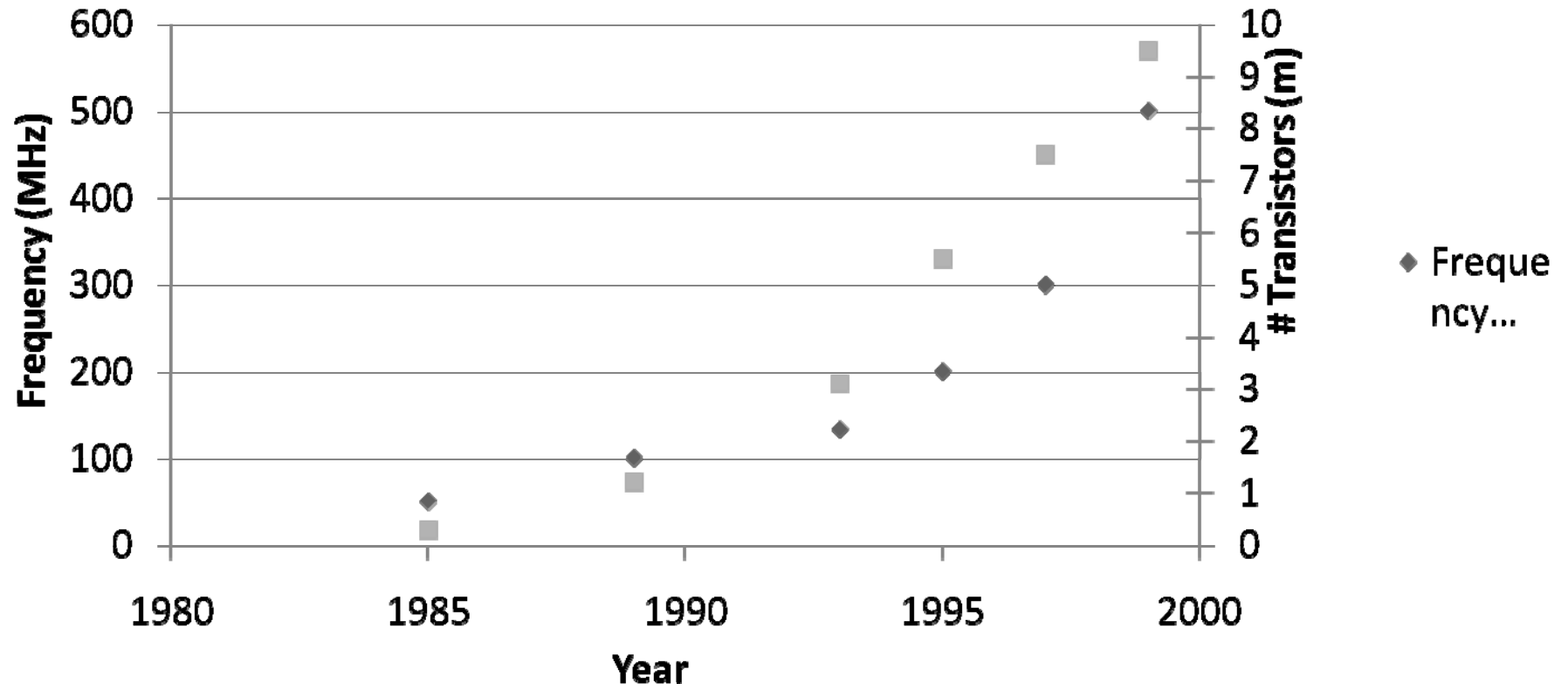
# Creating Value:

- Understand how technologies will evolve
  - (Both your own and those on which you rely)
- Understand how customer needs will evolve
- Organize effectively to develop world class products and services that meet customer needs

# Tools for value creation

- Predicting Technological Change
  - Limits and Growth Rates
  - Trend extrapolation
- Predicting the Evolution of Customer Needs
  - Basic segmentation
  - Crossing the chasm
  - New technologies, new needs
- Utilize moderate structure and dynamic organizational processes

# Trend extrapolation: Semiconductors

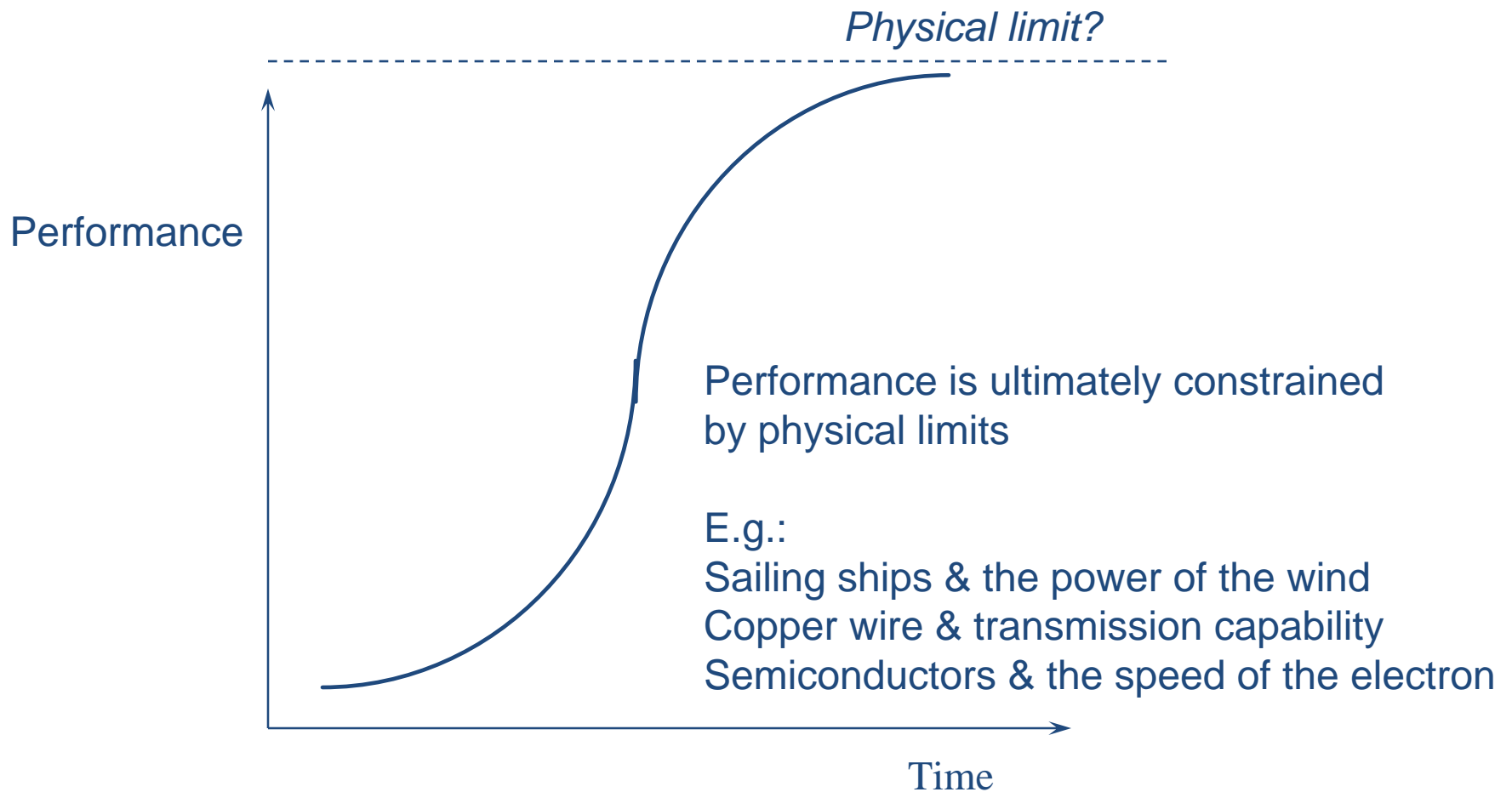


# Issues in Trend Extrapolation

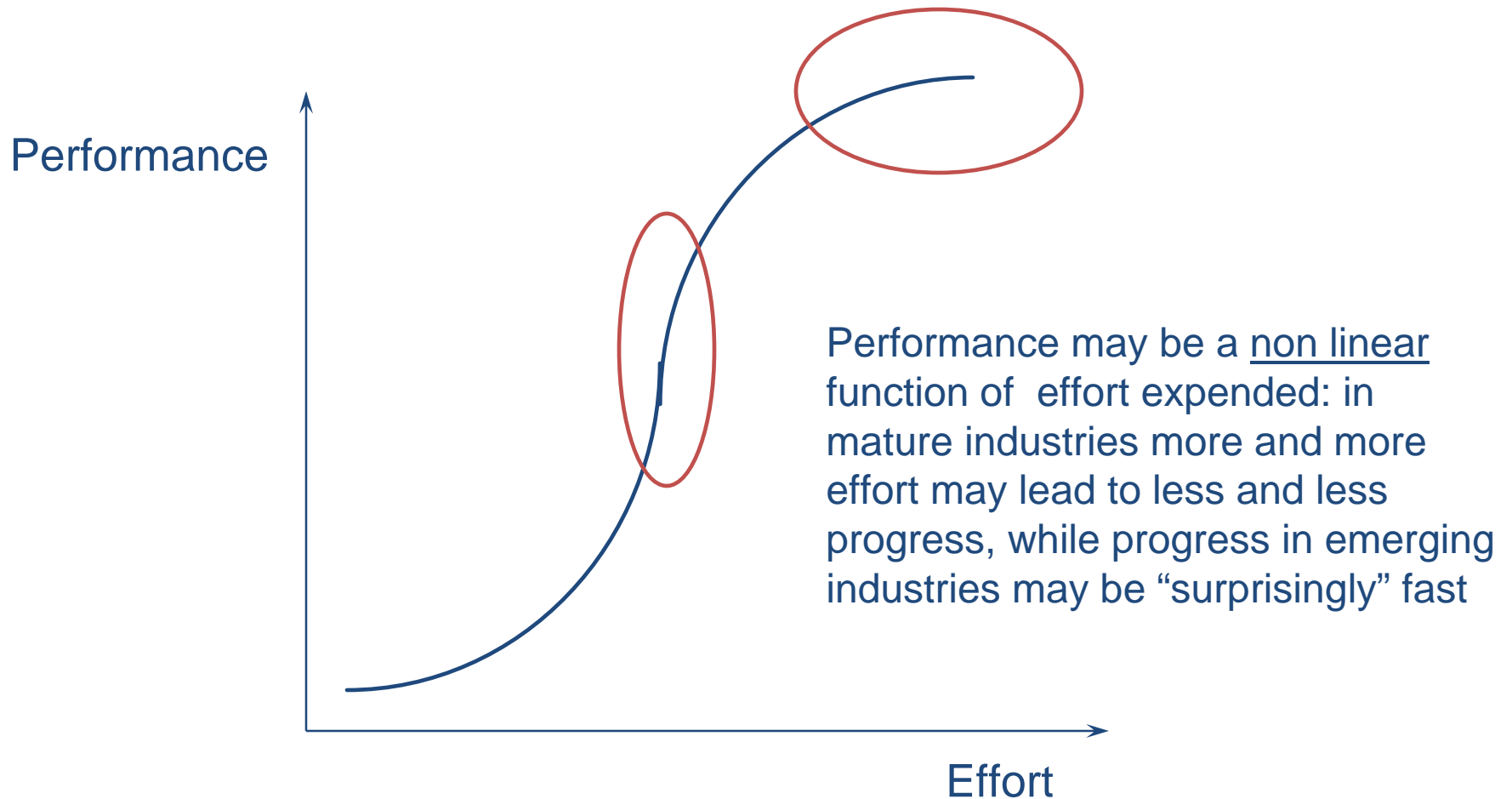
- Which parameter shall I predict?
- Do all good things come to an end?
- Exploring the difference between progress as a result of the passage of time, and progress as the result of returns to effort
- Predicting progress in complementary technologies

# Do all good things come to an end?

## Technological exhaustion



# Modeling the returns to *effort vs. time*



# The Unexpectedly Long Old Age of Optical Photolithography

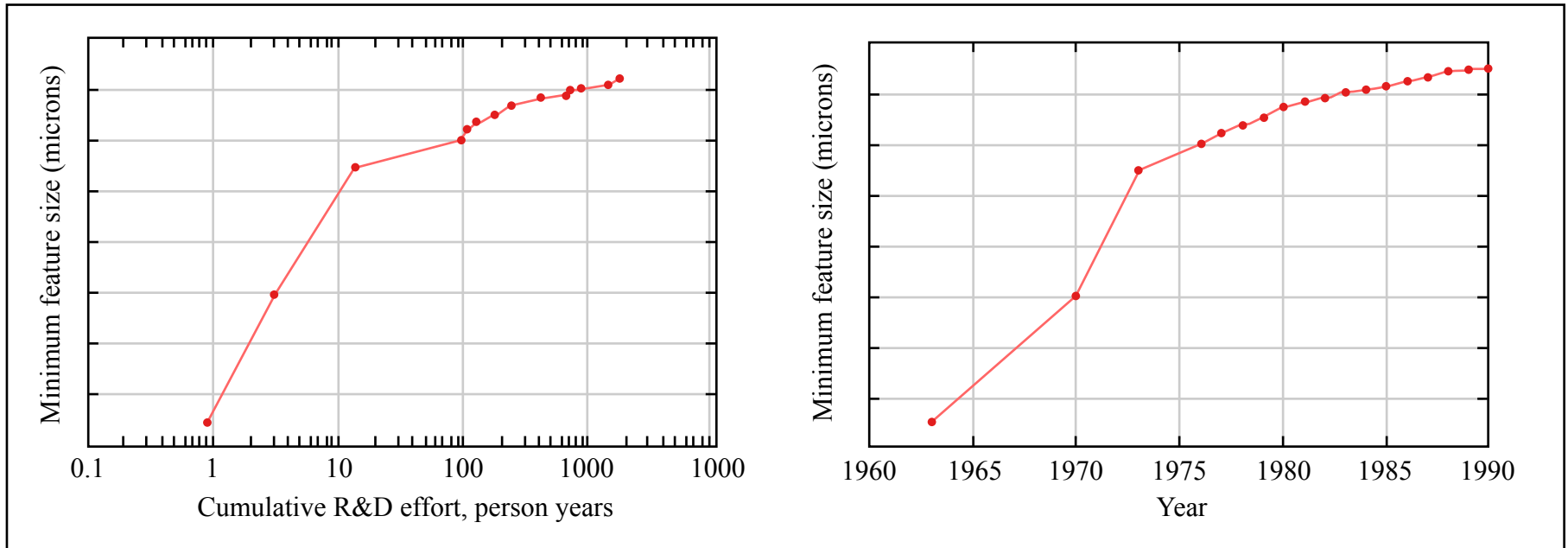


Image by MIT OpenCourseWare.

Source: Henderson, 1995.

# S-Curves, Real and Imaginary

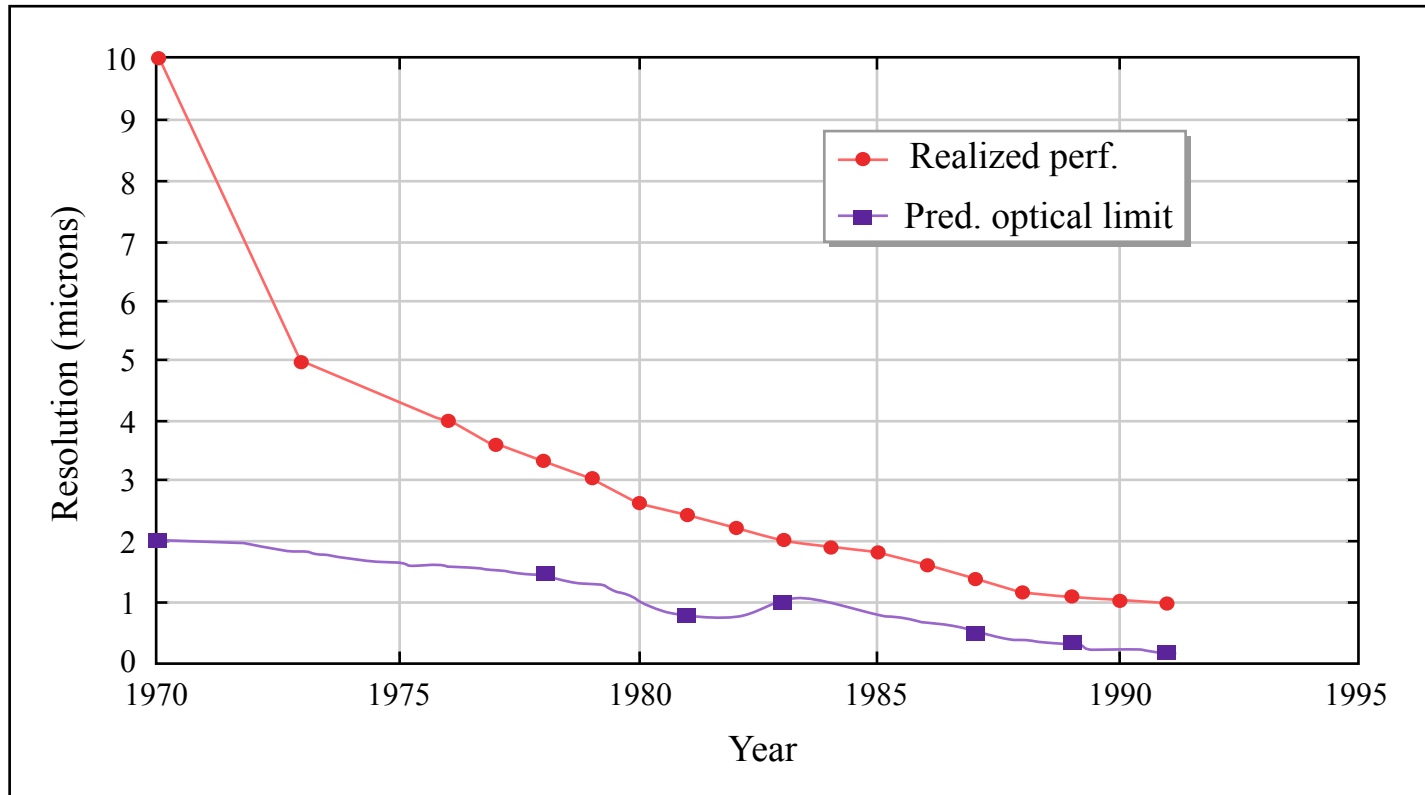


Image by MIT OpenCourseWare.

Source: Henderson, 1995.



# Implications of the S-curve

- Technological performance is a function of effort, NOT time
- R&D is often less productive when focused on either early prototypes or mature technologies
- Managing the transitions between S-curves is a critical strategic task: sticking with an old S-curve can be disastrous

# S-curves often challenge existing organizations severely

## *Alignment Equipment*

<i>Firm</i>	<i>Contact</i>	<i>Proximity</i>	<i>Scanners</i>	<i>Step &amp; Repeat I</i>	<i>Step &amp; Repeat II</i>
<i>Cobilt</i>	44		< 1		
<i>Kasper</i>	17	8		7	
<i>Canon</i>		67	21	9	
<i>Perkin-Elmer</i>			78	10	< 1
<i>GCA</i>				55	12
<i>Nikon</i>					70
<b><i>Total</i></b>	<b>61</b>	<b>75</b>	<b>99+</b>	<b>81</b>	<b>82+</b>

Source: Henderson & Clark, 1990.

