innovation

September 15, 2006
Version 1.3

IT AIN'T DONE

Prepared for:
Lance Carlson
Institute for the Creative Process
Alberta College of Art and Design

Prepared by:
Dubberly Design Office
2501 Harrison Street, #7
San Francisco, CA 94110

1 415 648 9799

in

formed from, with / inside the extant

innovation

i/o dentified

no

negates the status quo

nova

new, brilliant and significant; star-like

ovation

ovulation, from re-cognition, meriting recognition

vat

glued, brewed, and stewed

at

toward (a goal) or located in a context, time, and place

in no va tion

ego-instigated

ion

free to form new bonds

on

about; active and progressive; ontological

innovation

IT AIN'T DONE

We state openly that this book is far from complete. It was created primarily as an internal reference for individuals developing the Innovation concept map. Not only must we continue to search for new—and existing—models of innovation, we must also reexamine and revise the classification of models that have already been included. Any insight or suggestion for the continued development of this book is welcomed.

Introduction

Innovation is the application of an insight that creates new value, improves upon the status quo, and becomes widely adopted for the benefit of society.

Innovation occurs in different environments, initiated by different organizations at different times. The innovation's purpose and measure of success depends on the goal of the innovators and the needs that the innovation addresses.

This document compiles models of innovation that various individuals and organizations have articulated over the years. It contains six sections corresponding to the circumstances surrounding innovation: How, Who, What, When, Where, and Why. The models span from taxonomies to flow diagrams of proposed innovation processes. The Why section currently does not have any models. This vacancy invites us to consider the motivations behind innovations and to put to paper the reasons why we desire applications of new ideas.

This book was prepared for the Institute for the Creative Process, Alberta College of Art and Design by Dubberly Design Office. It accompanies a concept map of Innovation. Both the book and the concept map are for individuals and organizations that are intrigued by innovation and the desire to create new value through the applications of insight.

Satoko Kakihara, Sean Durham, and Ryan Reposar compiled the book. Nathan Felde and Paul Pangaro contributed significantly to the development of both this book and the map that it accompanies. A number of others also shared ideas with us that helped shape this work. To these individuals we owe many thanks.

How

Who

What

When

Where

Why

innovation

through a process

in which anyone can participate

changing beliefs, processes, artifacts

at anytime

within a community

to create advantage

How does innovation happen?

but is often unmanaged

through a process (that can be managed)

In the context of a community, **observation** (of customers, technology, laws)

leads to **insight** (the joining of two or more formerly separate ideas)

to create an **effect** (value—knowledge, culture, wealth)

with **consequences** for the community (spreading adoption)

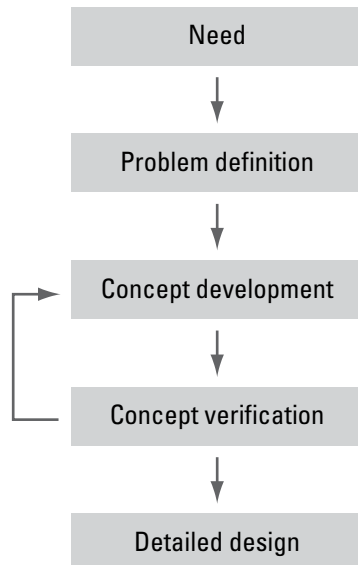Parallels design, engineering, and R&D processes

Contrasts with TQM and Six Sigma practices (You can't measure your way to innovation)

Product Development Process

after Fey and Rivin (2005)

New products originate from new concepts. Victor R. Fey and Eugene I. Rivin, co-founders of the TRIZ Group, state that the product development process begins with the recognition of a need that leads to a defined problem.

Concepts are then generated, evaluated, and developed by tests and prototypes. These phases of concept development and concept verification then enable the design process.
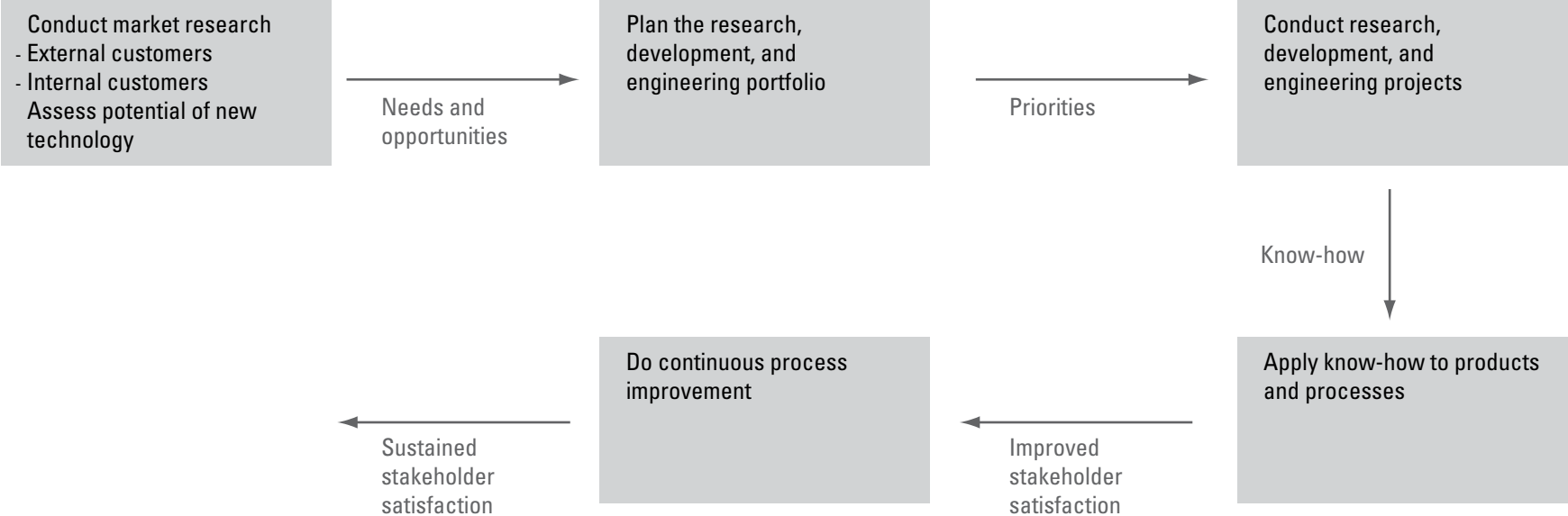
```
┌─────────────────────────┐
│          Need           │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│    Problem definition   │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│   Concept development   │◄──┐
└─────────────────────────┘   │
             │                │
             ▼                │
┌─────────────────────────┐   │
│   Concept verification  │───┘
└─────────────────────────┘
             │
             ▼
┌─────────────────────────┐
│     Detailed design     │
└─────────────────────────┘
```

Continuous Process of Technology Development

after McKinsey & Company

Stage models often depict the evolution of an idea into a concept that becomes a commercialized or applied product. McKinsey & Company's stage model, derived from consulting, begins with market research that leads to planning research, conducting research, applying know-how, and continuously improving on the outcomes.

Conduct market research
- External customers
- Internal customers
  Assess potential of new technology

Needs and opportunities →

Plan the research, development, and engineering portfolio

Priorities →

Conduct research, development, and engineering projects

Know-how ↓

Apply know-how to products and processes

← Improved stakeholder satisfaction

Do continuous process improvement

← Sustained stakeholder satisfaction

Simple Value Chain

after Geoffrey A. Moore (2005)

In his Simple Value Chain, Geoffrey A. Moore includes the steps of Research, Design, Source, Make, Market, Sell, and Service. These functions combine and link together to create a market. Moore proposes that even such a basic model differs in the way it applies to different business architectures, such as the Complex-Systems Model (pg. 37) and the Volume-Operations Model (pg. 38).

Value chain elements	Complex systems	Volume operations
Research	Qualitative scenarios	Quantitative analytics
Design	Integration of modules	Modules that integrate
Source	At the margin	At the mean
Manufacture	Adaptive methodologies	Deterministic processes
Market	Value chain orchestration	Branding and promotion
Sell	High-touch persuasion	Low-touch distribution
Service	Open-ended consultations	Close-ended transactions

Innovation

after Allan Afuah (2002)

Allan Afuah, a professor in Corporate Strategy and International Business at the University of Michigan Business School, defines innovation as "the use of new technological and market knowledge to offer a new product or service that customers will want." New technological and market knowledge is used to create a product that costs less, has improved attributes, has new attributes, and has not previously existed in the market.