# But they also create major opportunity

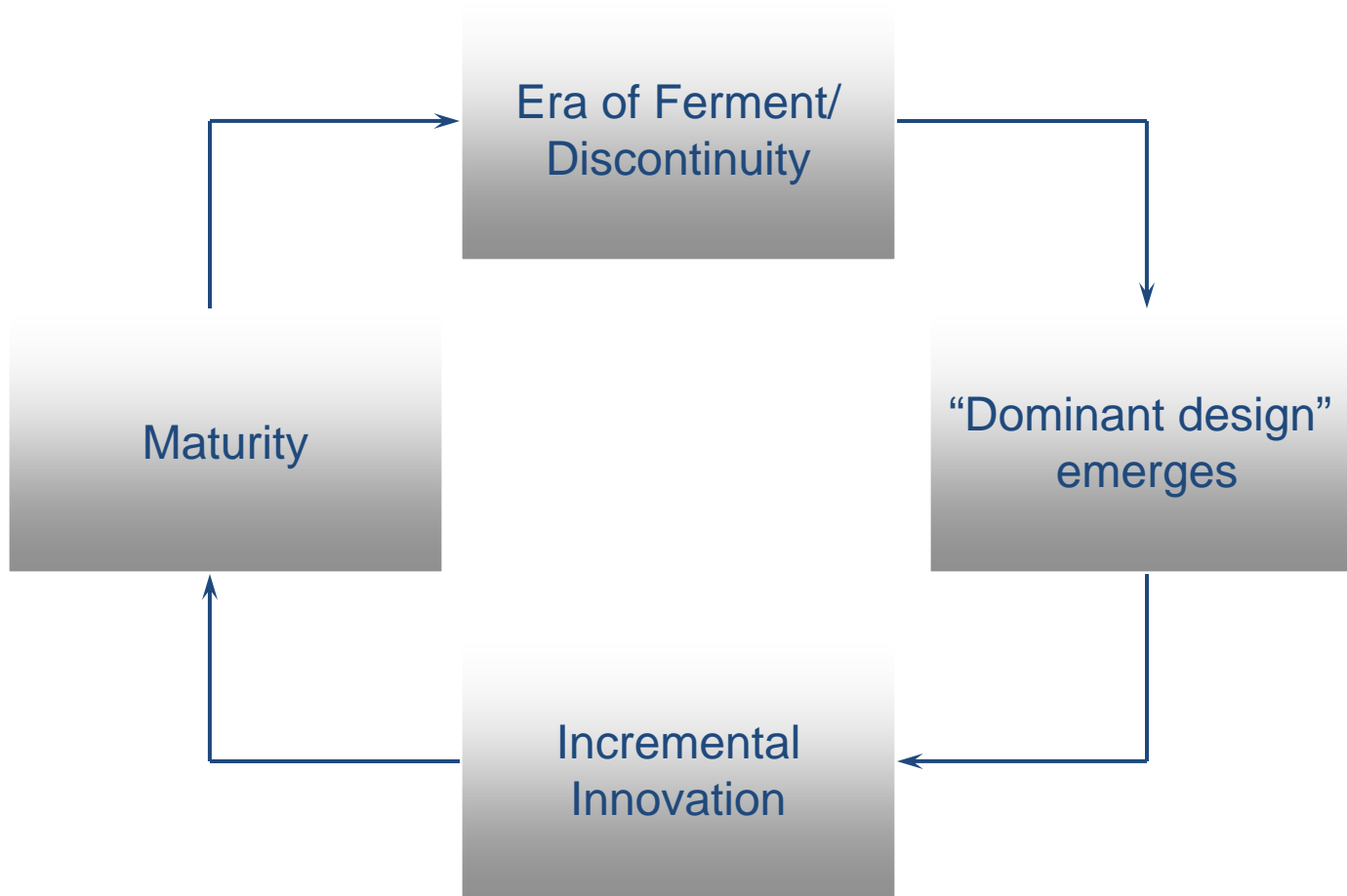
- Corning glass
  - Cookware to optical fiber
- Nokia
  - Rubber boots to cell phones
- IBM
  - Mainframes to PCs to Services
- Eli Lilly
  - “Random” drug discovery to genetics and genomics

The Evolution of Markets

or

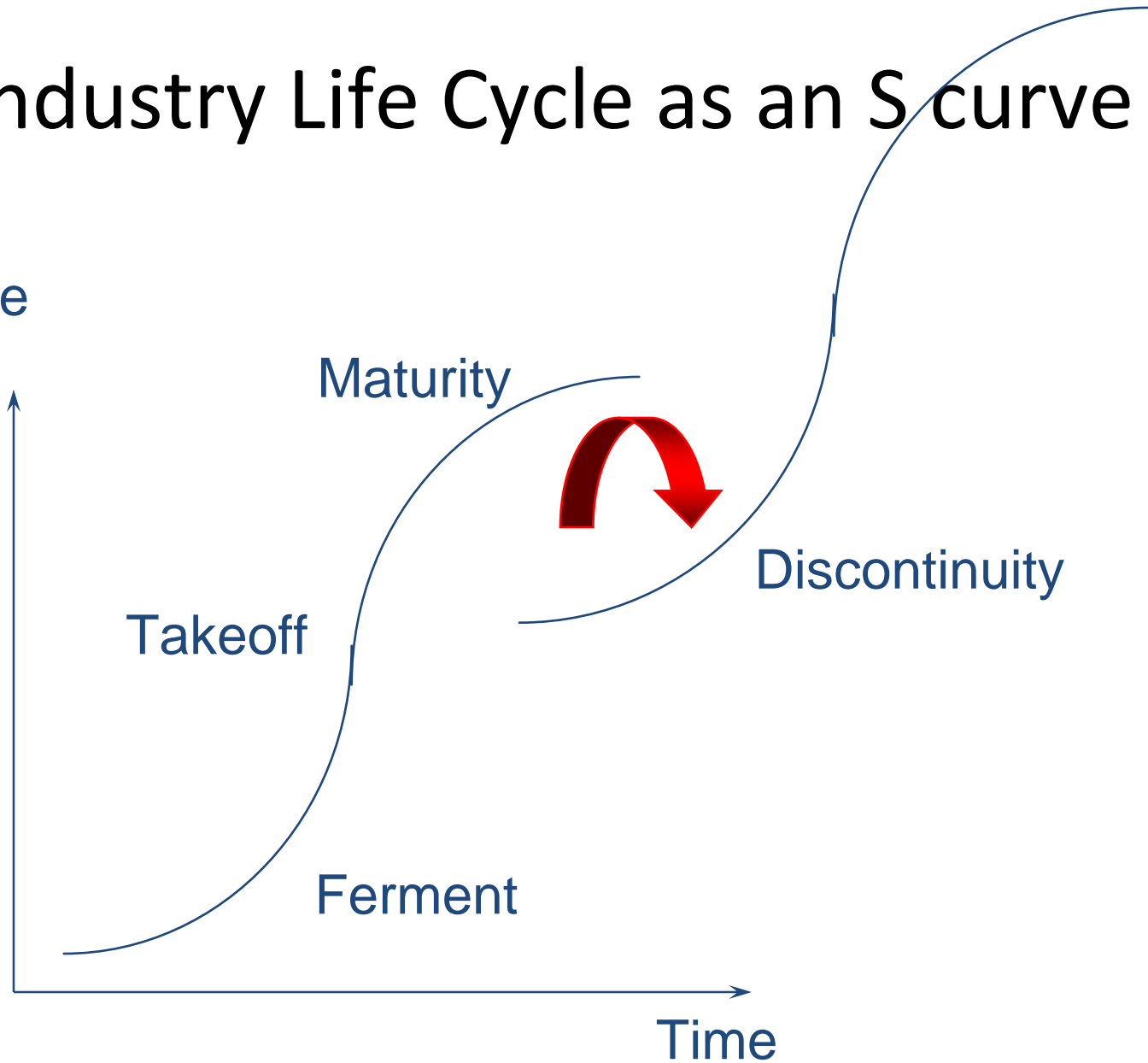
Predicting the pattern of customer  
needs

# A Key Framework: The industry life cycle



# The Industry Life Cycle as an S curve

Performance



Maturity

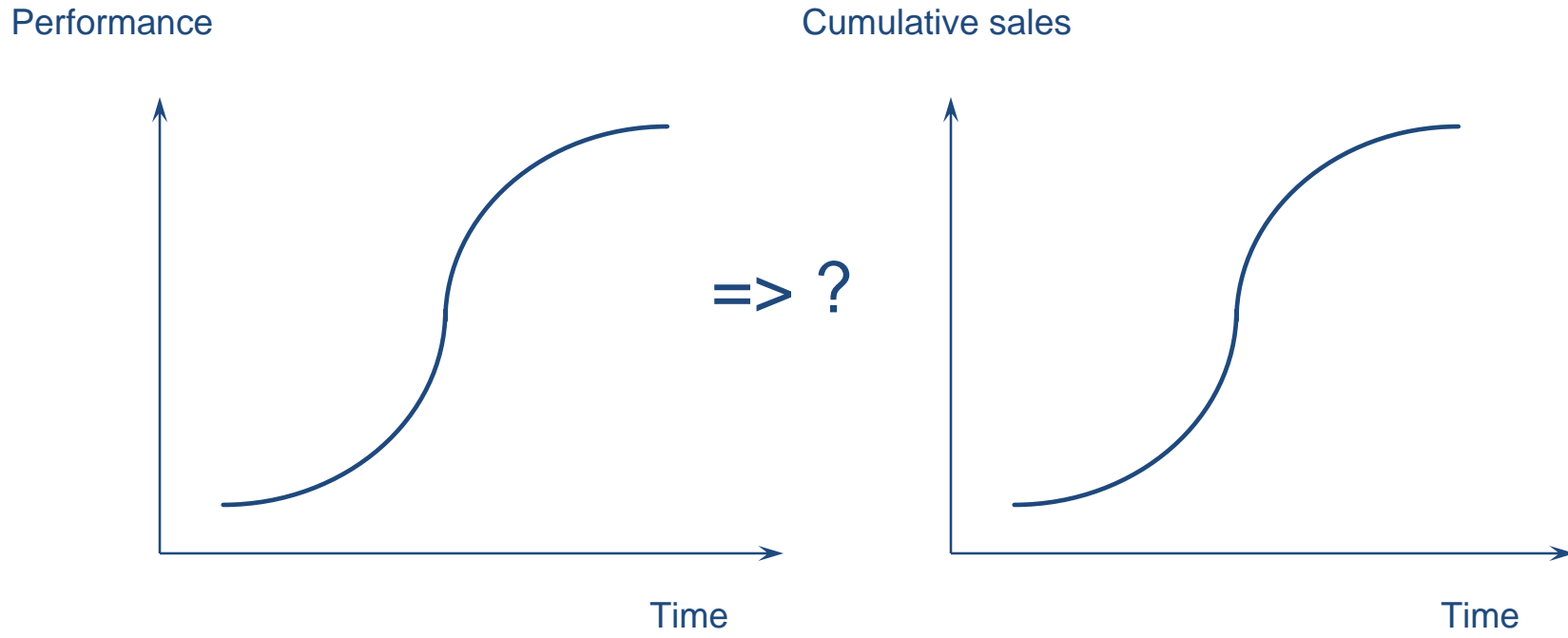
Takeoff

Ferment

Discontinuity

Time

# What is the relationship between the S curve and the diffusion curve?



# Diffusion is Hard...start with limits and growth

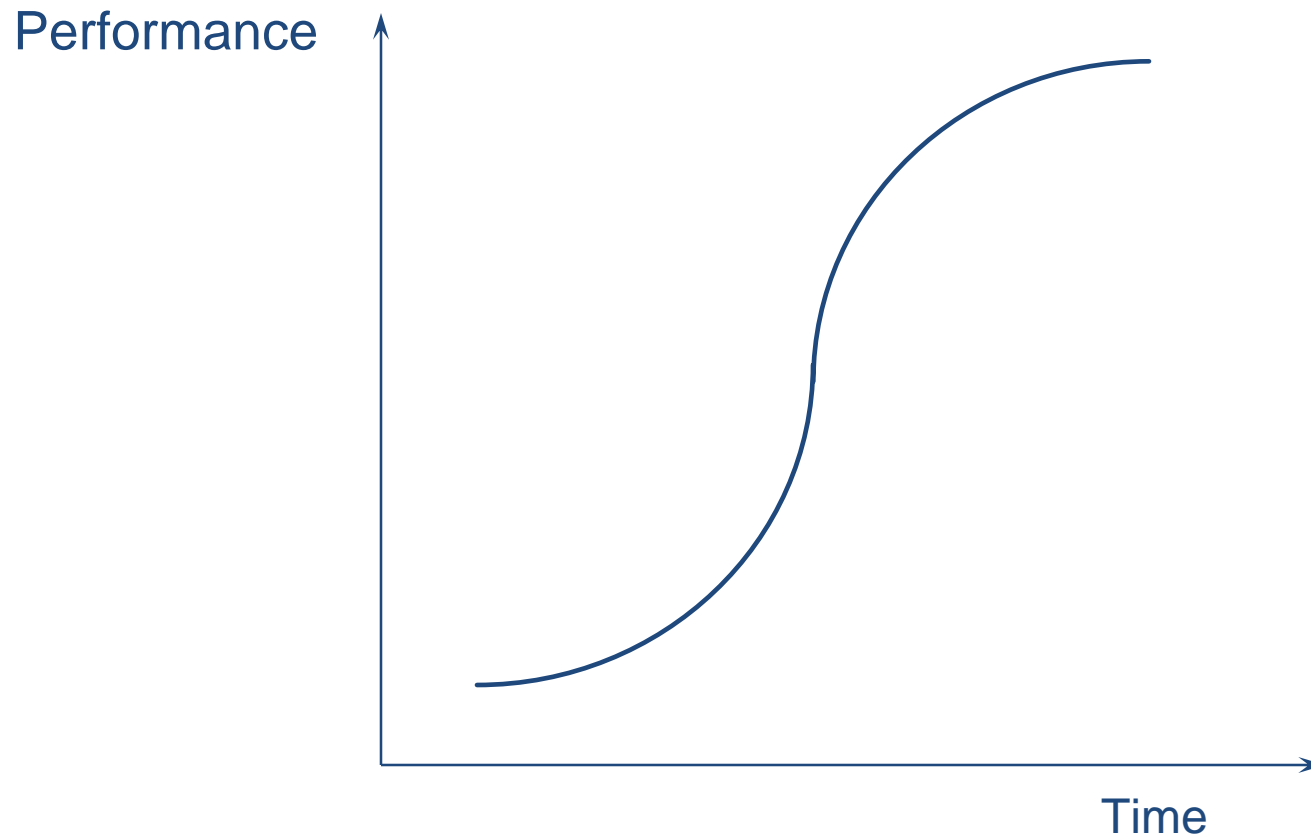
- Supply:
  - Technology S-curves! ...a natural constraint.
  - Effective Organization ...we're not there yet.
- Demand:
  - Ultimate Market Limit...changes with demographic growth & changing preferences
  - Rate of Information Transfer
  - Substitutes
  - ...
- Competition:
  - Price competition can shift growth...
- ...and the interactions between Supply, Demand, and Competition!



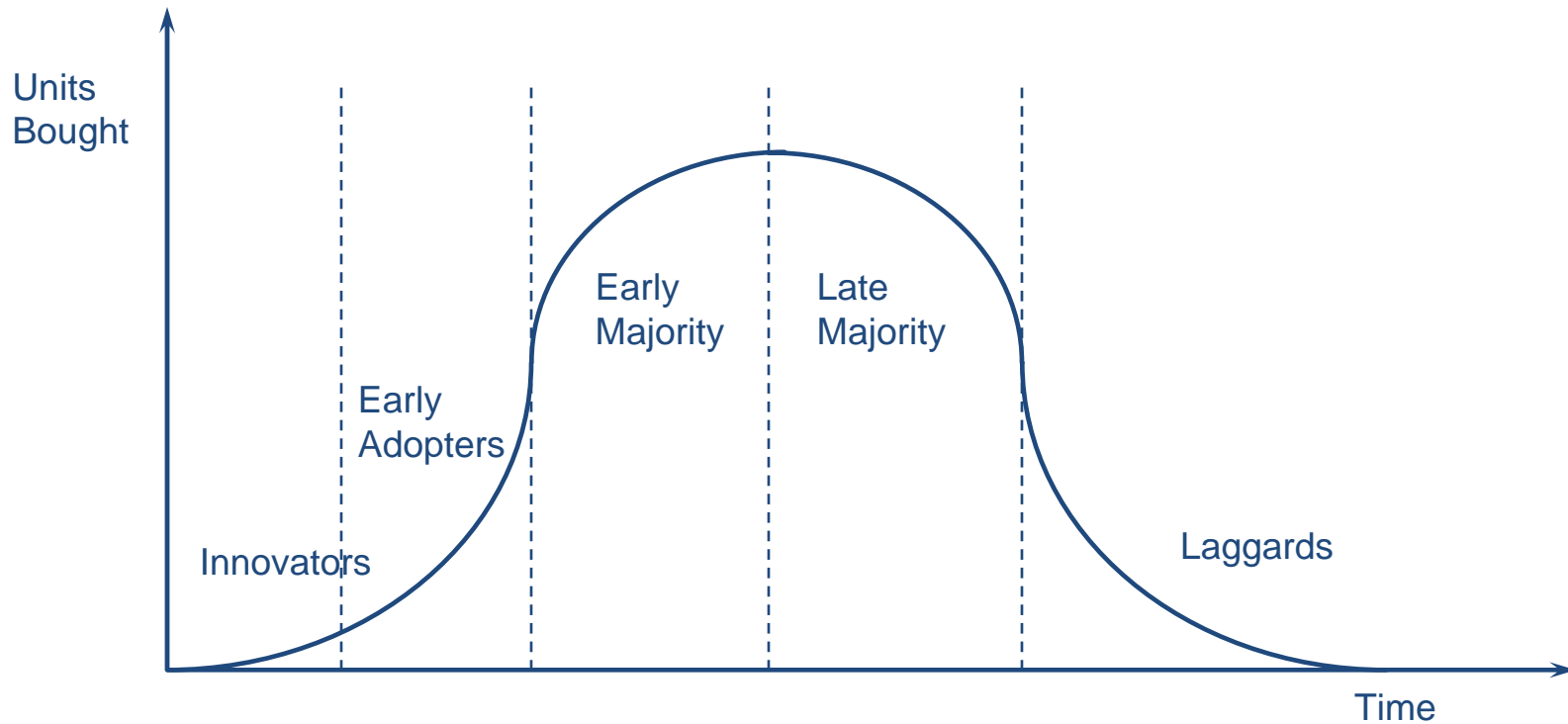
# Market Evolution over the Life Cycle

- Market segmentation
- Crossing the chasm
- New markets, new needs:
  - The Innovator's Dilemma

# The Key Question: Who buys a technology as it evolves?

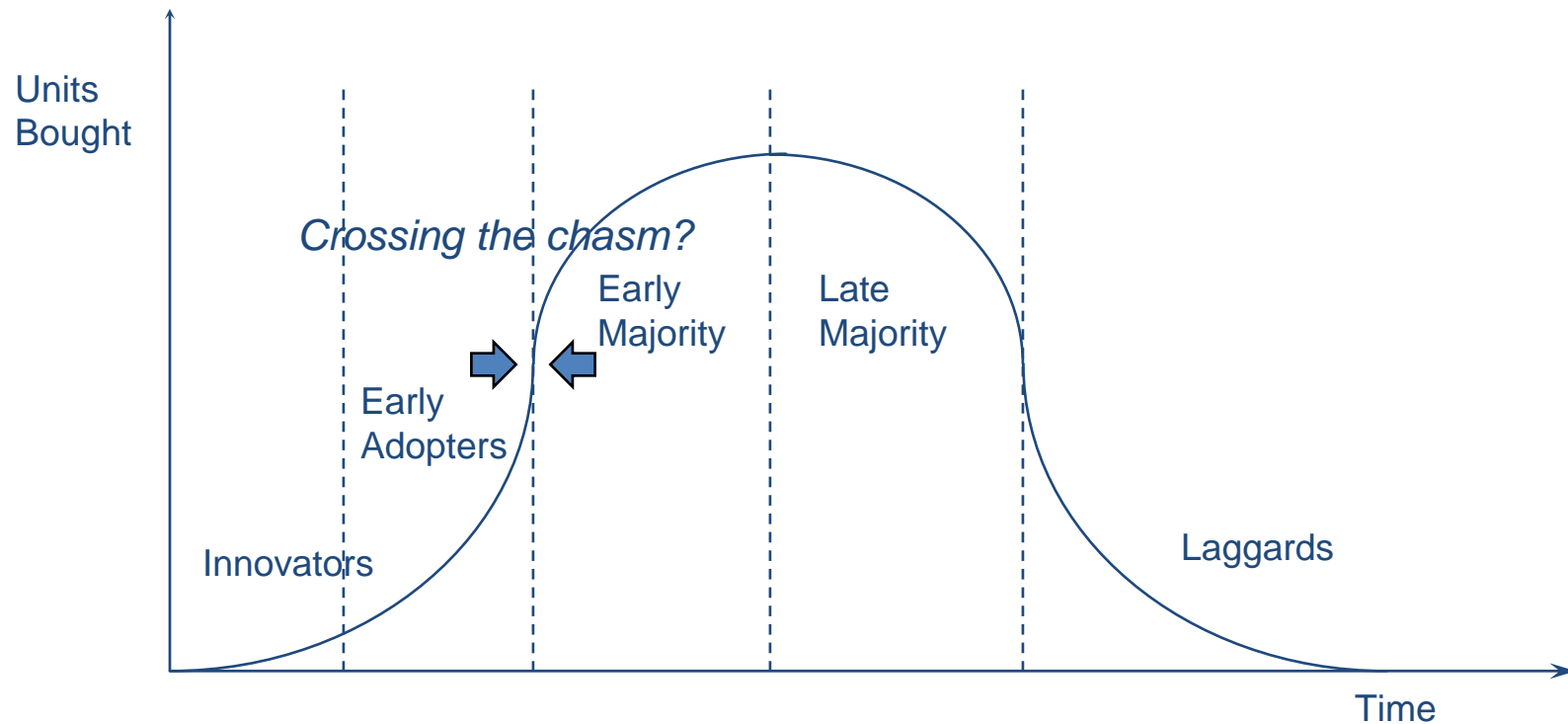


# Understanding market dynamics: Basic segmentation (Rogers)



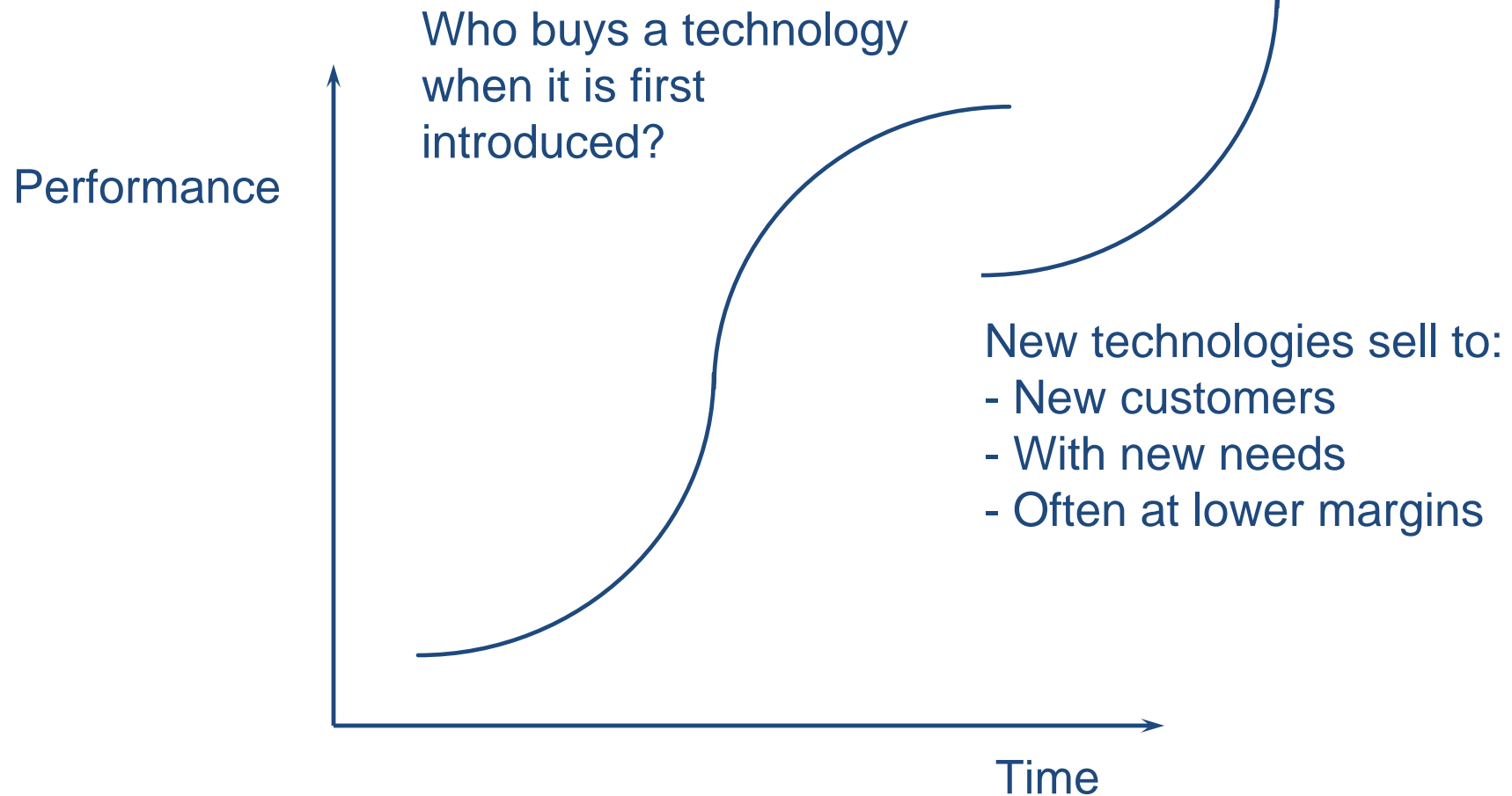
*Adopters differ by, for example, social, economic status -- particularly resources, affinity for risk, knowledge, complementary assets, interest in the product*