New product
- Low cost
- Improved attributes
- New attributes

Competencies
and assets

New technological
knowledge

New market knowledge
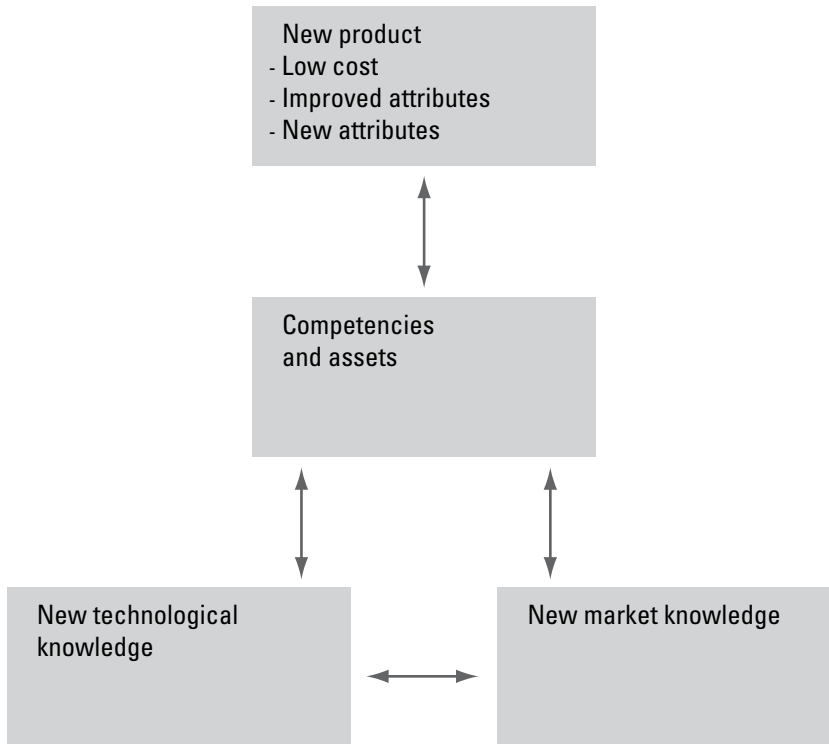
Process for Generating Breakthrough Innovation

After their collaboration on The World's Largest Innovation Lab, General Electric and Stone Yamashita Partners proposed an eight-step process for generating innovation. The eight steps are Explore, Immerse, Ideate, Envision, Hypothesize, Design, Refine, and Market. Individuals proceed through each stage by asking questions, prototyping, and filtering information and assumptions.

In order to generate breakthrough innovation . . .

Explore the world at large and open your mind to new possibilities
Immerse yourself in the lives of your customers
Ideate about how to challenge the status quo
Envision a breakthrough way to improve people's lives
Hypothesize a thoughtful, creative strategy and business model
Design the customer experience and supporting business model
Refine the design to make it truly breakthrough
Market your innovation to realize its full potential

Proceed through each stage of the process by . . .

Asking   Come up with the ideas that will challenge the status quo by asking the right questions.
Prototyping Make the ideas more real—at any stage in the process—so that they can be experienced, evaluated, improved, or reconsidered.
Filtering   Challenge assumptions and conclusions to draw out the breakthrough from the banal.
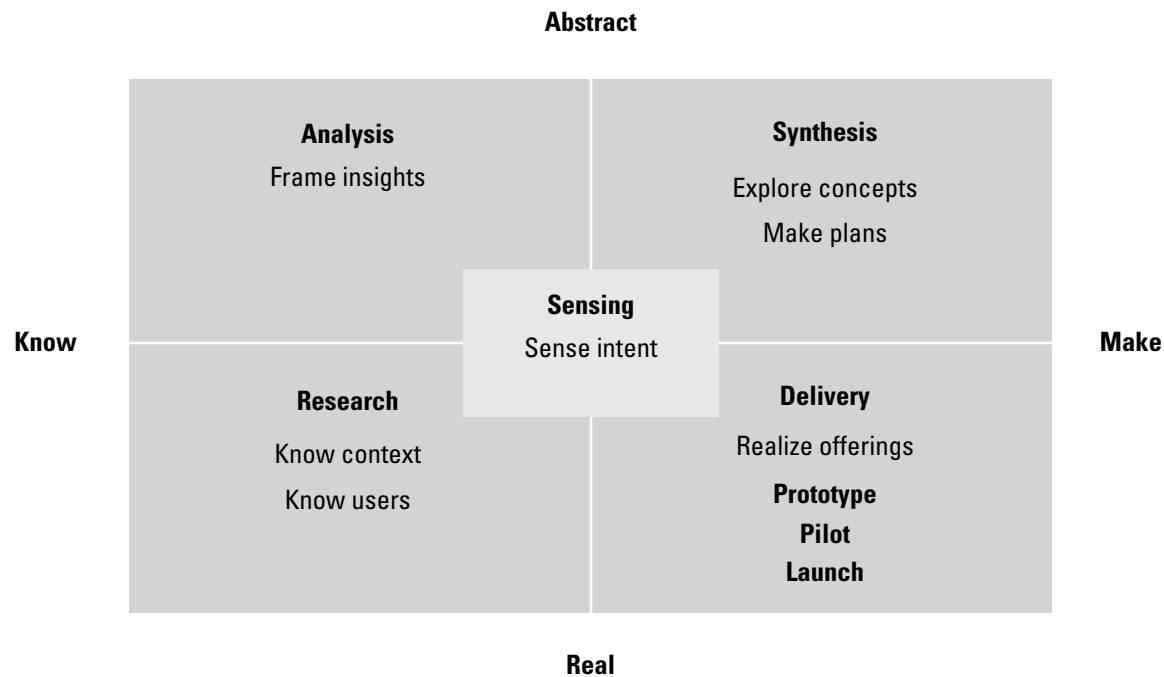
Explore	Immerse	Ideate	Envision	Hypothesize	Design	Refine	Market
Speaker sessions Haven for exploration and radical thinking Exploration of other cultures and organizations	Ethnography Interview	Brainstorming Future customer journey	Customer journey map	Strategic hypothesis map			
Trend debates	Customer archetype	Prototype	Story, "headline from the future"	Map system Operations mapping	Mock-up	Rehearsal	
Team Wiki	Map of organizational competencies and assets	Sketch of favorite ideas	Role-play Storyboard	Roadmap of obstacles and strategies "Stop, start, continue" exercise	Scale model	Alpha version	Pre-production prototype
Prototype	Map of competitive landscape	Extreme debate Best-practice observation	Team Wiki	Business plan, project plan, budget	Blueprint	Beta version	Concept model
Data cards					Process map	Open source product	Scenario forecast Pre-personalization sample
						Pilot project	Living lab
					Technical specifications CAD Speed dating (multi-disciplinary dialogue)		Feedback loop Customer advocacy group

Innovation Planning Process

after Vijay Kumar of Doblin Group

Vijay Kumar of Doblin Group, an innovation strategy firm based in Chicago, articulated his Innovation Planning Process, which consists of sensing intent, researching context and users, analyzing insights, synthesizing concepts, delivering offerings, and fostering uptake. He proposed that,

to innovate successfully, companies need an "innovation planning process, supported by structured methods, tools, and frameworks" that integrate multidisciplinary teams and multiple specialty areas. Kumar emphasized that these phases do not take place in a specified order.

Abstract

Analysis

Frame insights

Synthesis

Explore concepts

Make plans

Sensing

Sense intent

Know

Make

Research

Know context

Know users

Delivery

Realize offerings

Prototype

Pilot

Launch

Real

Innovation Planning Toolkit

after Vijay Kumar of Doblin Group

Kumar's Innovation Planning Toolkit contains a set of activities for each mode of the Innovation Planning Process. Tools such as context maps, scenario plans, and concept prototypes offer ways for organizations to develop and apply their ideas.

Sense intent
Trend map
Diagnostic system
Concept space

Know users
Research plan
Video/Photo research
User camera study
Ethnographic interview
User insights database
Five human factors
Experience map

Know context
Context map
Eras map
Value web
Innovation map

Frame insights
User data analysis
Context data analysis
List sorting
Flow, experience model
System simulation
Analytic frameworks

Explore concepts
Concept definition
Concept matrix, map
Concept systemizer
Scenario plan
Concept manager

Make plans
Strategic roadmap
Innovation brief
Strategic plan
Tactical plan
Business case

Realize offerings
Behavioral prototype
Concept prototype
Pilot and launch plan
Change plan

Innovation Cycle

after Sheridan M. Tatsuno (1990)

Sheridan Tatsuno takes a Zen approach to innovation in his Innovation Cycle. His "Mandala of Creativity" traces the life cycle of ideas, where old ideas do not die but are instead reused with new developments. The cycle includes phases of searching for ideas, nurturing them, and finding appropriate ways to recycle them. Tatsuno founded NeoConcepts, a company that specializes in new product development.