# Understanding market dynamics: Crossing the chasm: (Moore)

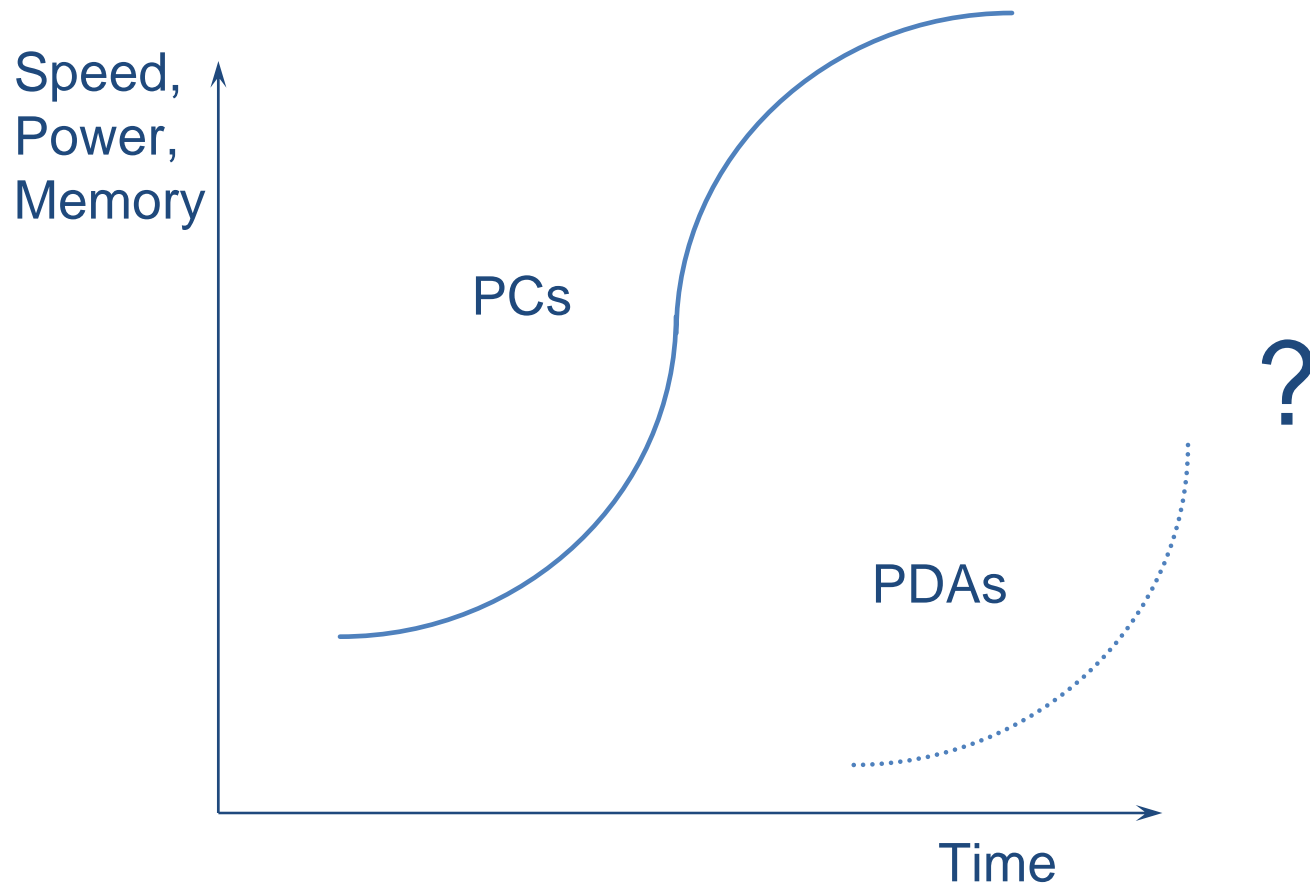


***Making the transition from “early adopters” to “early majority” users often requires the development of quite different competencies: e.g. service, support capabilities, much more extensive training.***

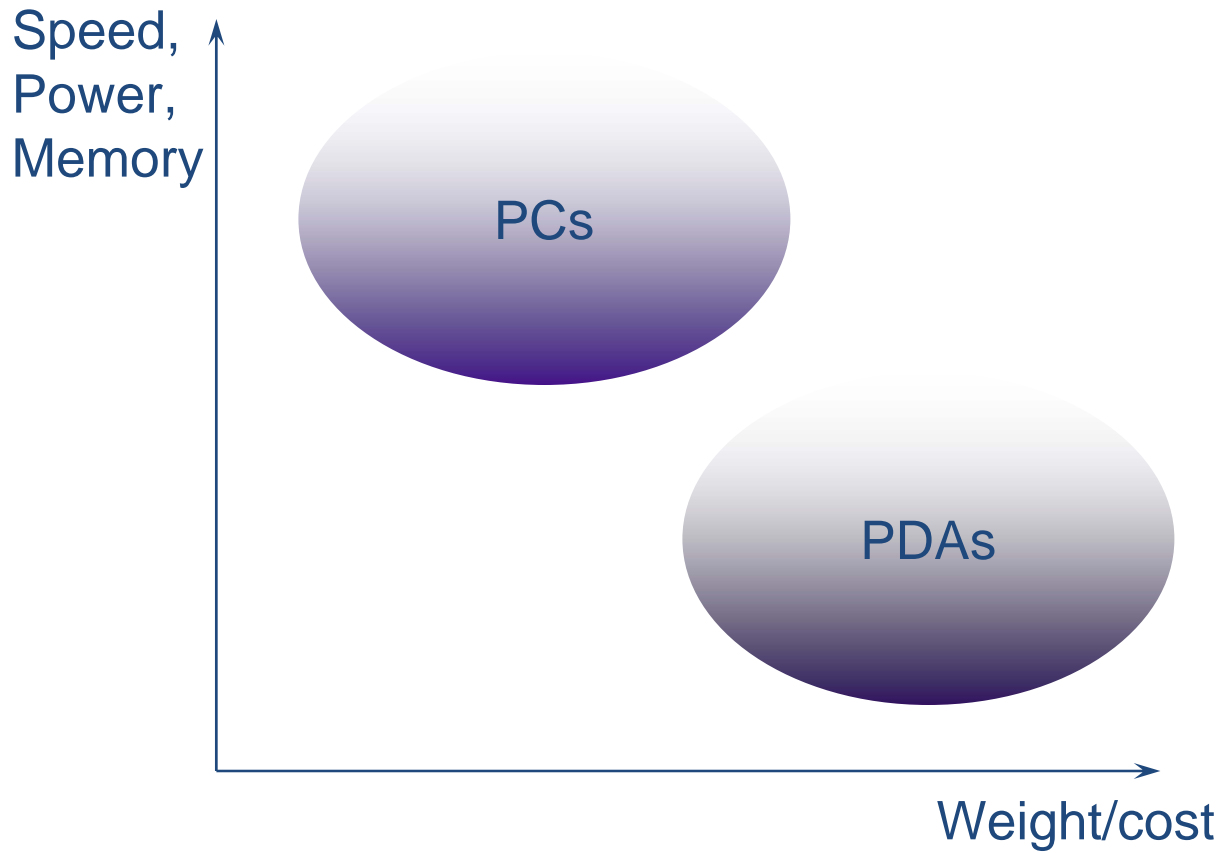
# Managing customers at moments of discontinuity



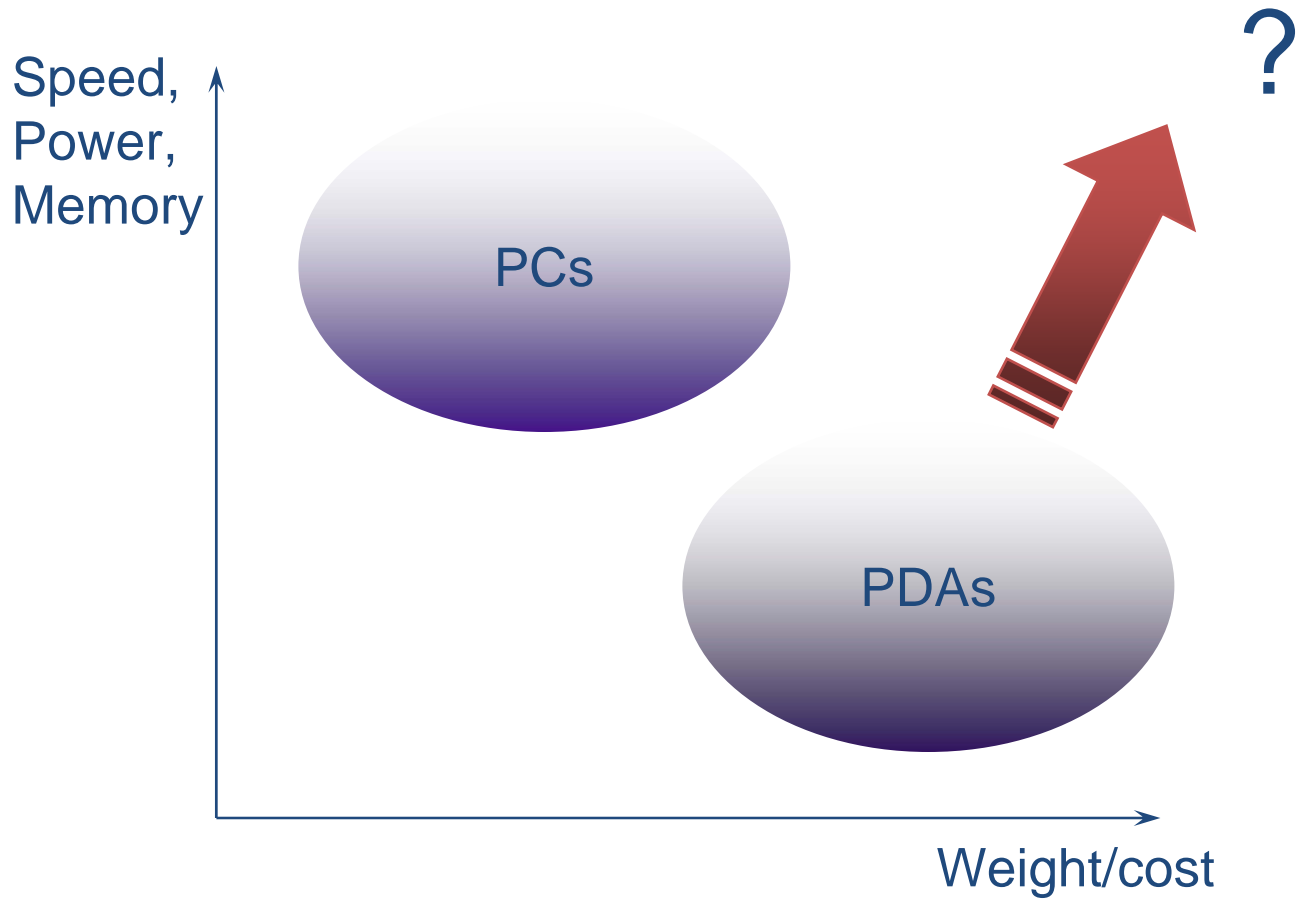
Initially, PDAs did not seem to be a threat to PCs:



# PDAs sold to customers with different needs:

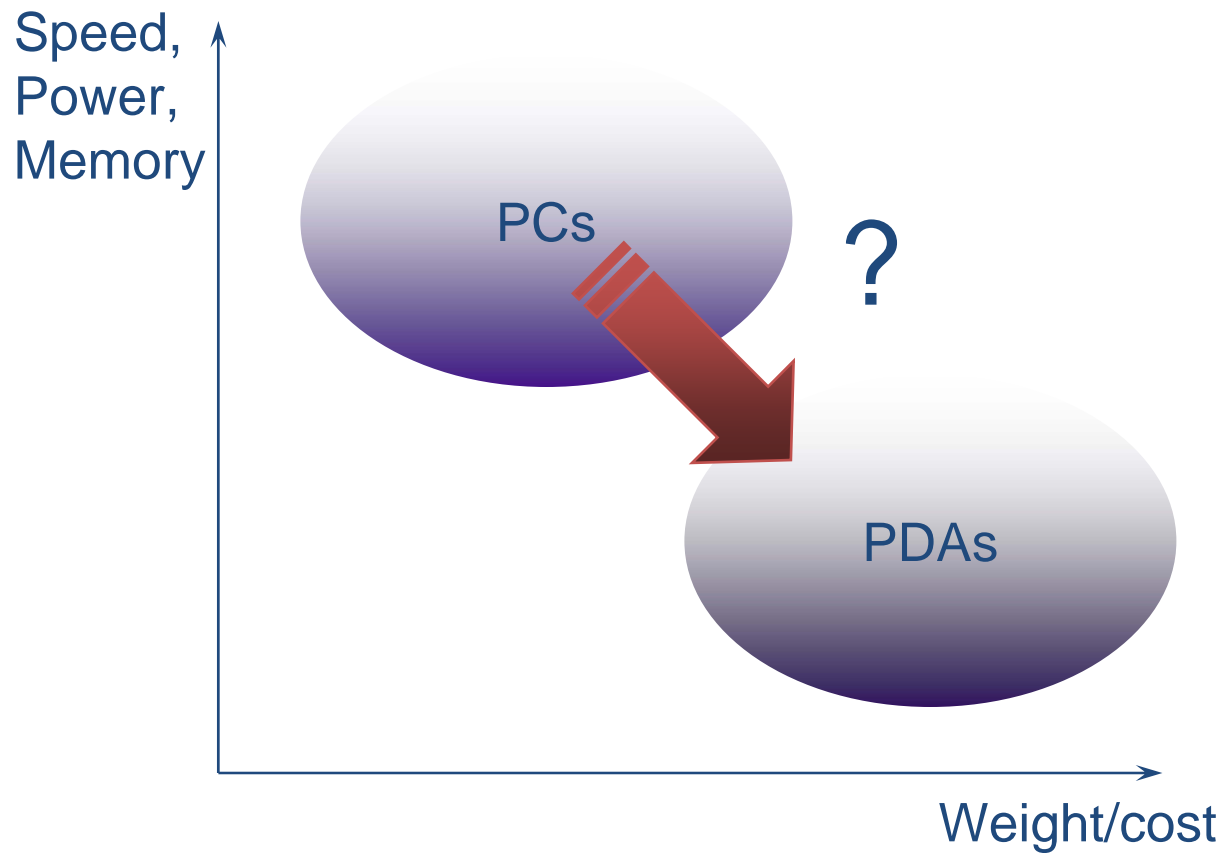


But as PDAs improve they may come to challenge PCs

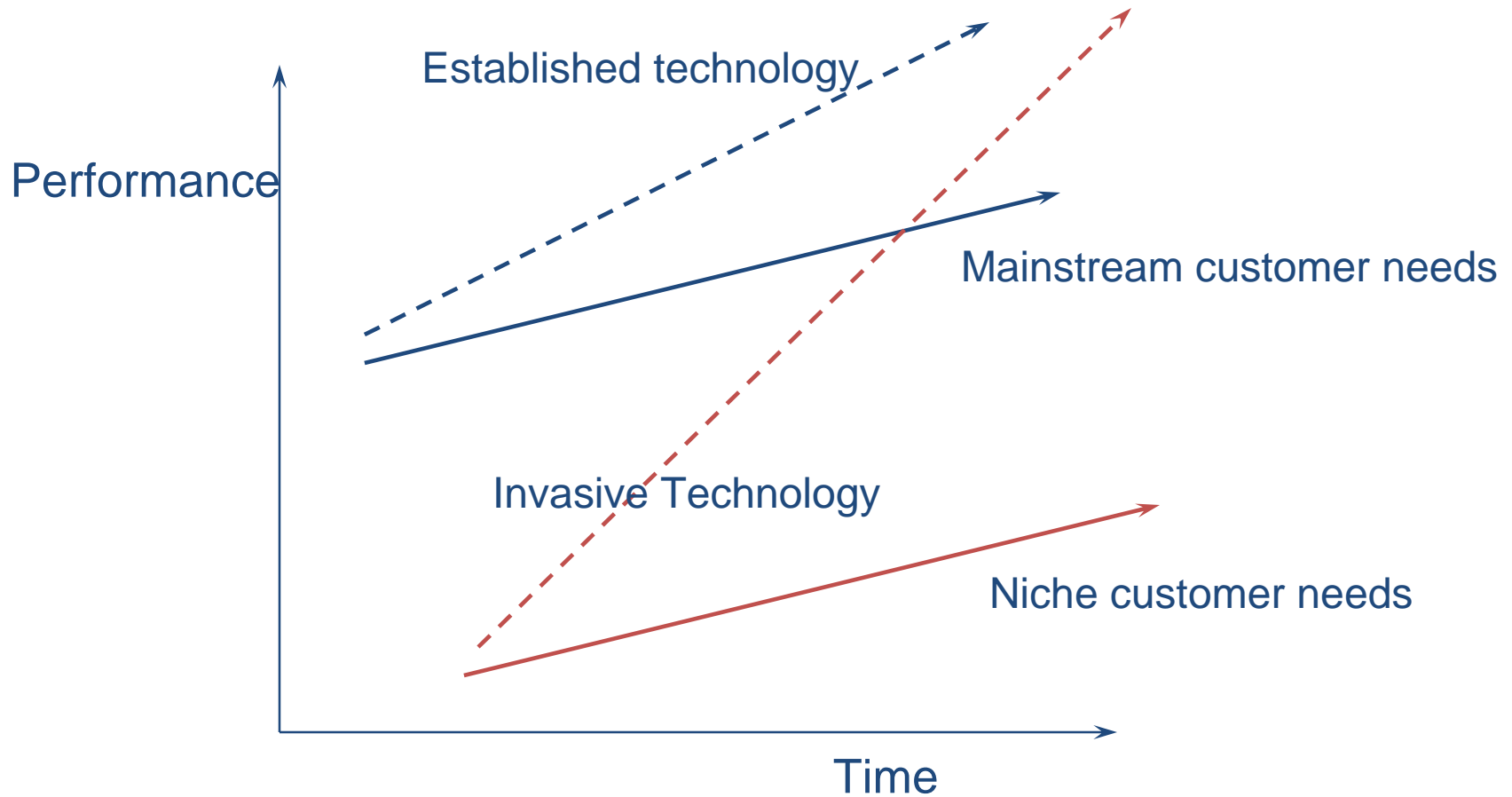




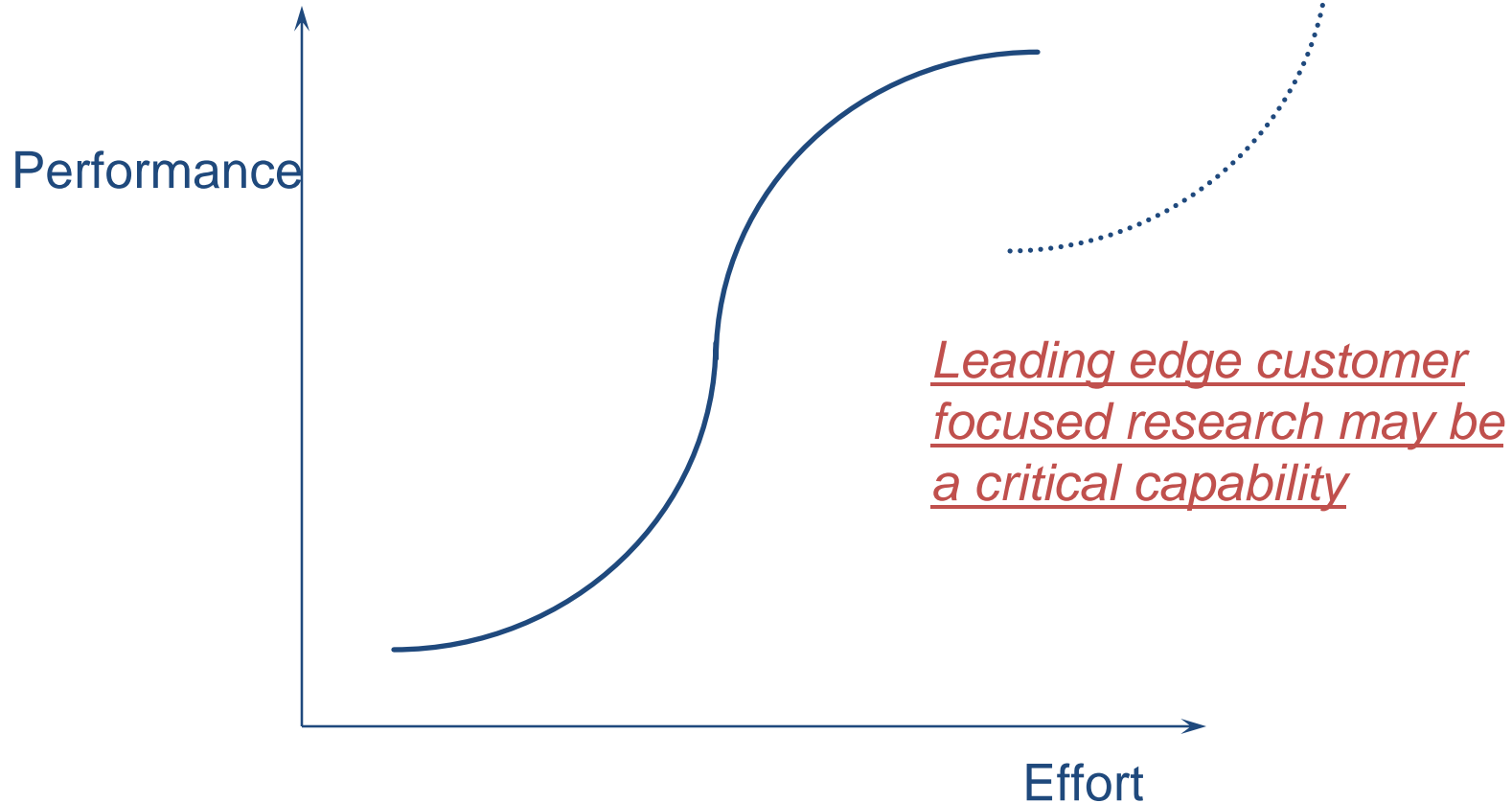
# Or consumer preferences may change



# “Disruptive” technologies may threaten established firms



# Managing the change in customer groups may be the hardest task!



# What can be done?

- “Ready, aim, fire”
- Small scale experiments
- Virtual products
- Lead user research

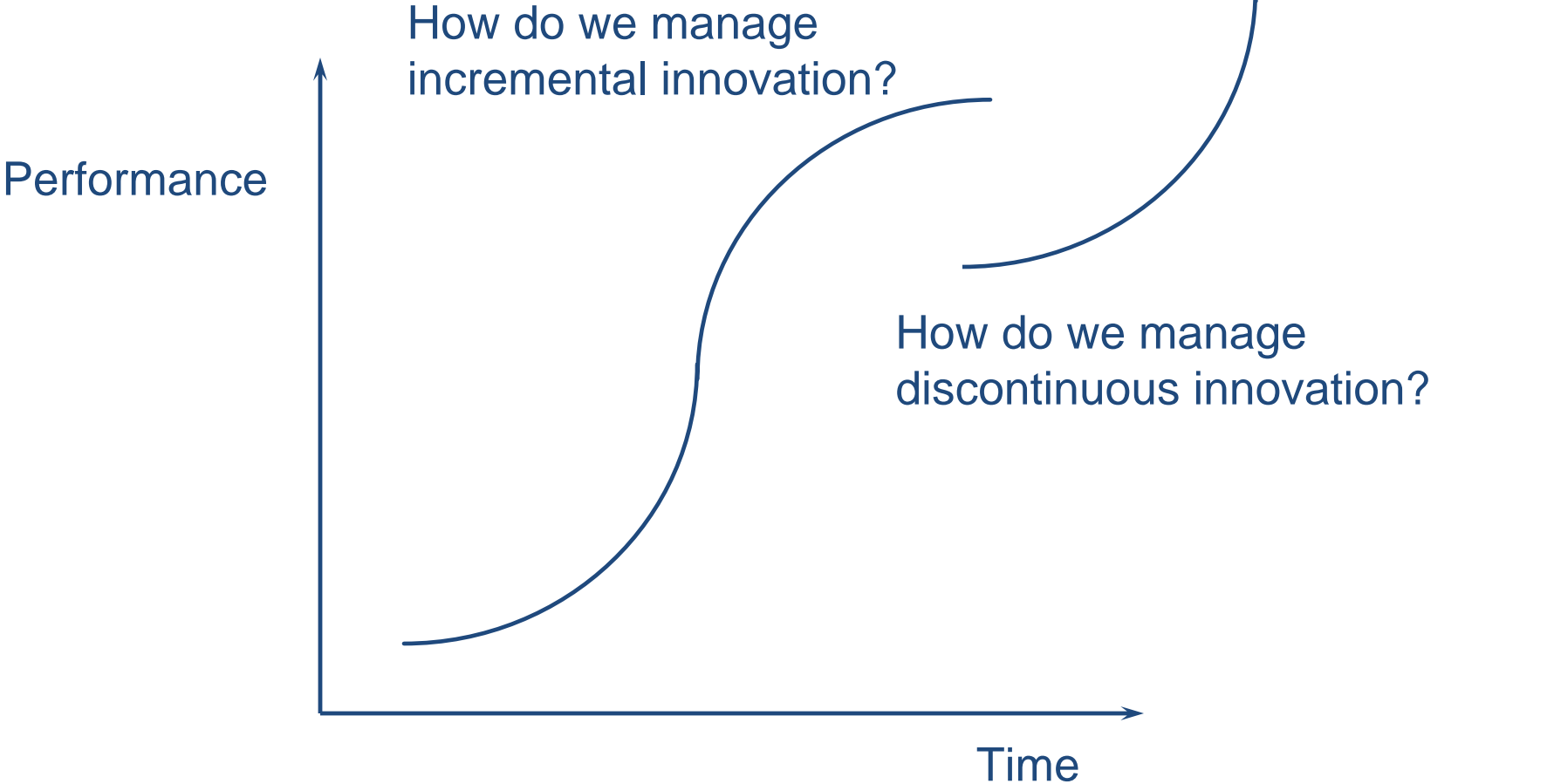


Significant  
resources required!

# Creating Value:

- Understand how technologies will evolve
  - (Both your own and those on which you rely)
- Understand how customer needs will evolve
- **Use technologies** to develop world class products and services that **meet customer needs**
  - **How?**
    - **Get lucky...works once or twice**
    - **Do it consistently with effective Organization Structures and Processes**
      - e.g., Apple, Google

# Effective Organization changes during discontinuities



# Strategic Challenge: Changing Environments are Unpredictable and Ambiguous!

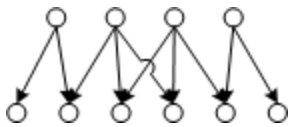
## SOURCES

- Future S-curves and market evolution are hard to predict!
- Blurred timing and paths
- Shifting competitive basis, from products to business models
- Lack of control over key technology resources

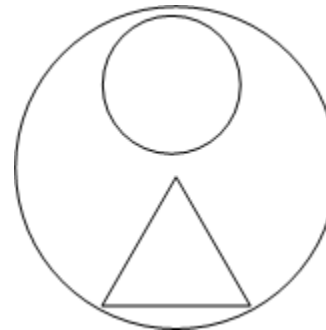
## IMPLICATIONS

- Planning is limited
- Reacting is insufficient
- Traditional strategies of “defend a position” and “leverage core competence” are incomplete
- Shift from “closed” internal innovation to “open” innovation with partners

# Potential Solution: Organizational Structures that respond to change



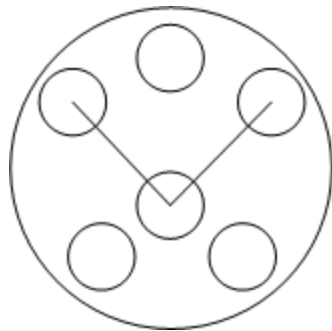
**Hierarchy**



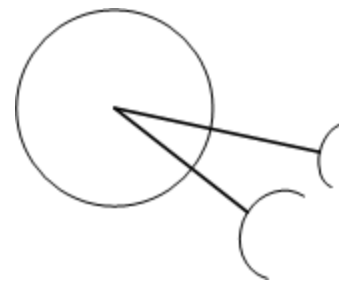
**Roles**



**Rules**



**Unit Networks**



**Alliance Networks**



Organizational Structures enable coordinated responses to environmental change by shaping action in real-time



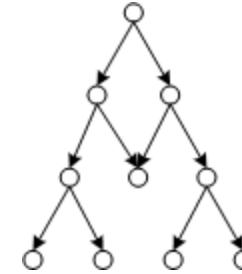
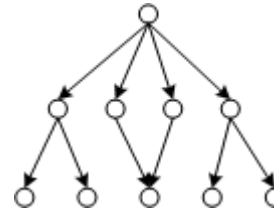
# Amount of Organizational Structure can vary greatly!

Low

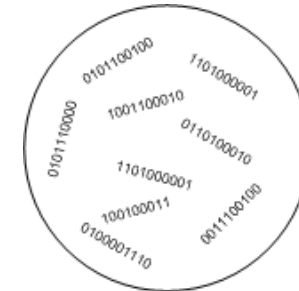
Medium

High

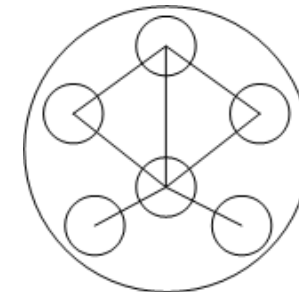
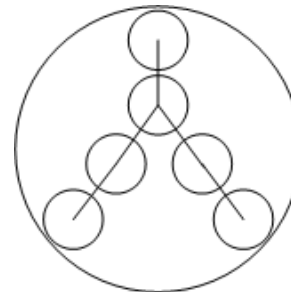
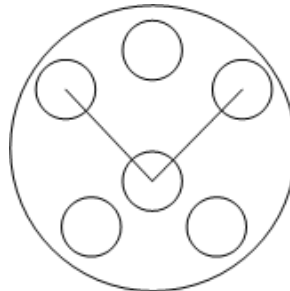
Hierarchy



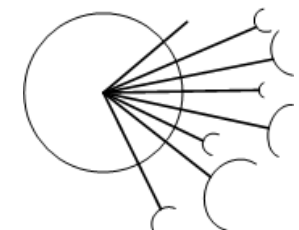
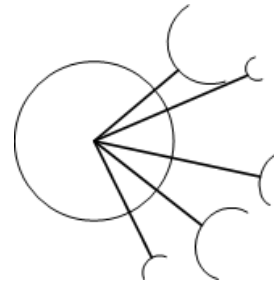
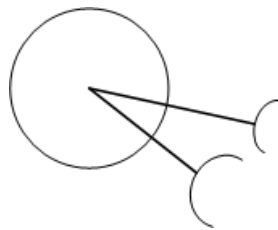
Rules



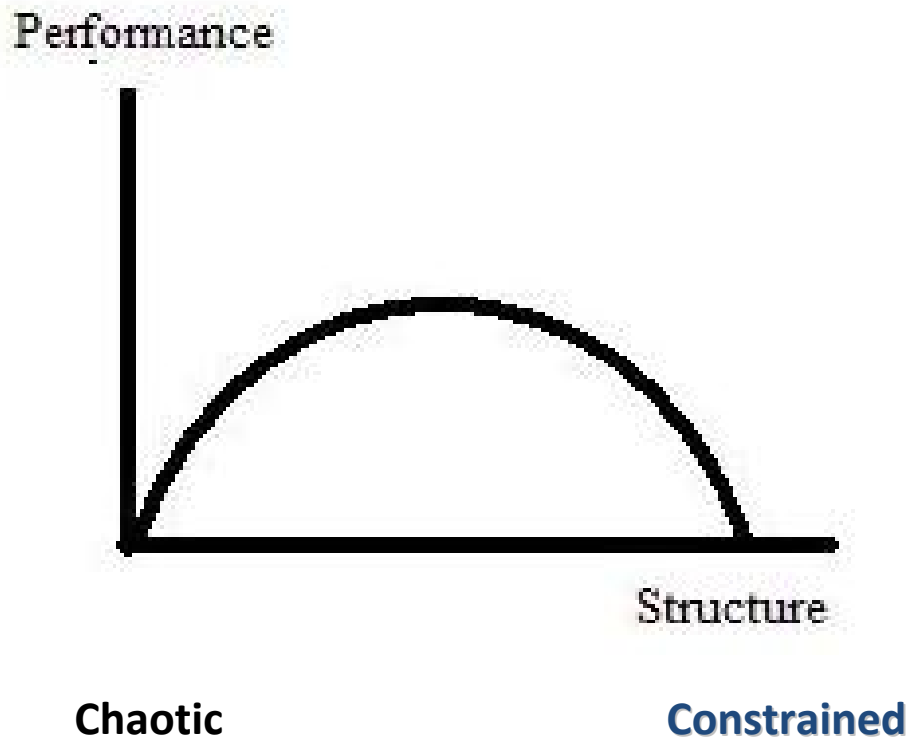
Unit Networks



Alliance Networks

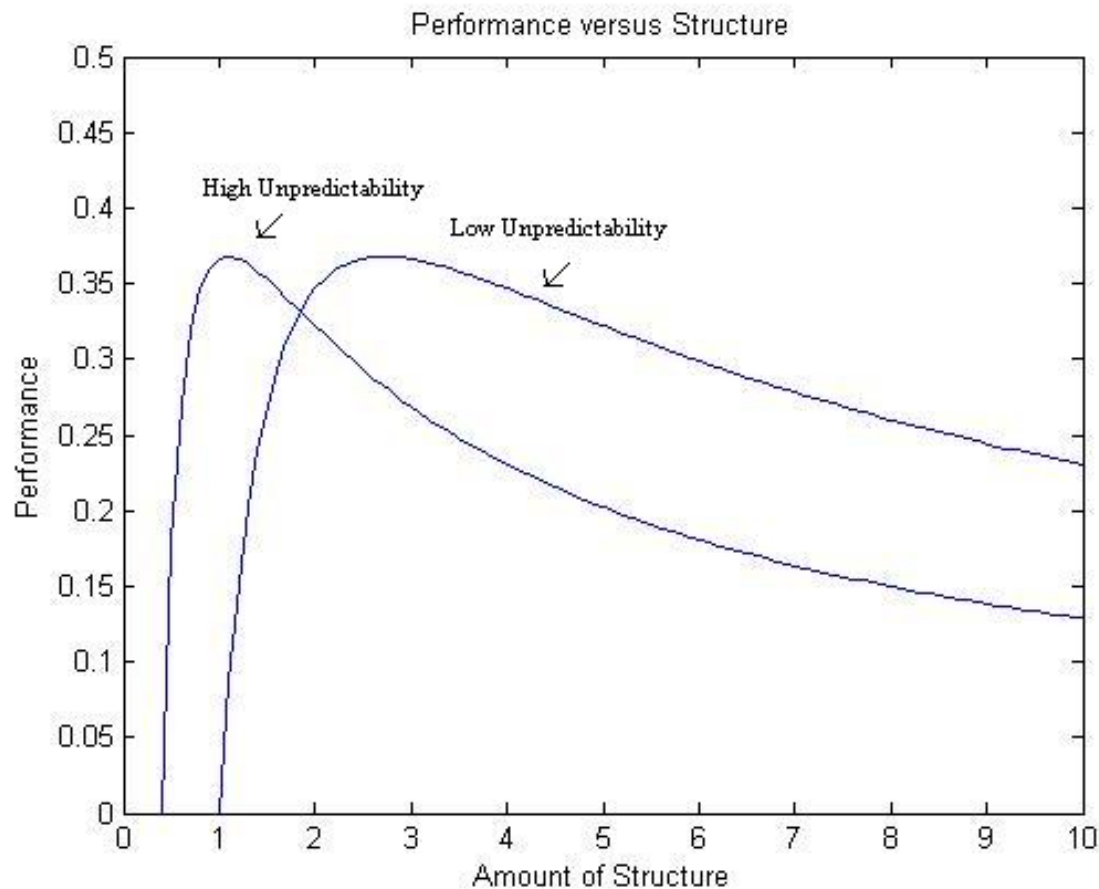


# Inverted U-shaped Relationship btwn the Amount of Structure and Performance



- Fundamental Relationship illustrates the tension between efficiency and flexibility
- Observed in multiple industries and for multiple types of structure:
  - Hierarchy
  - Roles
  - Rules
  - Networks

# New Modeling and Evidence suggests Asymmetry and Dependency on Market Dynamism



- Asymmetry: more forgiving on the side of too much structure
- Optimum is less structured and more severe in less predictable environments

# Examples: Simple Rules in Dynamic Markets

Company	Simple rules
<b>Intel®</b>	<ul style="list-style-type: none"><li>• Priority Rules helped Intel shift from DRAMs to Microprocessors</li><li>• Simple Rules about minimum project size</li><li>• Copy Exactly</li></ul>
<b>Pfizer®</b>	<ul style="list-style-type: none"><li>• Clear ranking molecule types as research priorities</li><li>• Maximum number of molecule types pursued at any one time</li><li>• Projects “killed” according to step charts</li></ul>
<b>Miramax Films®</b>	<ul style="list-style-type: none"><li>• Movies must<ul style="list-style-type: none"><li>– Center on a basic human condition and flawed, but sympathetic character</li><li>– Have a clear beginning, middle, and end</li></ul></li><li>• Disciplined financing (50% more efficient than industry standard)</li></ul>

The Crying Game  
Pulp Fiction  
The English Patient  
Life is Beautiful  
Shakespeare in Love

# Explains mysterious organizational phenomena:

- Liability of newness: less structured entrepreneurial firms can “collapse from within” while large firms w/ more structure can “muddle through” with little innovation
- Maintaining optimal structure is more precarious (more V-like than U-like!) in unpredictable markets:
  - Emerging markets
  - High-technology industries
- Effective strategy is more simple in highly dynamic markets
  - Less structure enables more flexible responses

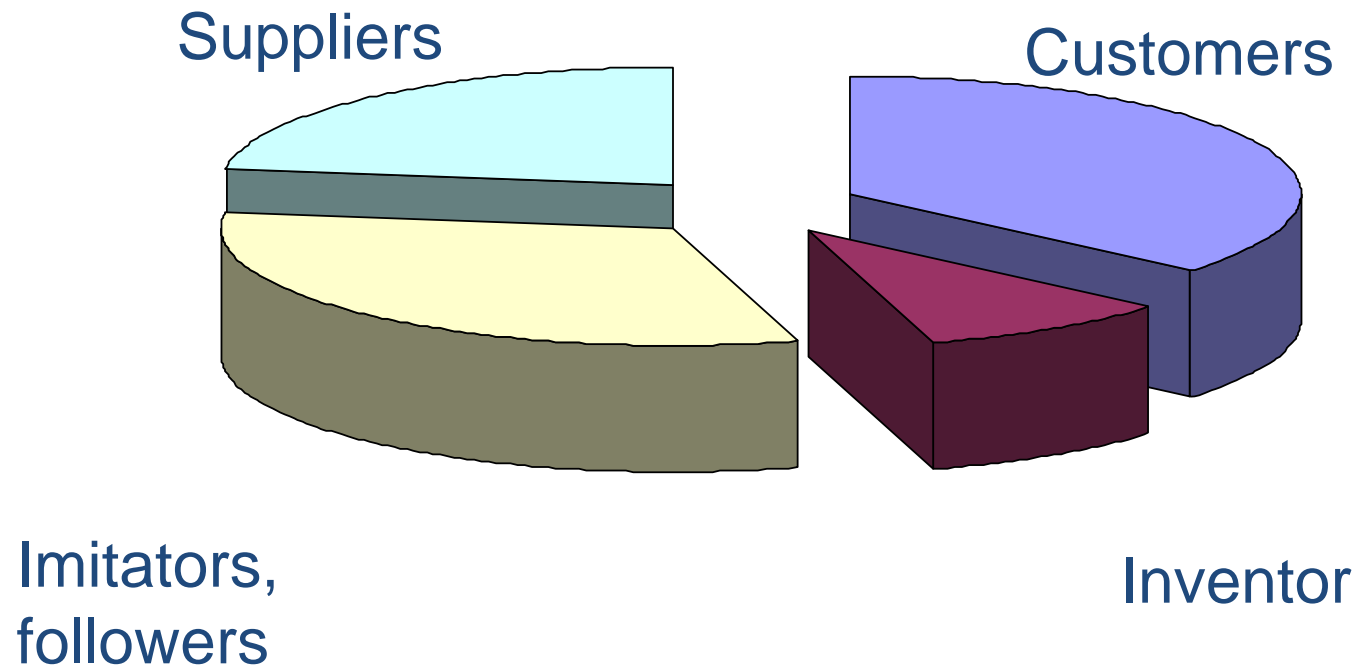
# Key Lessons about Organization Structure

- Managers need to manage not only the Content but the Amount Structure
- Employees can (and sometimes should) subvert structures!
- Structure is merely a constraint on action...the right side of the inverted U-shape suggests that improvisation and creativity must be combined with structure to produce innovations.
- Organizational Processes that change over time are as strategically important as Organizational Structures that do not...

# How shall we capture value?

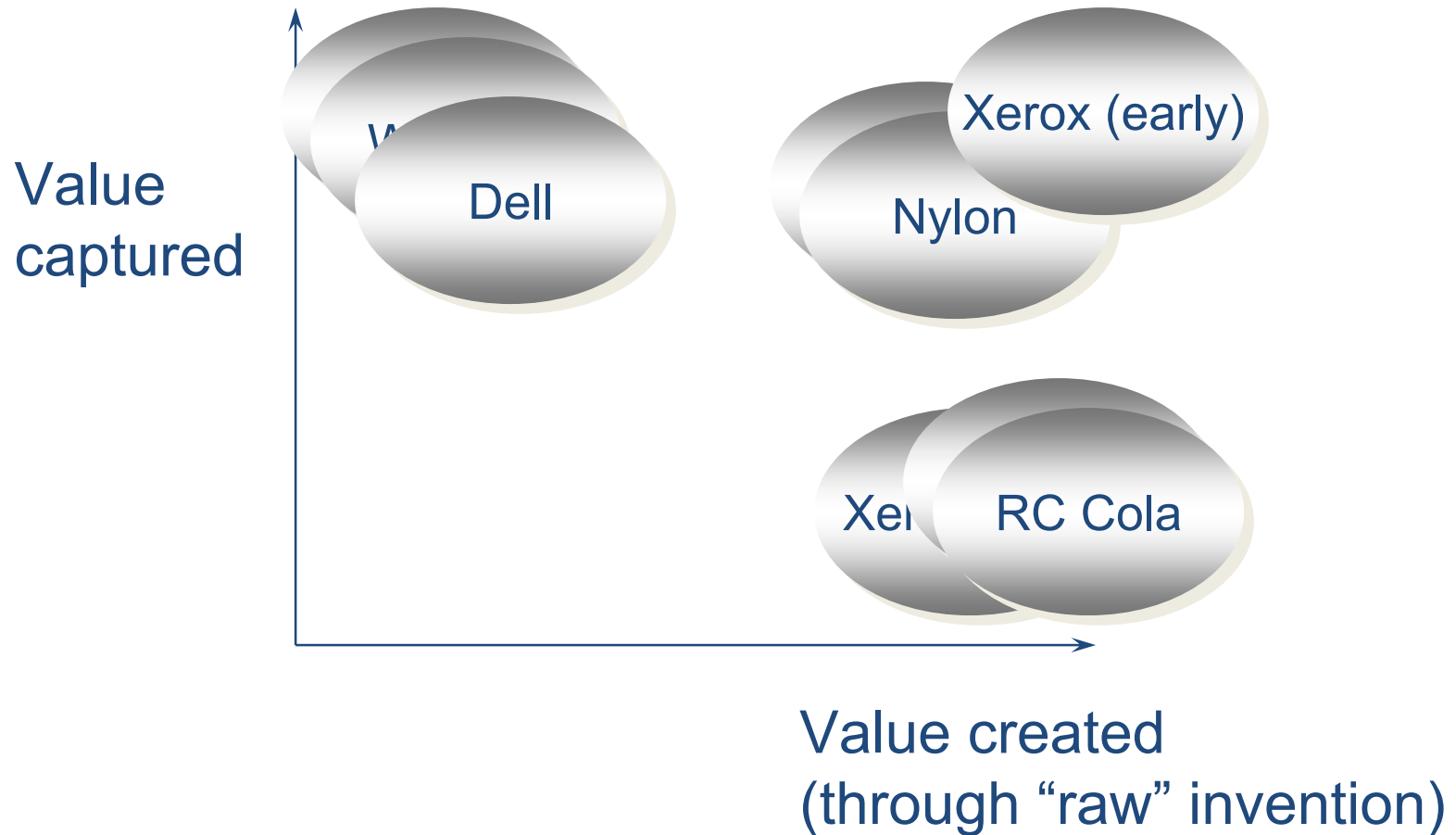
Uniqueness, Complementary Assets & the  
Structure of the Value Chain

Or:  
What determines the Inventor's  
Share?