Sairiyo
(Recycling)

Tansaku
(Search)

Ikusei
(Nurturing)

Hassoo
(Breakthroughs)

Kaizen
(Refinement)
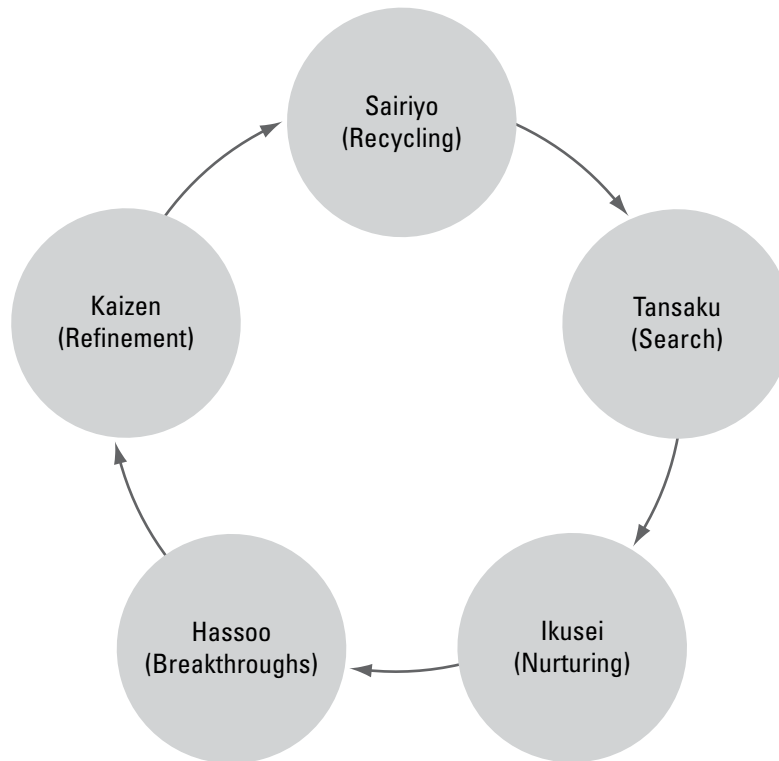
Foresight to Insight to Action Process

after Bob Johansen of Institute for the Future

The Institute for the Future, located in Palo Alto, California, researches the impact of technology on society. Its mantra is "Foresight to insight to action"—the idea of understanding knowledge about the future to brainstorm new possibilities and channel them to action. The purpose is not to predict the future, but rather to make a difference in the present through linear progression of thinking and understanding.

Situation	Conceived through…	Description
Verifiable present	Observation	What you have
Probable future	Foresight	What you are likely to get if things are left as they are
Possible future	Insight	What you might get by applying resources
Desireable future	Action	The best possible outcome, what you should work for

Who innovates?

in which anyone can participate

People in business or non-profit organizations, from the arts to the sciences

In any role, for example, customers, researchers, designers, management, labor, suppliers

In any domain, from education and healthcare to religion and the military

People who innovate are entrepreneurs

Motivation/Ability Framework

after Christiansen et al. (2004)

The Motivation/Ability Framework has two axes: Motivation, the "pot of gold waiting for the winners," and Ability, the "capability to obtain resources, craft them into a business model, and offer products and services to customers."

The axes have scales measuring each factor from low to high, and depending on the amount of each available in the market environment, indicates the likelihood of innovation in the market.

Generally determined by
- Market size/growth
- Competitive dynamics/ industry attractiveness
- Economics of opportunity/ business model attractiveness
- Competitive forces

Government levers
- Tax treatment (credit, subsidies, etc.)
- Antitrust policy
- Competitive policy
- Rate regulation
- Regulatory asymmetry
- Network element pricing

	Low —————————————————— Ability —————————————————— High
High Motivation	**Looking for a target** Firms constrained in accessing resources or reaching potential customers	**The Hotbed** Teeming with innovation
Low	**The Dilemma** No readily available avenues to create profitable businesses	**Looking for the money** Firms struggle to find ways to monetize an opportunity

Generally determined by
- Resource availability
- Standards
- Market access
- Industry developments

Government levers
- Resource-related regulation
- Unbundling
- Standards

9 Innovation Archetypes

after GE and Stone Yamashita Partners (2005)

In their collaboration with GE, Stone Yamashita Partners identified nine innovation "archetypes" that they felt were important in a team working toward innovation. They believe that different archetypes can work off of each others' ideas and together reach the goal of innovation. The archetypes cover a spectrum of skills, from idea generating and research to communication and roadblock-removal.