# Is it the case that great ideas = pots of money?



# Three key ideas:

- Uniqueness
  - Controlling the knowledge generated by an innovation: being the only game in town
- Complementary Assets
  - Controlling the assets necessary to exploit the knowledge generated by innovation
- Five Forces & the Value Chain
  - Understanding the dynamics of power in the value chain

# Uniqueness and Complementary Assets

Complementary assets are:

Available

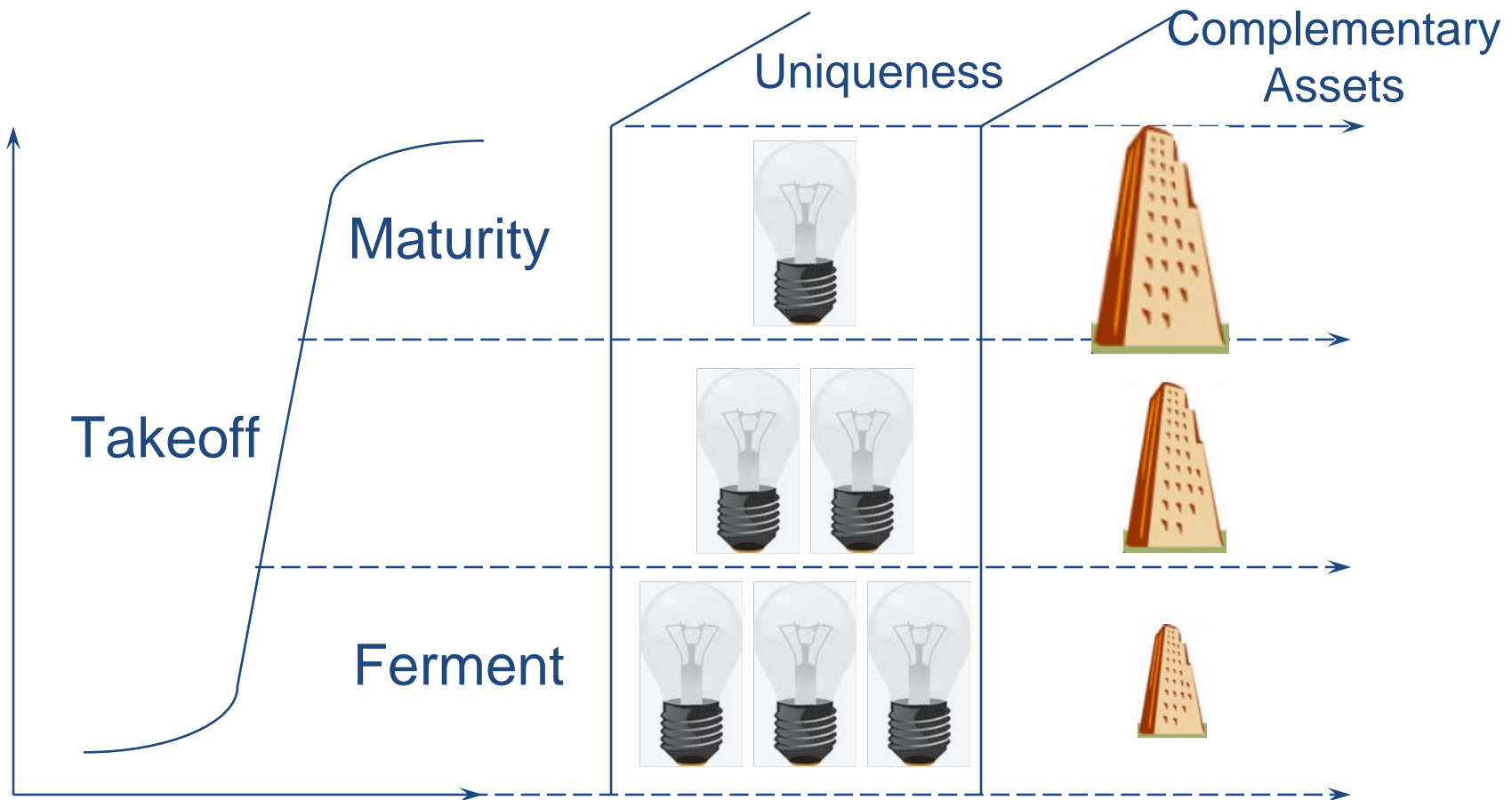
Tightly held

Easy to maintain

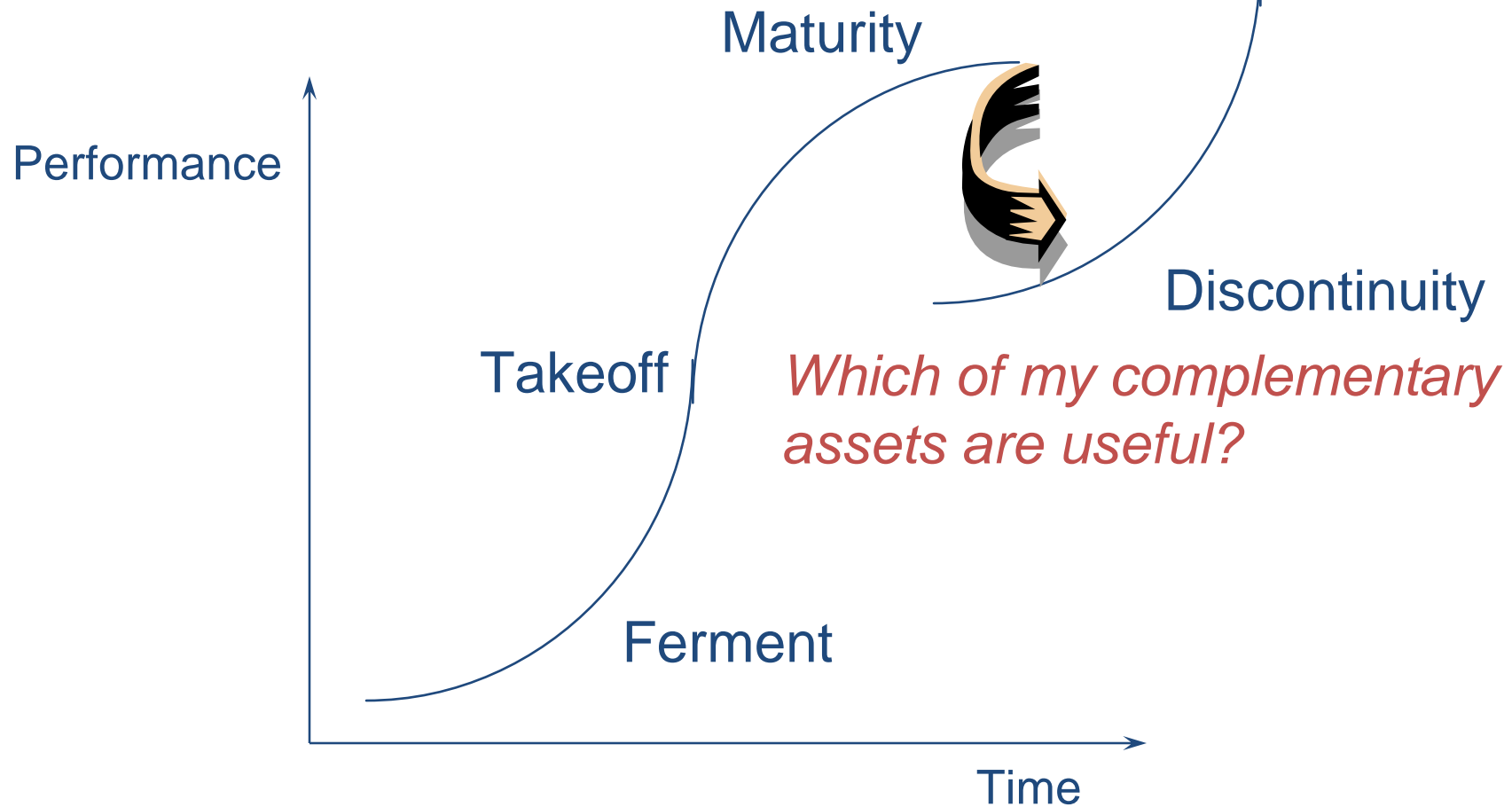
Uniqueness is:

Hard to maintain


# Uniqueness & Complementary Assets over the Life Cycle:



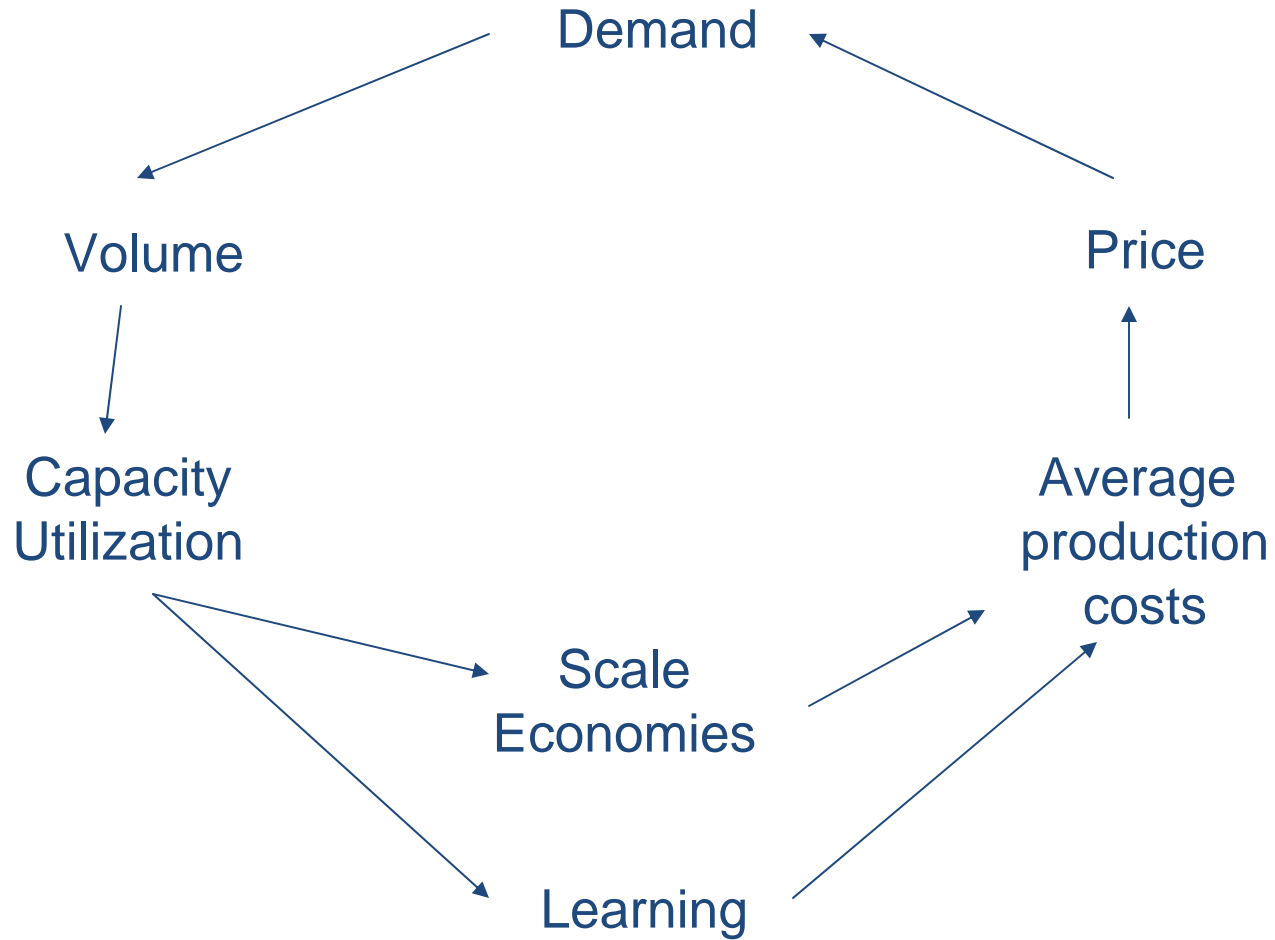
# Managing discontinuities means managing complementary assets:



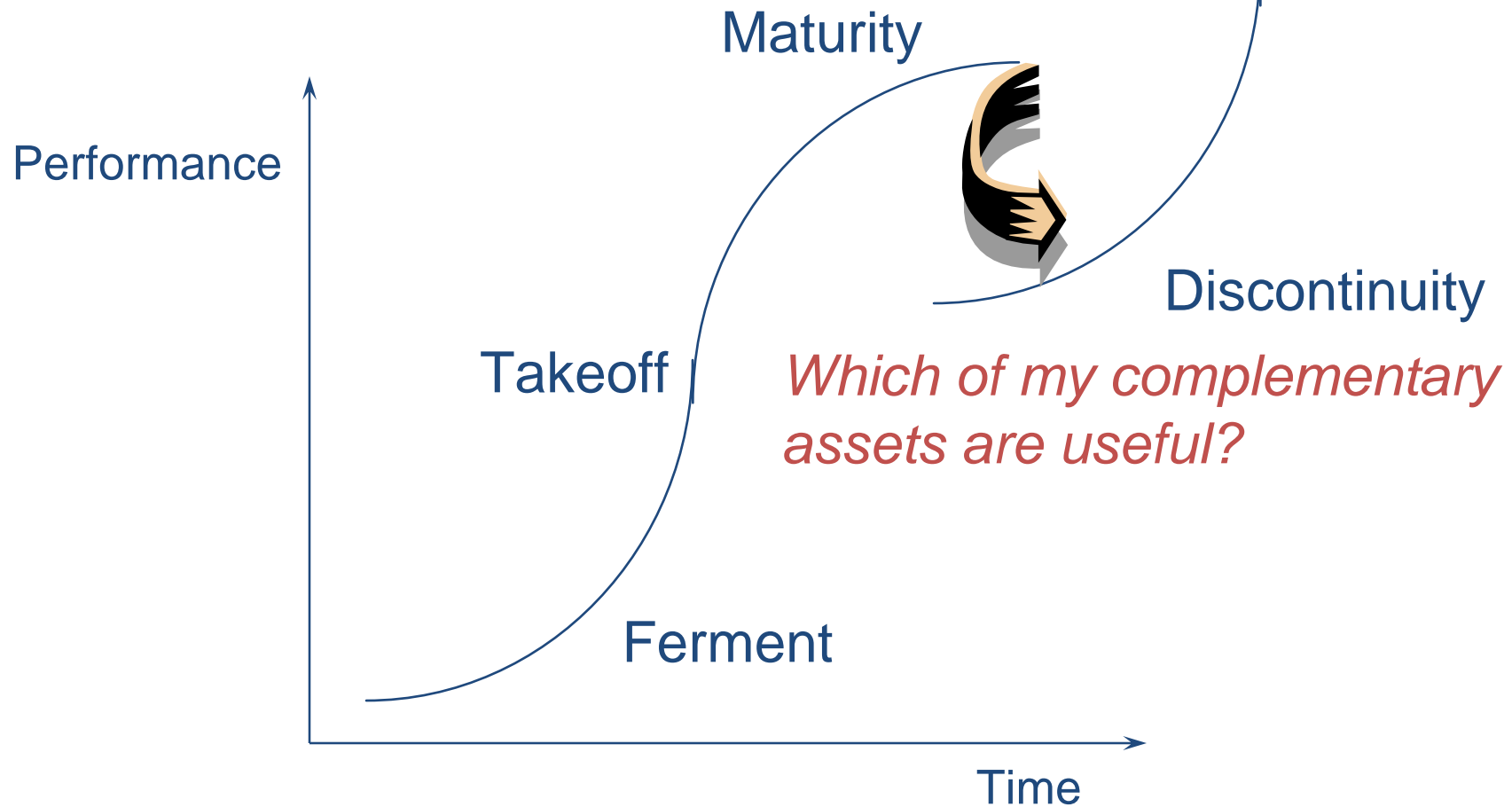
# Using the model to dive deeper:

- Taking advantage of positive feedback to build strong complementary assets:
  - In marketing & R&D (Novartis)
  - In process technology (Intel)
  - In network externalities (Google, Nokia)
- Building an understanding of which assets may be available:
  - Are there spillovers?
  - What is the shape of the learning curve?
  - What is the structure of demand?
  - Do network externalities create value?

# An example



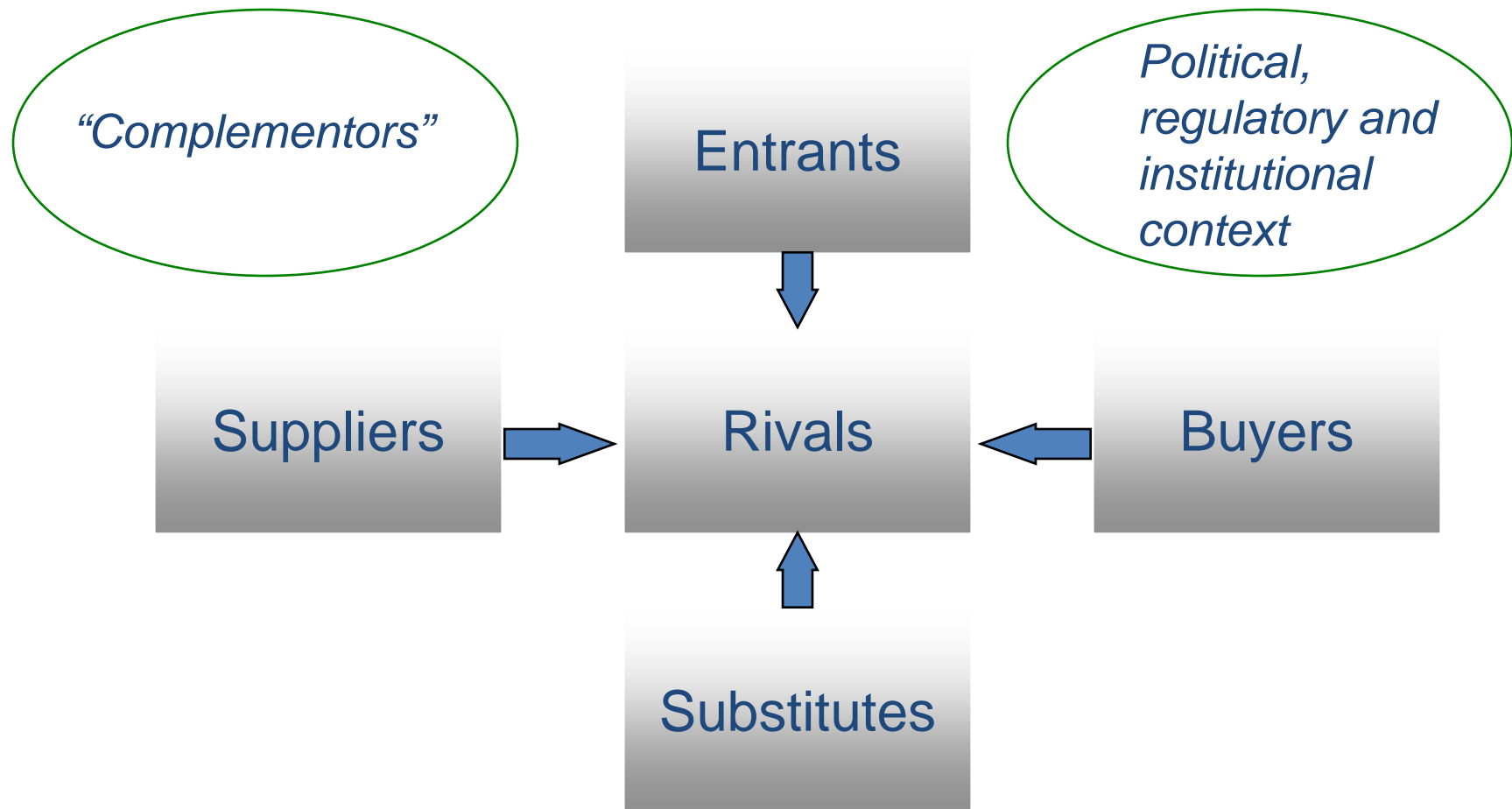
# Managing discontinuities means managing complementary assets:



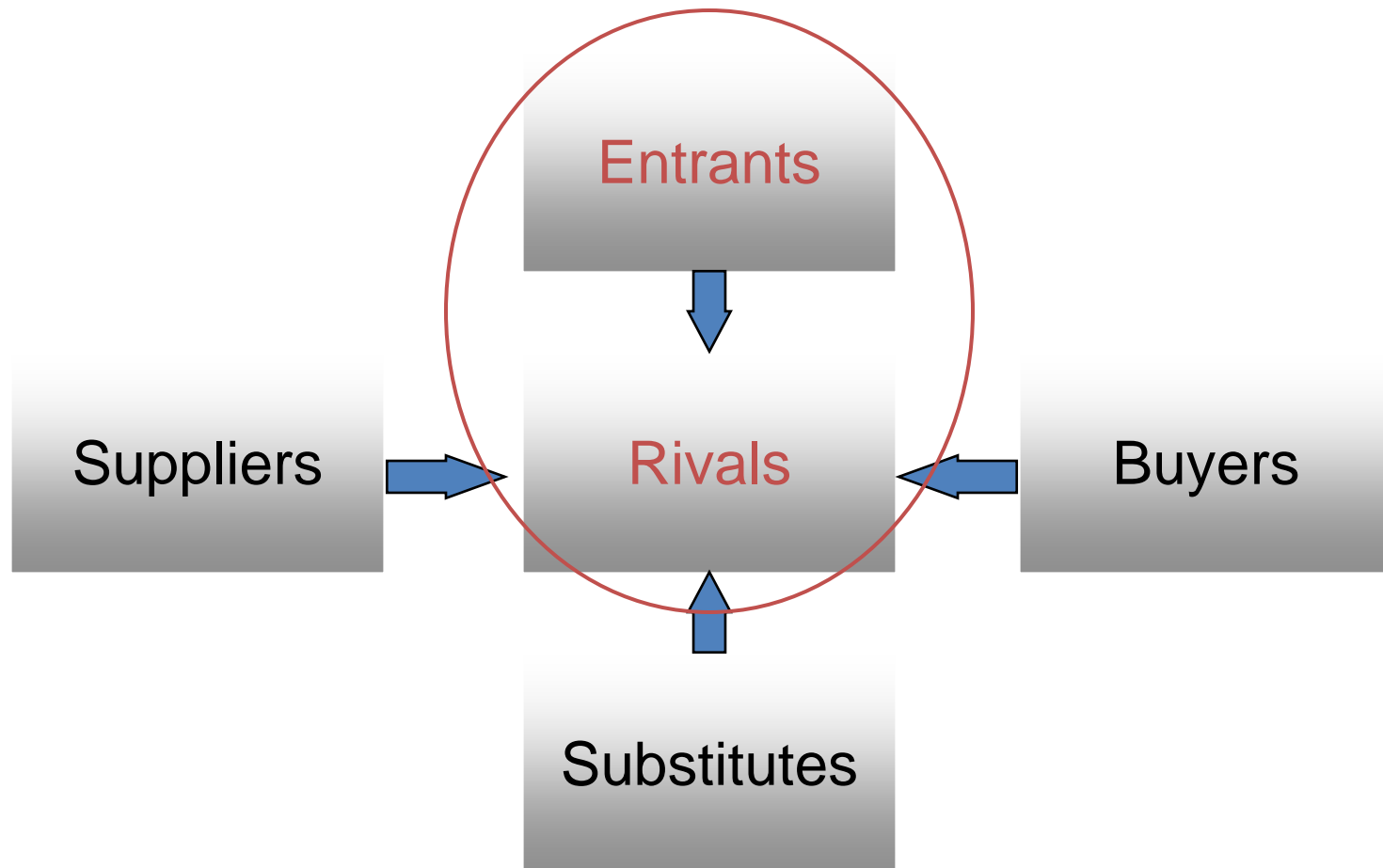


# Industry Structure and the Value Chain

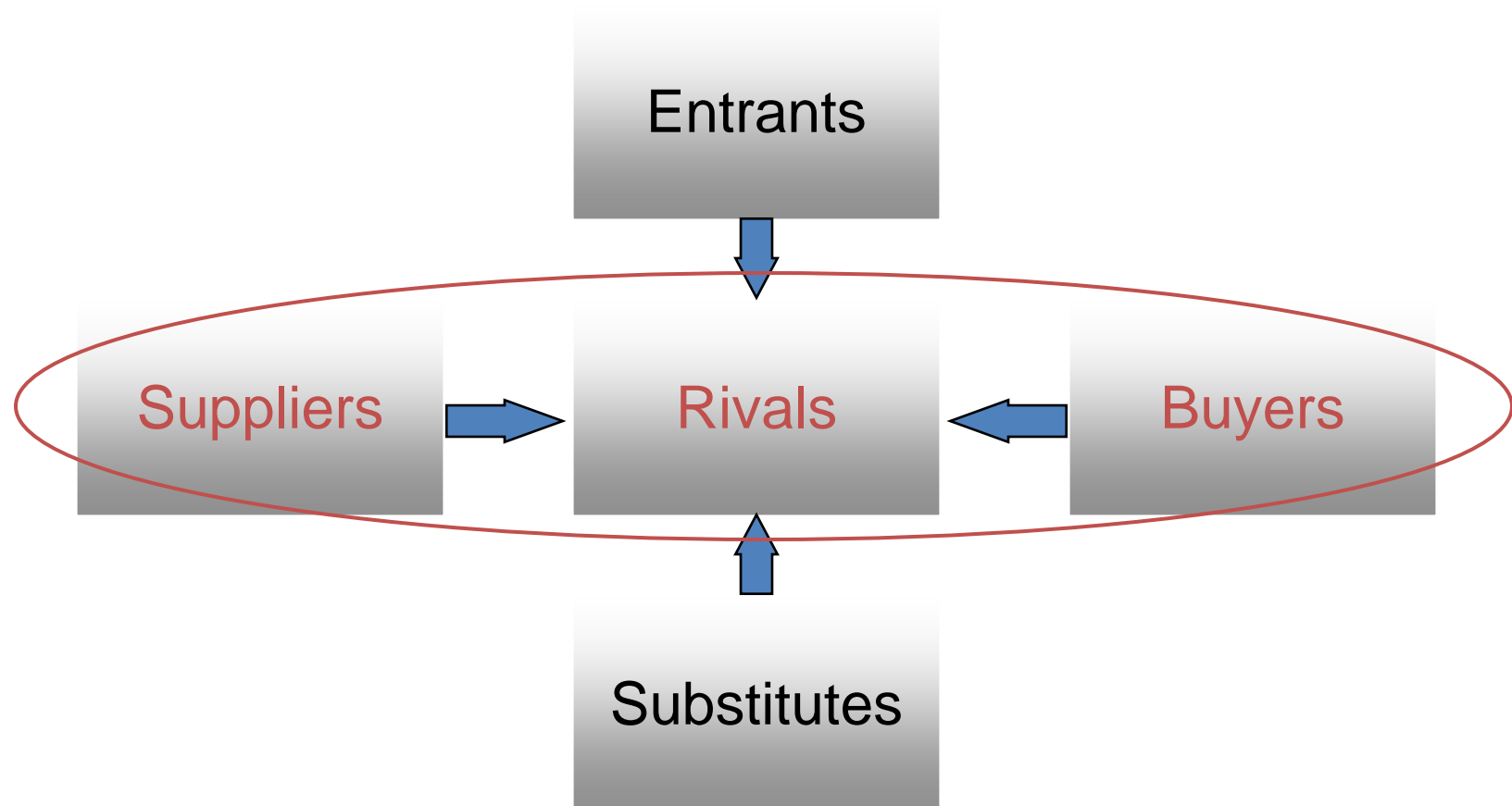
# Porter's "5 (actually at least 7) Forces": Thinking about the balance of power



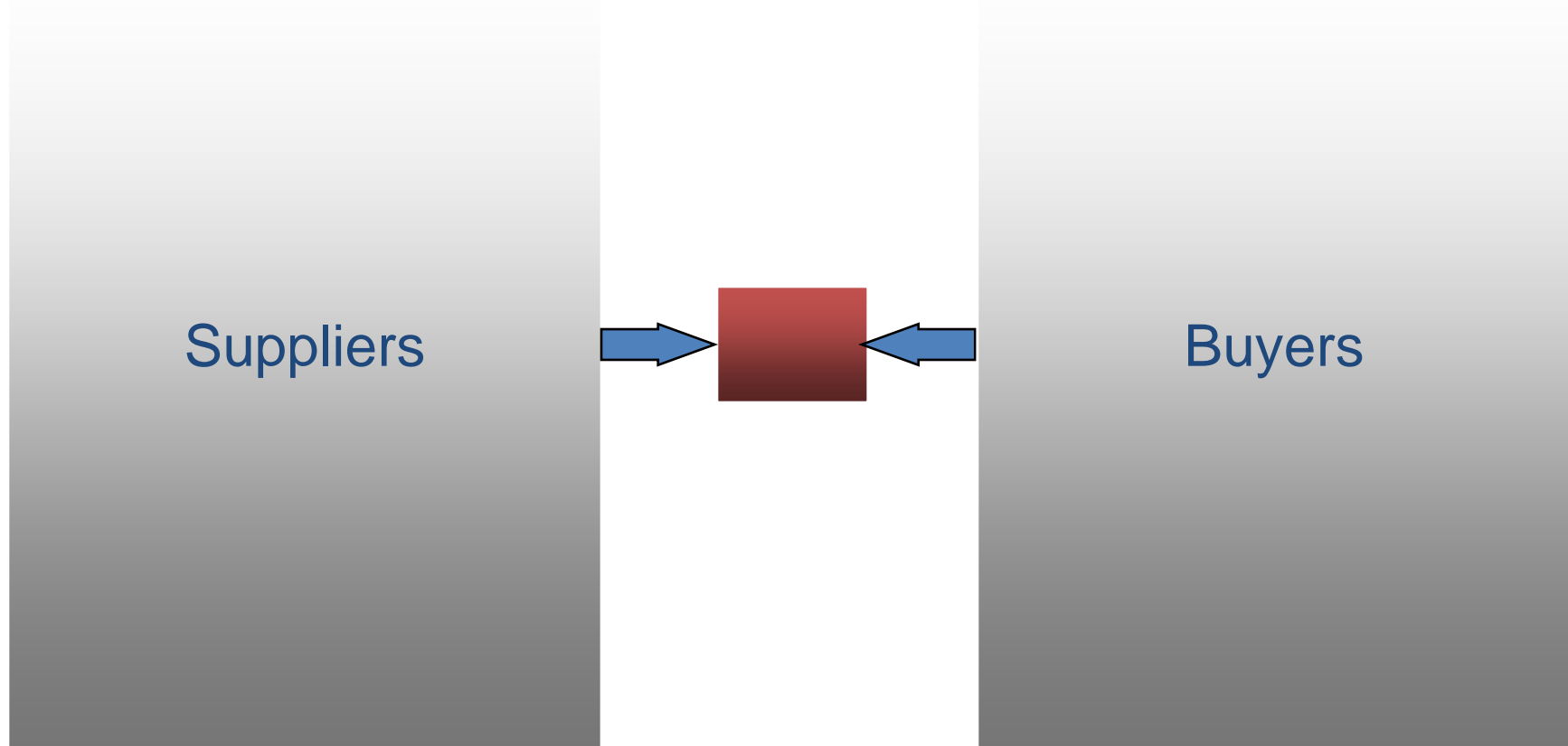
# C.Assets/Uniqueness speak to Rivalry and the Threat of Entry.



Porter reminds us to think about the structure of the value chain:



# Powerful suppliers and buyers may constrain profitability

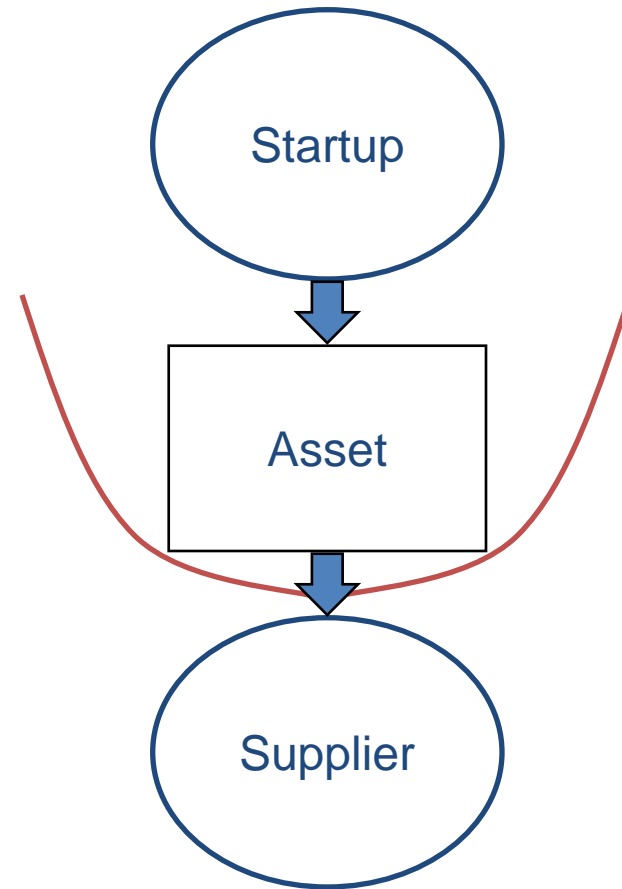
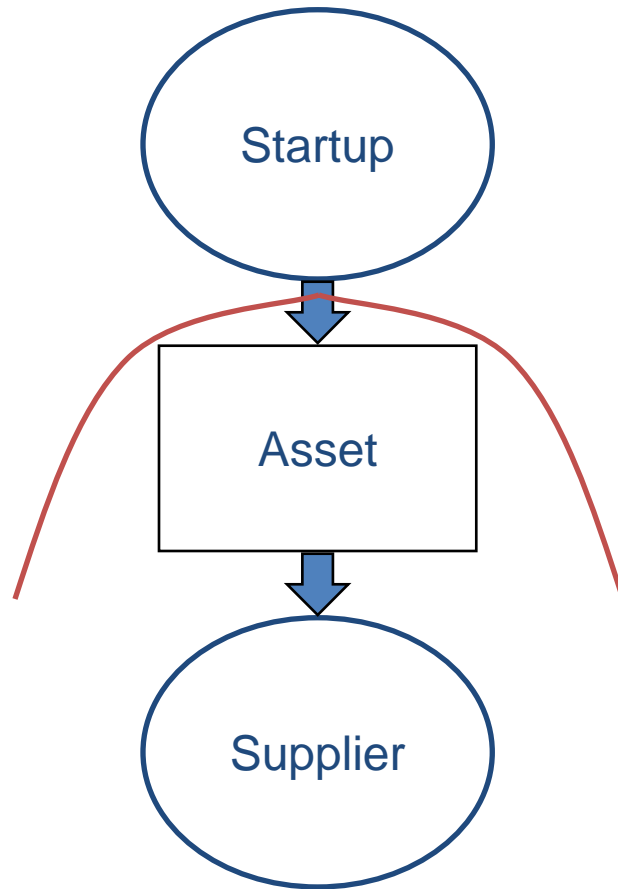


# Making money from Innovation: Summary

- Creating value is not enough:
- It is important to capture value as well
- Value can be captured through a variety of mechanisms, including uniqueness and complementary assets
- Value capture strategies change over the life cycle
- Technology strategy and business strategy should thus be intimately linked

Make vs. Buy

# Comparing “make” vs. “buy”



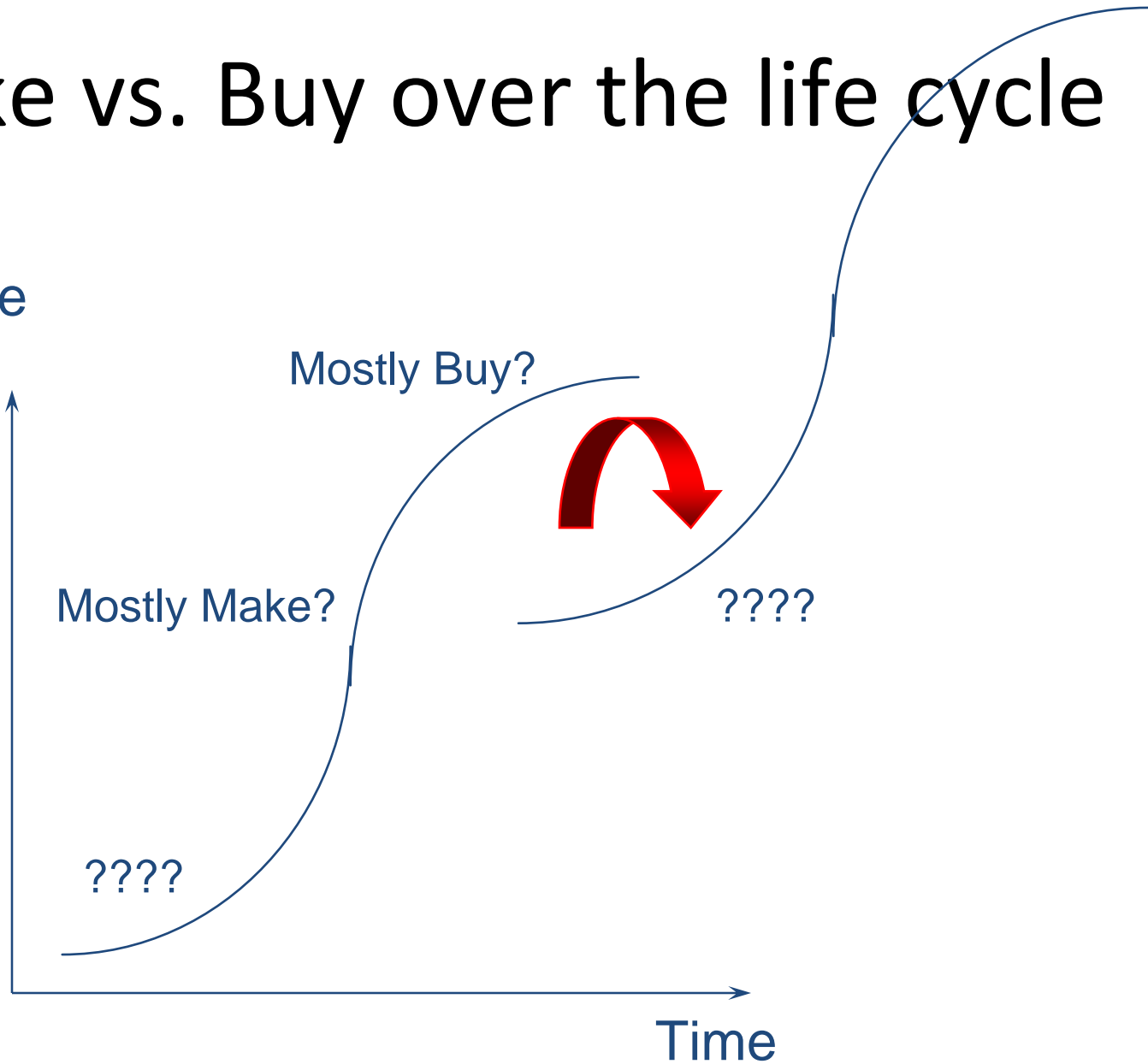


# Key Considerations:

- How easy is it to write contracts?
  - How tight is the IP regime?
  - How much uncertainty is there?
  - “Specificity” of the asset – how “thick” is the market?
- What will happen to “entrepreneurial energy”?
- What will be the key complementary assets going forward?

# Make vs. Buy over the life cycle

Performance



# So “make” (i.e. do it in-house) if:

- There are significant IP worries
- There are likely to be contractual problems
  - We can’t be sure of getting the “fair” price
  - We can’t be sure they’ll do the work “right”
  - *I.e., when market are “thin” or there is limited information*
- We have unique competencies that are relevant
  - Or could create them
- And if buying won’t destroy everyone’s incentives to be creative and energetic

## But remember...

- One cannot “buy” profit – if everyone knows it is there – it will be in the price
- Besides, shouldn't we “stick to our knitting”?
- Wouldn't you rather deal with an independent firm, whom you could fire, than an internal subsidiary?

Standards and Strategy:  
Competing in Increasingly Open  
Worlds

# Thinking about the dynamics of the strategic space

Access is:

Control is:

	Open	Closed
Public	<p>Details of standards are available to all: no single firm has control over how they evolve: no charge for their use</p> <p>E.g. TCP/IP, HTML</p>	<p>Standards are owned and controlled by the public sector but are not freely available</p> <p>E.g. Cryptography</p>
Private	<p>Details of standard are made available to all: but owner has control over how the standard evolves and may charge for use</p> <p>E.g. Nintendo, Palm OS</p>	<p>Technology may be standard, but details are not made available beyond the firm</p> <p>E.g. Landmark Graphics, IBM 360</p>

In practice these boundaries are

fuzzy:

Access is:

More  
Open

More  
Closed

More  
Public

Linux

Symbian

IBM  
360

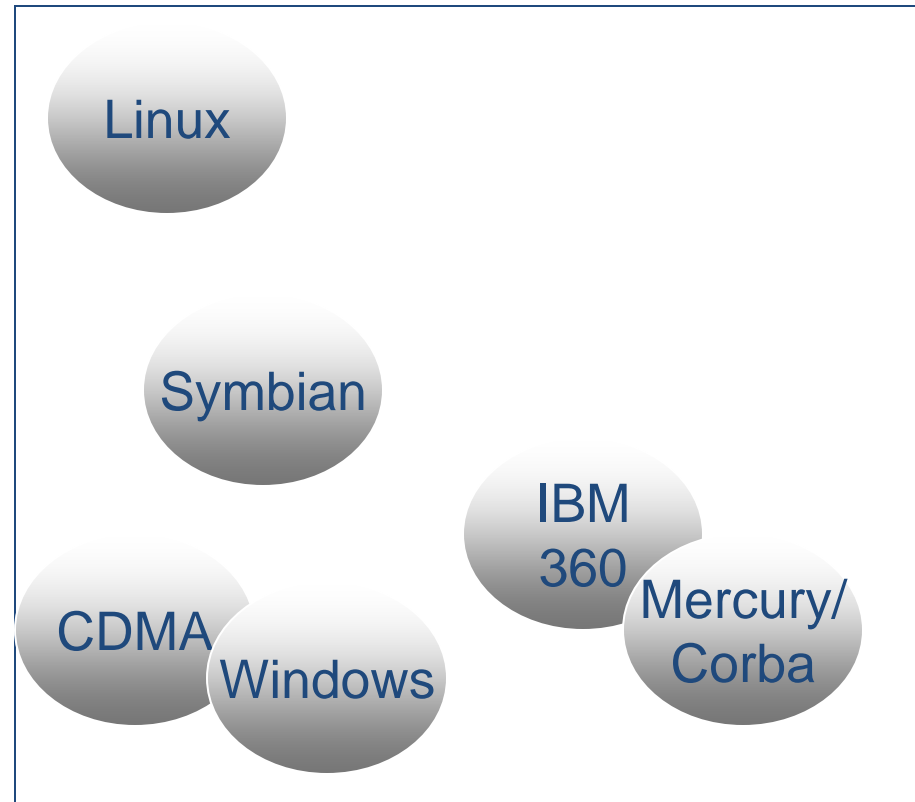
CDMA

Windows

Mercury/  
Corba

More  
Private

Control is:

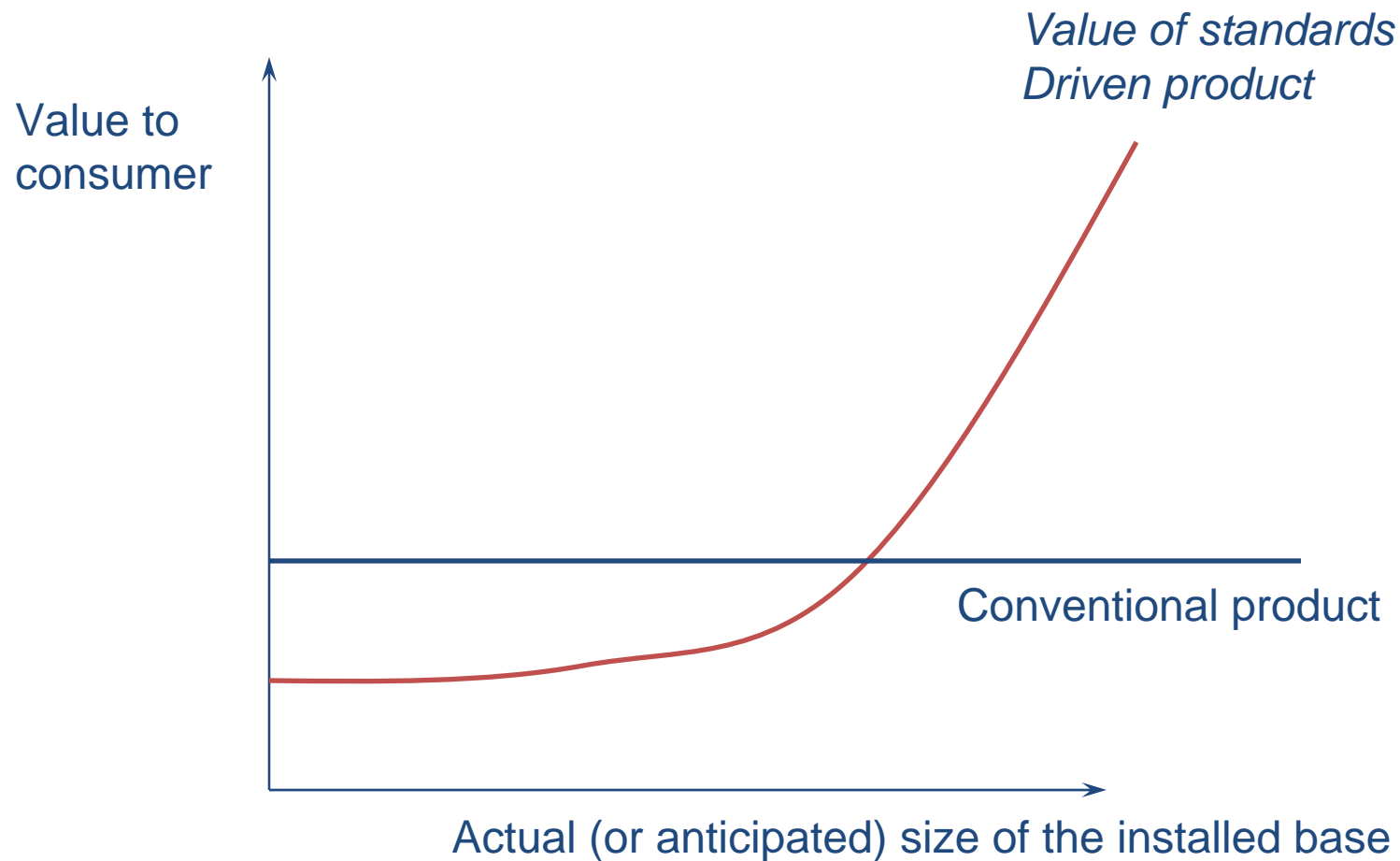


# There are two sources of network effects

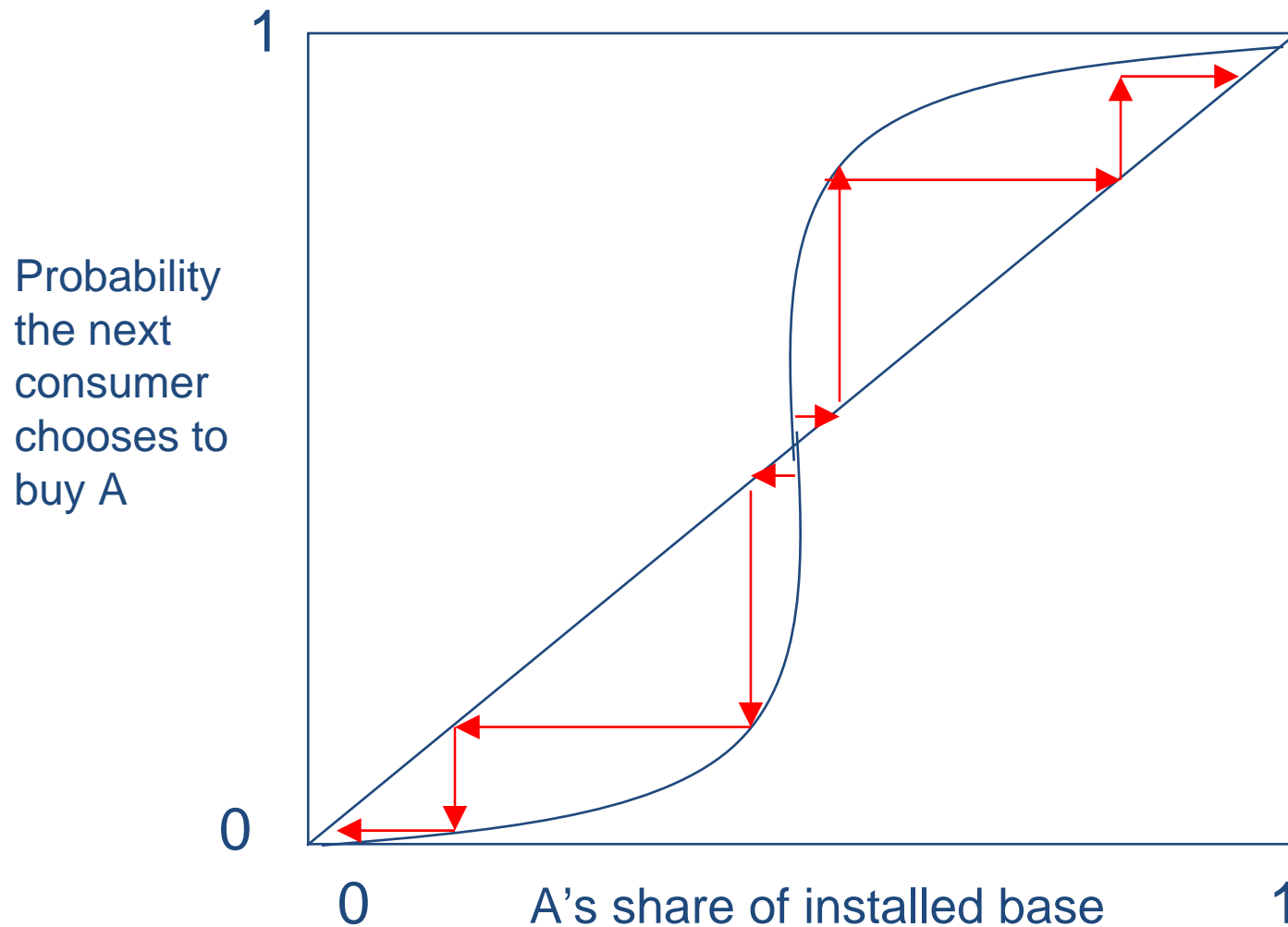
- Direct network effects
  - Network size
  - *Value increases with the number of other individuals who own the same product*
    - E.g.: Telephones, fax machines
- Indirect network effects
  - Complementary products/services
  - *Value increases with the number of complementary products that are available*
    - E.g.: CDs, software, VHS/Beta
  - Learning by using
  - *Standards mean customers invest only once in learning to use the technology:*
    - E.g.: Qwerty keyboard, Autocad



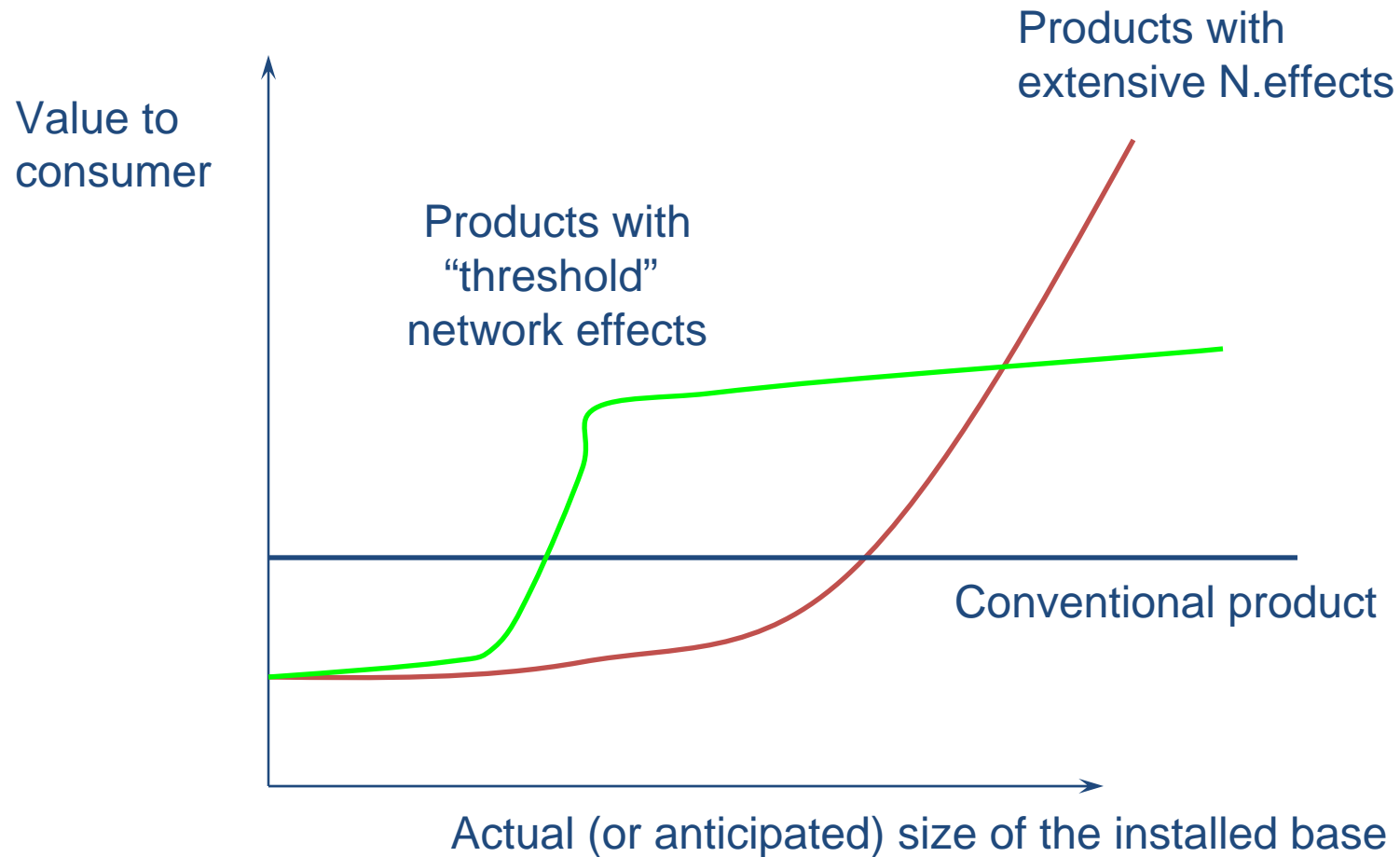
# With Strong Network Effects *Market Share Itself Creates Value*



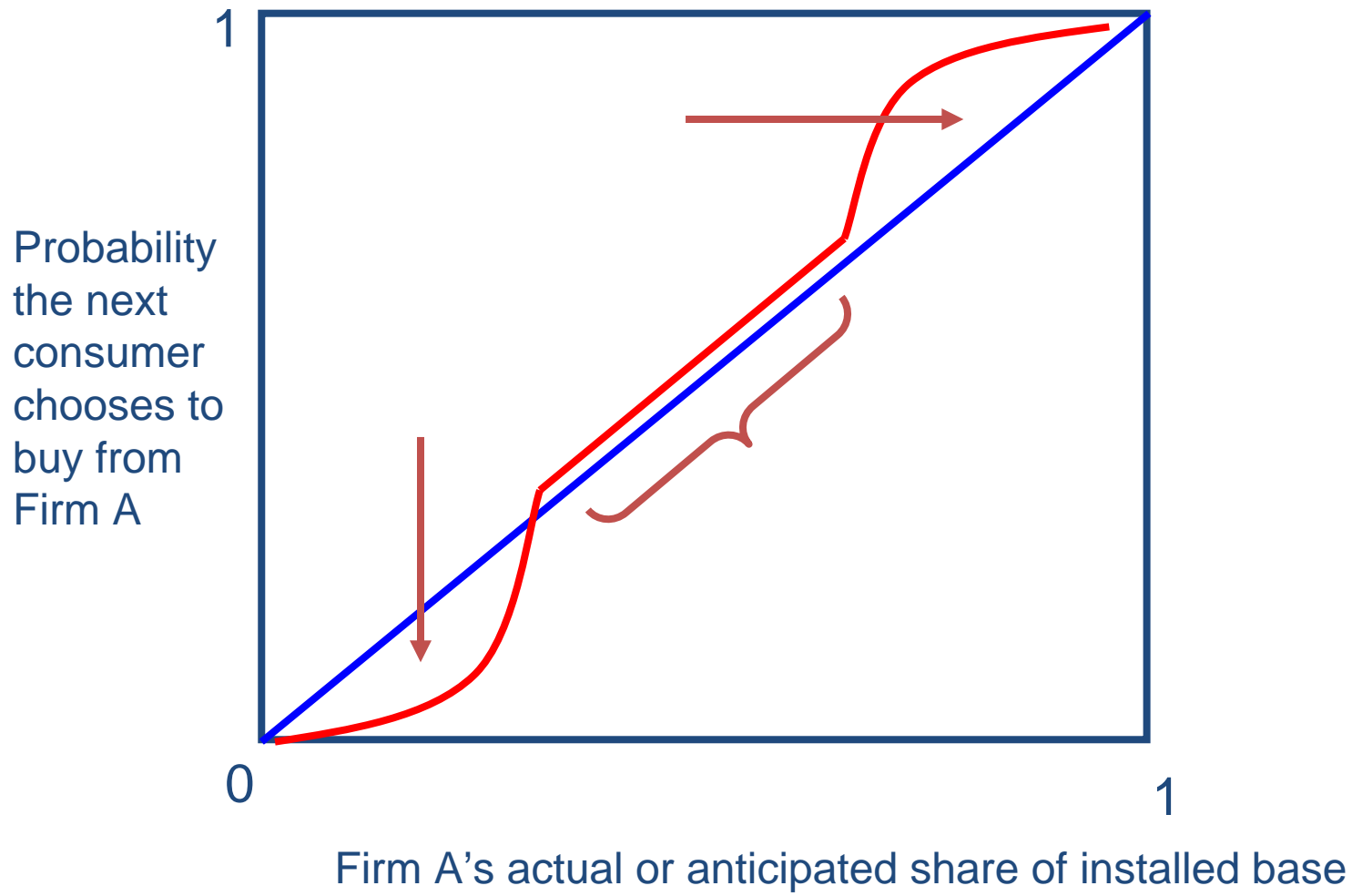
# If network effects are important, markets may “tip”



# Tipping dynamics differ with the strength of network effects



Markets with moderate network effects only tip once critical thresholds are reached



# Business models in the different quadrants

The technology is:

Control is:

	Closed	Open
Public		Compete on a level field Move to “soft” standards?
Private	Deliver a best in class system	Encourage the “ecosystem” Embrace/extend

# Strategic Management of Platforms and Ecosystems

# Managing Platforms Involves Industrial and Technological Leadership in Four Areas

- Four Levers of Platform Leadership:
  - Scope of activities: in-house vs. ecosystem activities
  - Technology design and IP: features/functions in platform
  - Encouraging relationships with complementors
  - Internal organization that facilitates platform changes

# Ecosystem dilemmas of Platform Leaders

- On the one hand, platforms create enormous incentives to “squeeze” your ecosystem:
  - Extending the platform into their space – e.g., envelopment
    - e.g. Microsoft: Windows platform now includes important middleware not originally part of the platform
  - Releasing your own complementary products in the critical areas (high growth, or strategic control points)
    - e.g., Microsoft: enters key complementor markets that are high growth (Office suite) or offering strategic control points (IE & the browser wars)
- But complementors must have an incentive to innovate...if you squeeze them they'll exit! They create much (if not most) of the value for the platform!

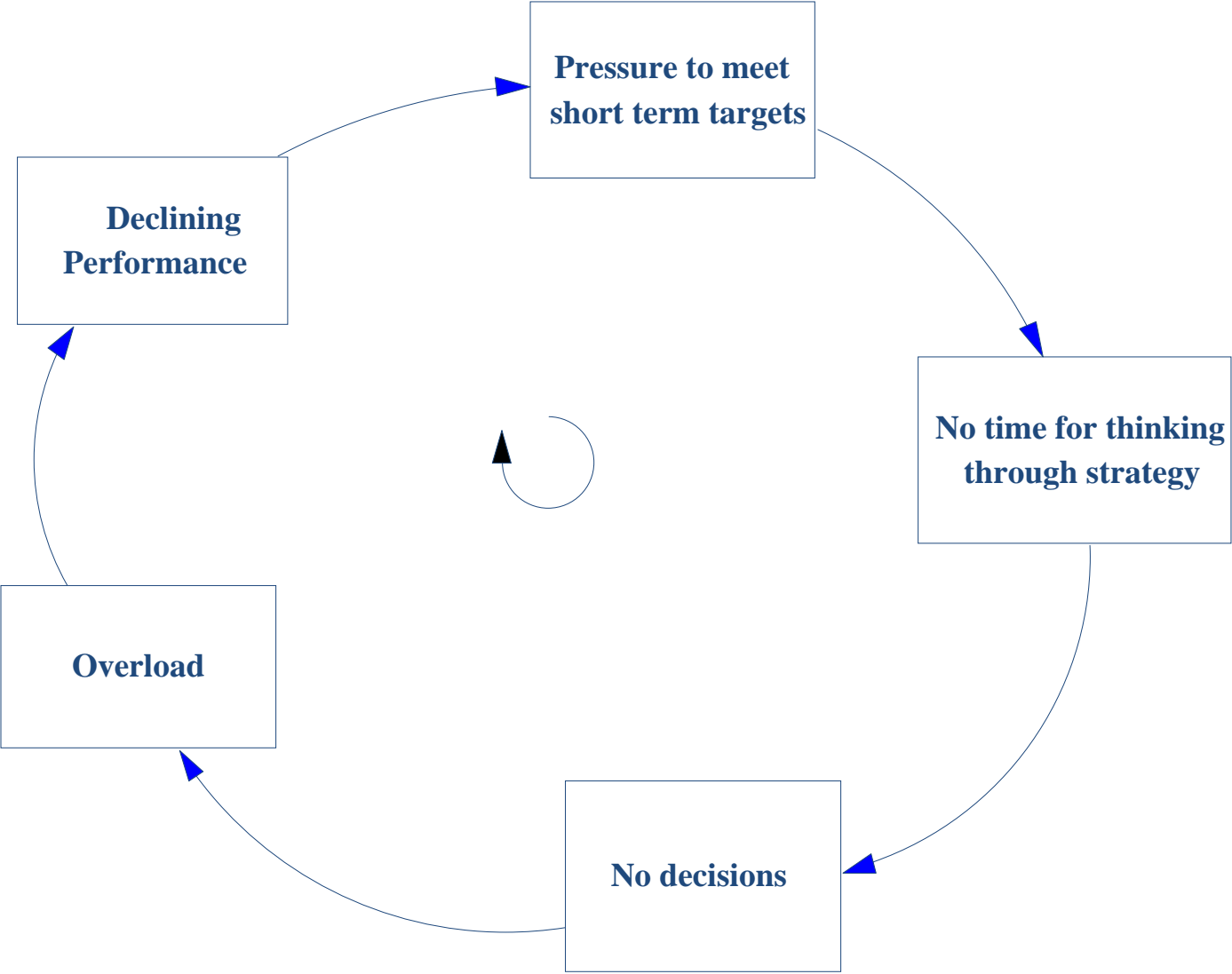


# How to resolve this dilemma? We'll examine Intel's solution, 1990-2004

- Dilemma: Capture value from Microprocessor platform, but don't curtail value Creation by Ecosystem in many complementary markets...
  - E.g., Security, PCI, USB, DVD, Video, Motherboards, Audio, and many others...
- Step 0: Consider entering markets where you have competencies
  - Avoid markets where Intel has no competency, no matter how tempting at the time (e.g., internet software)
    - Hard to resist temptation: 5 failed entries into internet software became quick exits
  - Consider entering some complementor markets...but do so carefully... (the rest of the strategy is about how to do so)

# Value Delivery

# What went wrong at Medtronic?



Remembering Organizational Change in Medtronic; How did they fix things?  
“Best Practice”

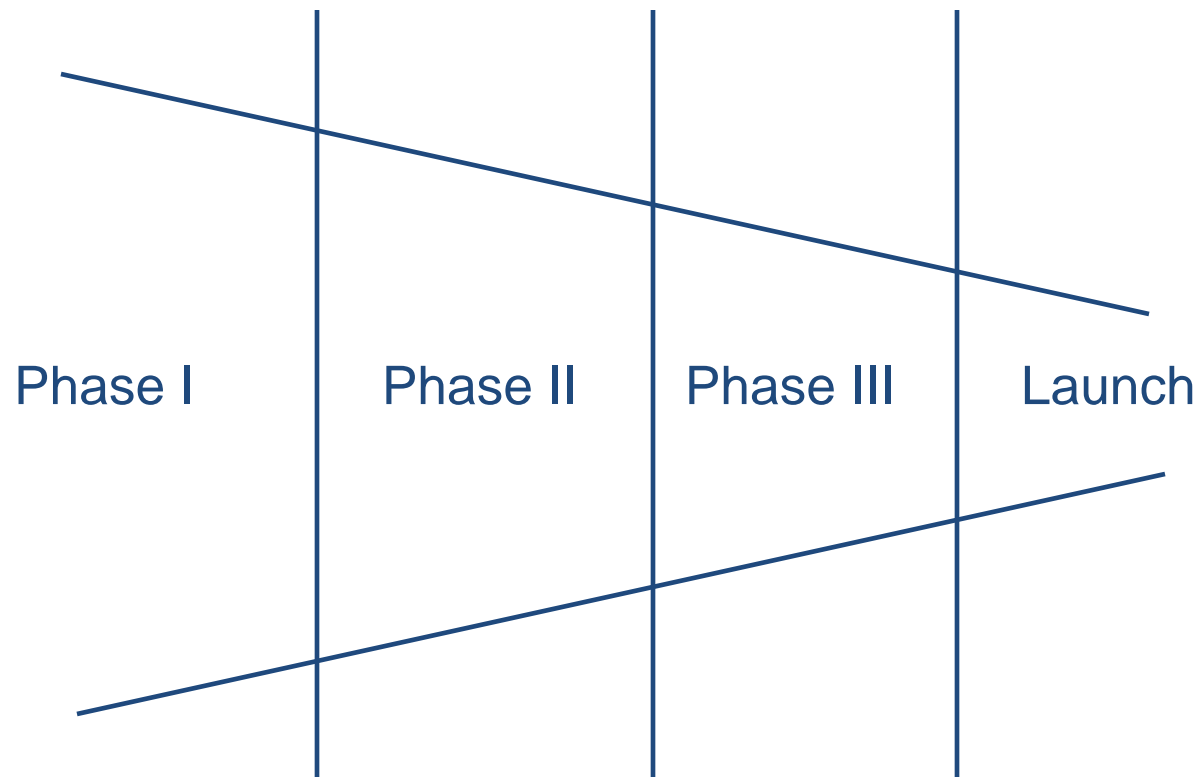
- Clear, committed leadership
- Well articulated strategic goals
  - “He cleaned up the front end...”
- Coherent management philosophy
- Measures and incentives
- Processes and practices
- A sense of urgency
- That reinforce each other

# Product Development Processes and Practices

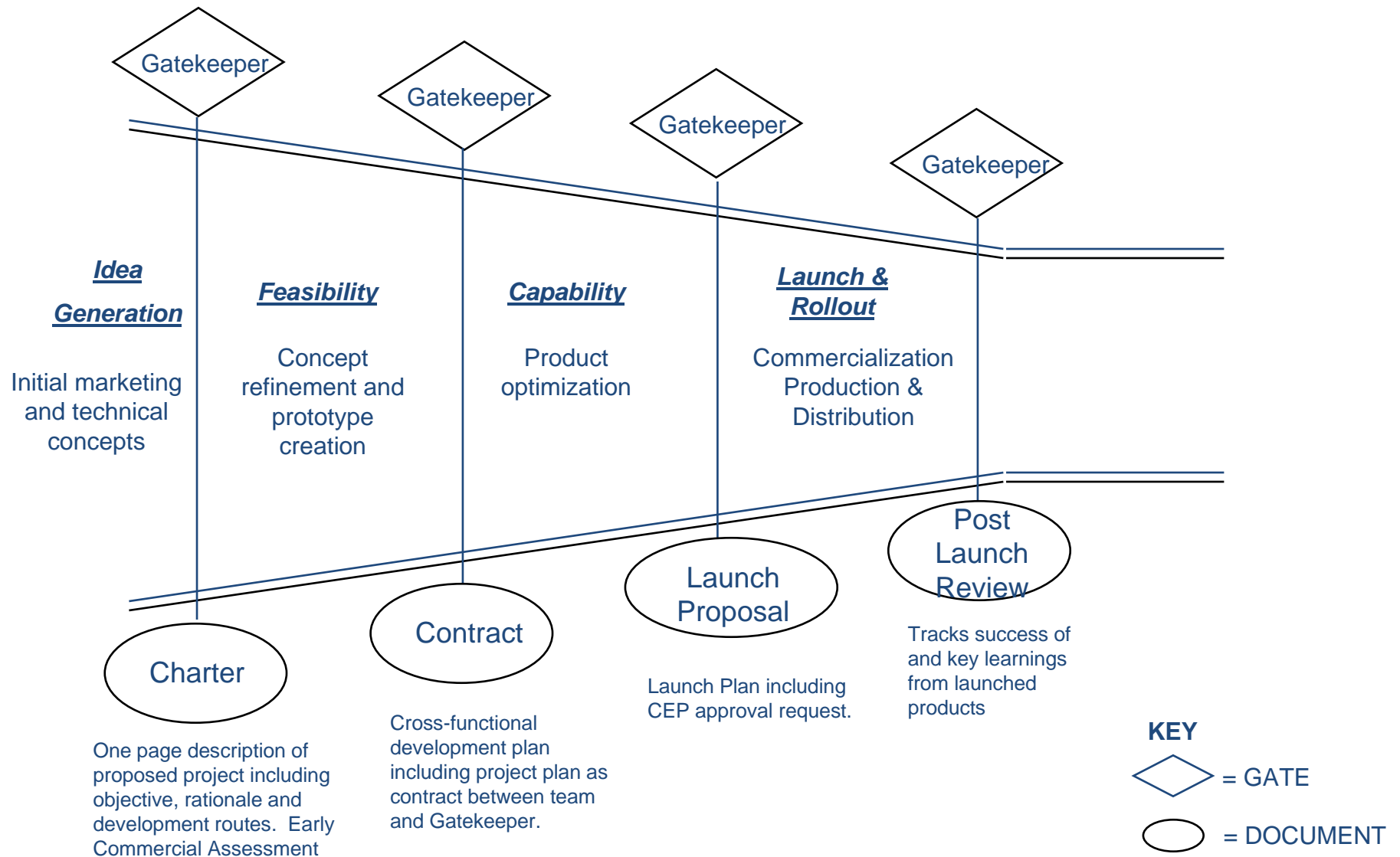
- Speed
  - “Being fast eliminates so many other problems...”
  - Clear product definition process, rooted in strategy
- Platform strategy
  - Leverage technology across the range
  - Clearly differentiate technology development from product development
- Cross-Functional Teams
- Project documentation
- Phase definition
- Rhythm
- Market inputs

# Funnels & Project Plans

# The innovation funnel

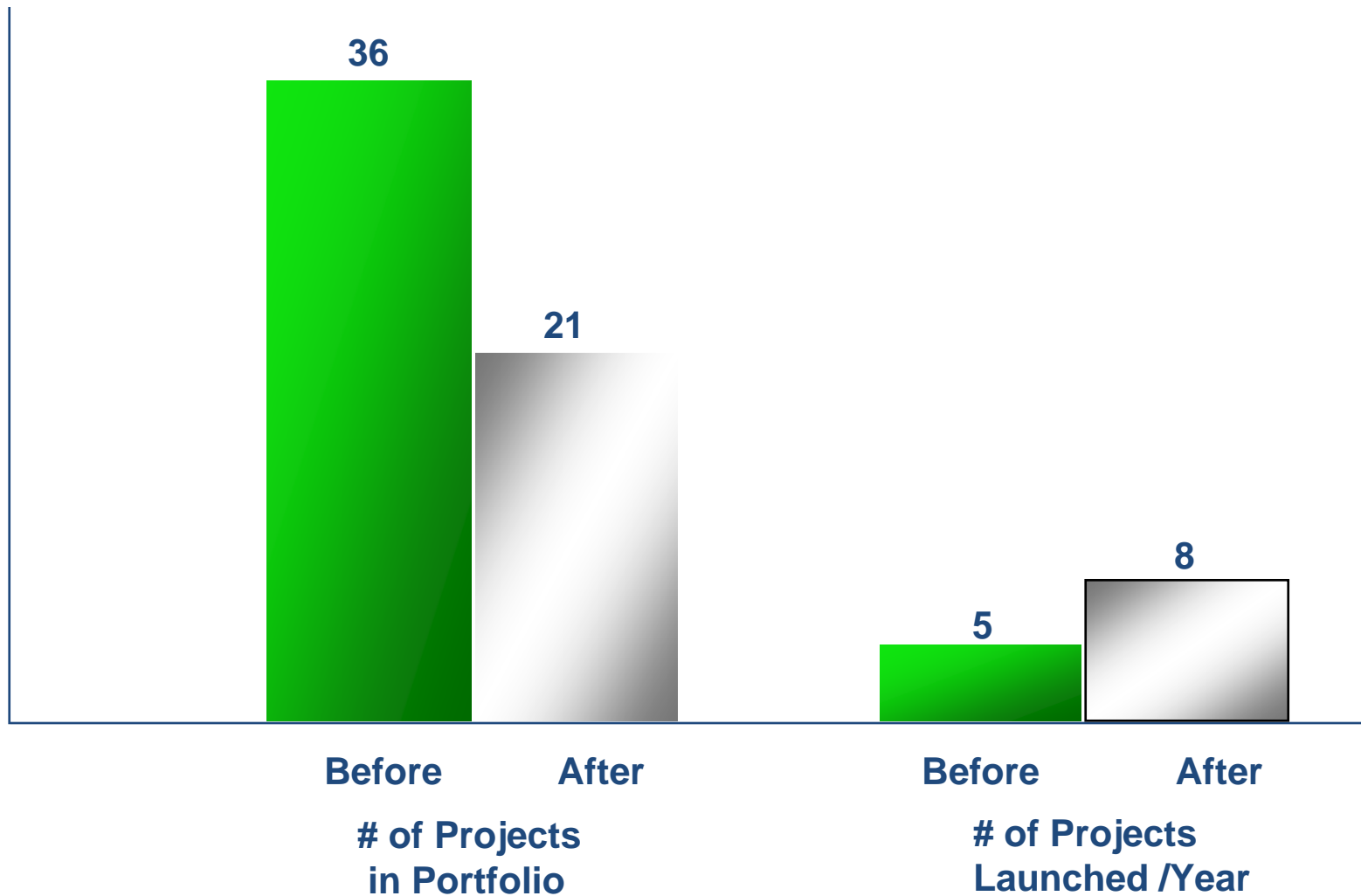


# An Innovation Funnel Example



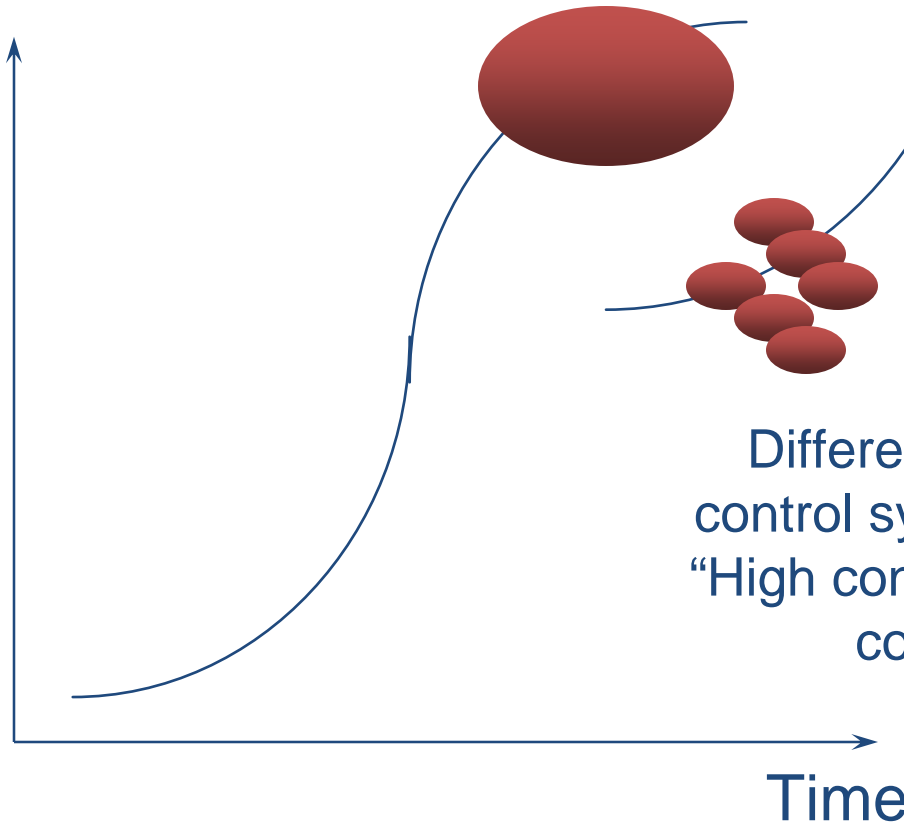


# Less Is More: Medical Products Co.



# Develop the ability to manage *ambidextrously*

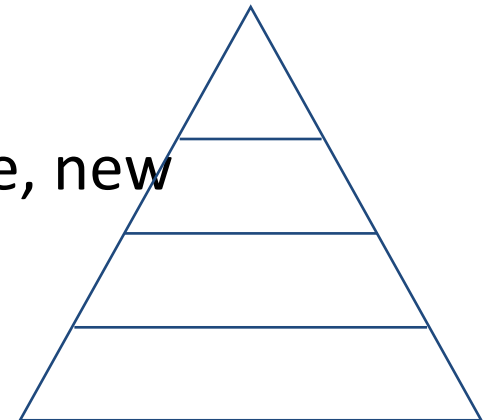
Performance



Different expectations,  
control systems, incentives.  
"High conflict, high respect"  
conversations

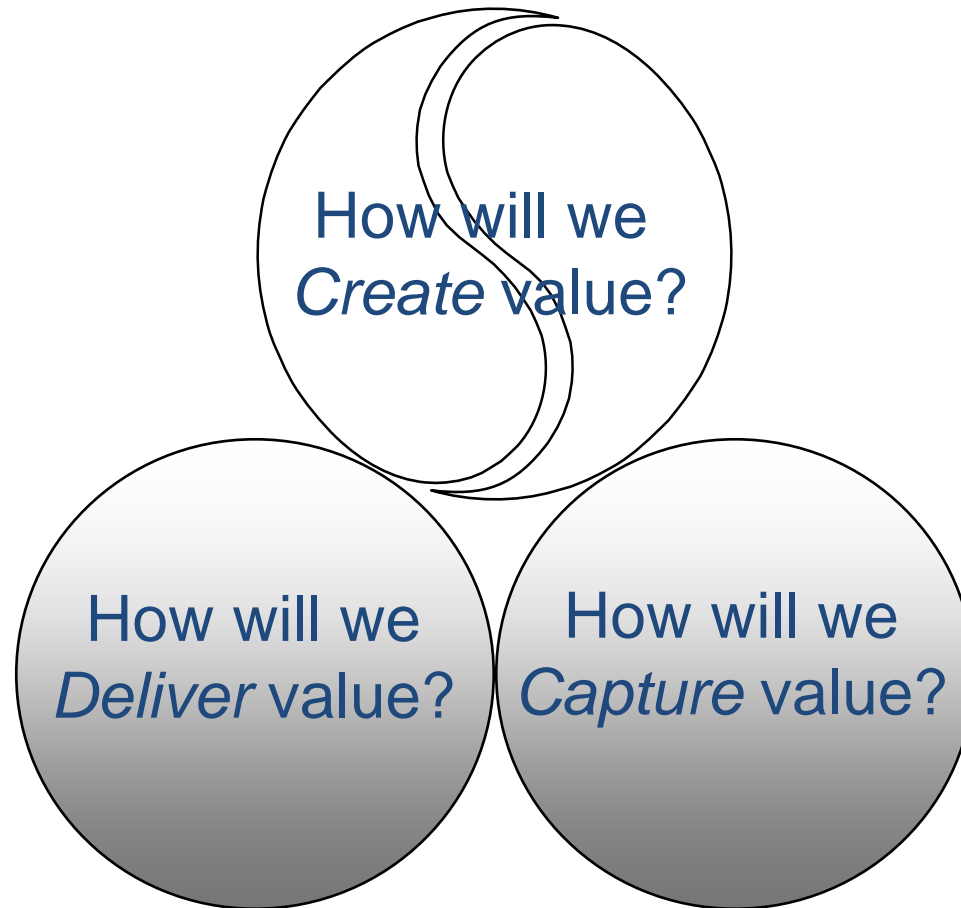
# Building the ambidextrous organization

- Lead:
  - Build the “ambidextrous” senior team: communicate the strategy, allocate resources
- Structure:
  - Explore transitional and intermediate forms
- Incent:
  - Explain “just what’s in this for me?”
- Build:
  - Lay the foundations for a new culture, new expectations



# Summary

# Effective strategies address three key problems:

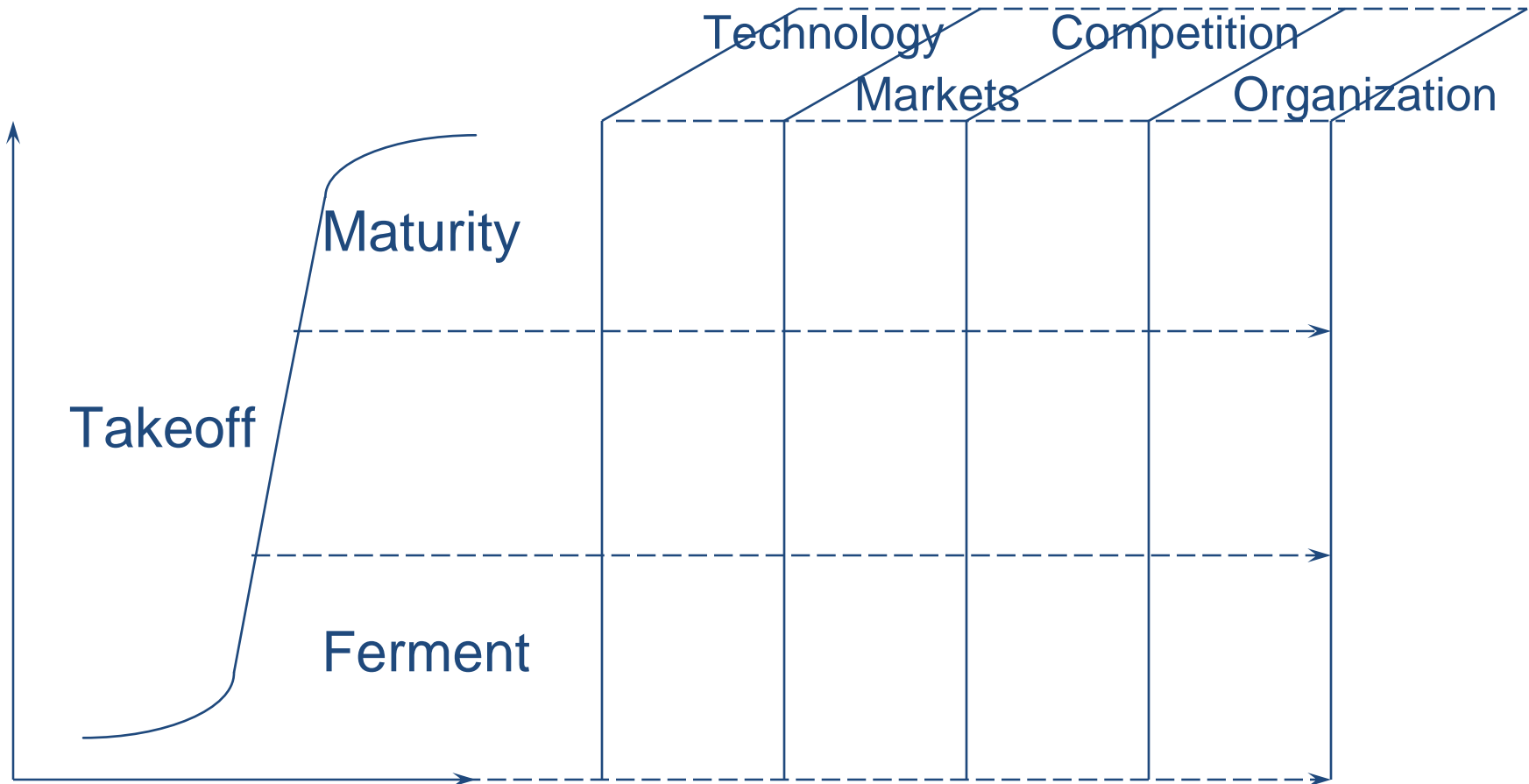


## Effective strategies answer 7 critical questions:

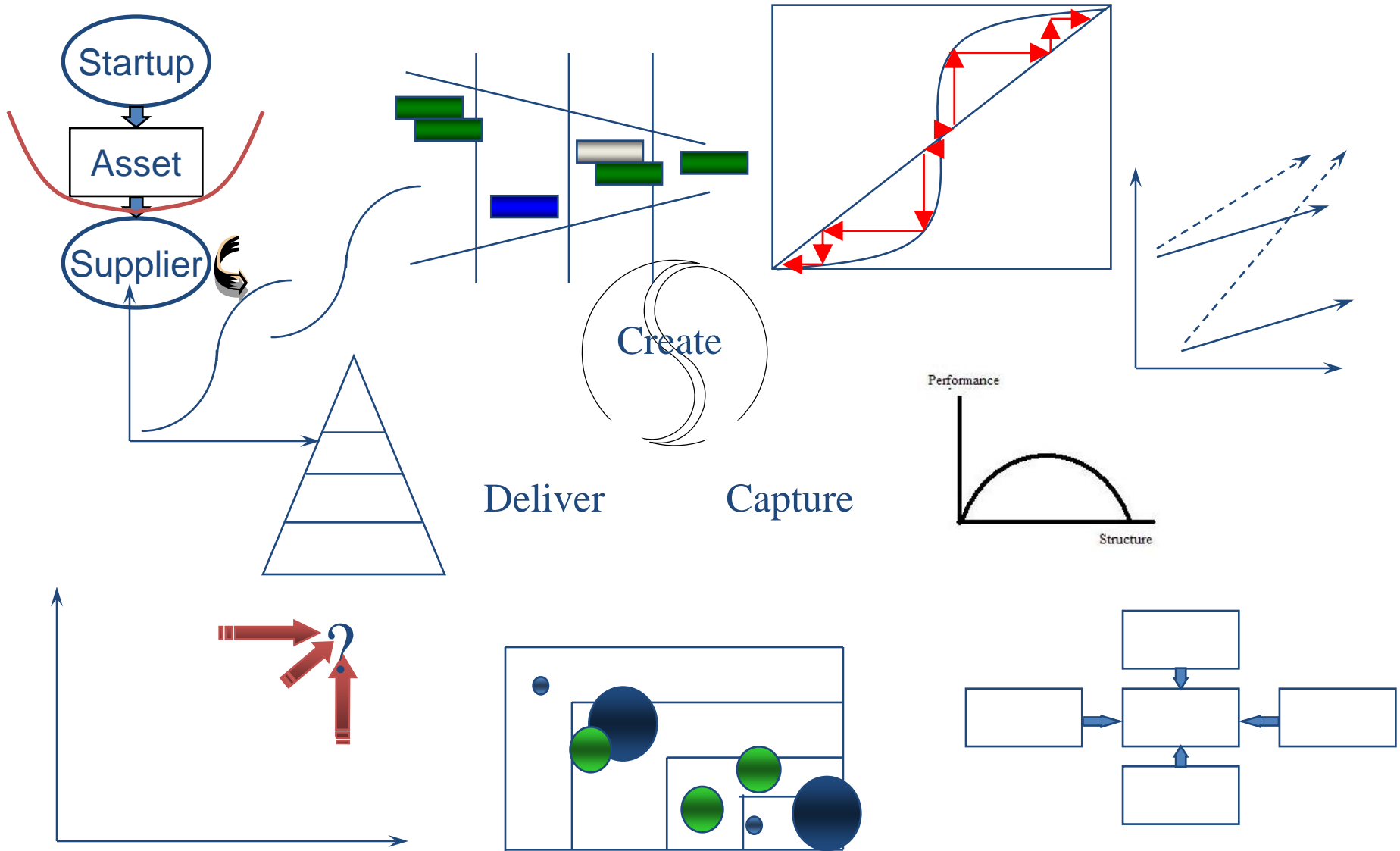
- How will we create value?
  - How will the technology evolve?
  - How will the market change?
  - How do we organize effectively?
- How will we capture value?
  - How do we compete to gain sustainable competitive advantage?
  - How should we compete if standards are important?
- How will we deliver value?
  - How should we execute the strategy?
  - How do we make strategic decisions and take decisive action?

# Understanding the life cycle is critical

:



# Technology strategy on one slide:





Good Luck!