	Archetype	Description
1	The Generator	The generator of the idea that gets an innovation rolling.
2	The Iterator	An idea-engineer who takes the original idea and turns it into an innovation.
3	The Tech Guru	The harnesser of technology to turn the innovation into reality.
4	The Customer Anthropologist	The keen observer of what customers truly hunger for.
5	The Producer	The champion of flow. The master of moving ideas along.
6	The Visionary	The force behind creating the world as it could be—and should be.
7	The Communicator	Amplifies and clarifies the idea in the minds of others outside the team.
8	The Roadblock Remover	With a hammer—or with velvet gloves—knocks away organization, political, and financial roadblocks.
9	The Futurecaster	Forecaster and modeler of the economic and social value of the future innovation.

10 Faces of Innovation

after Tom Kelley of IDEO (2005)

Teams at IDEO, a design consultancy based in Palo Alto, strive to include a variety of individuals. Tom Kelley, general manager of IDEO, identified 10 "faces" that he says contribute to the IDEO innovation process. The 10 "faces" fall into categories of Learning, Organizing, and Building. Each individual has a set of skills that he or she brings to the team and furthers the IDEO design process.

Learning

1   The Anthropologist   Brings new learning and insights into the organization by observing human behavior and developing a deep understanding of how people interact physically and emotionally with products, services, and spaces.

2   The Experimenter   Prototypes new ideas continuously, learning by a process of enlightened trial and error.

3   The Cross-Pollinator   Explores other industries and cultures, then translates those findings and revelations to fit the unique needs of the enterprise.

Organizing

4   The Hurdler   Knows the path to innovation is strewn with obstacles and develops a knack for overcoming or outsmarting those roadblocks.

5   The Collaborator   Helps bring eclectic groups together, and often leads from the middle of the pack to create new combinations and multidisciplinary solutions.

6   The Director   Not only gathers together a talented cast and crew but also helps to spark their creative talents.

Building

7   The Experience Architect   Designs compelling experiences that go beyond mere functionality to connect at a deeper level with customers' latent or expressed needs.

8   The Set Designer   Creates a stage on which innovation team members can do their best work, transforming physical environments into powerful tools to influence behavior and attitude.

9   The Caregiver   Builds on the metaphor of a health care professional to deliver customer care in a manner that goes beyond mere service.

10   The Storyteller   Builds both internal morale and external awareness through compelling narratives that communicate a fundamental human value or reinforce a specific cultural trait.

What is innovated?

resets goals, reframes problems, revises points-of-view,
improves effectiveness (not focused on efficiency)

changing beliefs, processes, artifacts
Products, services, theories, cultural expressions (art)

All aspects of business: research, development, design, manufacturing, distribution and supply, legal, finance, even raw materials

7 Sources of Innovation

after Peter F. Drucker (1985)

Peter F. Drucker, a writer and thinker on issues related to management and entrepreneurship, wrote that sources of innovation come from either within enterprises or industries or outside of them. He said that an enterprise can be a business or a public-service institution. Opportunities for innovation can come from events, needs, or changes in demographics and knowledge base.

Systematic innovation requires monitoring seven sources for innovative opportunity.

Sources within the enterprise, whether business or public-service institution, or within an industry or service sector:

1 **The unexpected**—the unexpected success, the unexpected failure, the unexpected outside event
2 **The incongruity**—between reality as it actually is and reality as it is assumed to be or as it "ought to be"
3 Innovation based on **process need**
4 Changes in **industry and market structures** that catch everyone unawares

Sources that involve changes outside the enterprise or industry:

5 **Demographics** (population changes)
6 **Changes in perception**, mood, and meaning
7 **New knowledge**, both scientific and nonscientific

5 Innovation Patterns

after Goldenberg at al. (2003)

The innovation patterns of Goldenberg et al. manipulate existing components of a product and its immediate environment to come up with something ingenious and viable.

Similar to the way ideas can be recycled and reused, these innovation patterns add or subtract components of a product to create innovative objects.

1 **Attribute dependency**
The attribute dependency pattern alters or creates the dependent relationships between a product and its environment.

Examples
By creating a dependent relationship between lens color and external lighting conditions, eyeglass developers came up with a lens that changes color when exposed to sunlight.

2 **Division**
The division pattern divides an existing product into its component parts so that you can see something that was an integrated whole in an entirely different light.

The modern home stereo has modular speakers, tuners, and CD and tape players, which allow users to customize their sound systems.

3 **Multiplication**
The multiplication pattern makes one or more copies of an existing component, then alters those copies in some important way.

The Gillette double-bladed razor features a second blade that cuts whiskers at a slightly different angle.

4 **Subtraction**
The subtraction pattern works by removing product components, particularly those that seem desirable or indispensable.

A highchair attaches to a kitchen table as a legless incarnation of the original model.

5 **Task unification**
The task unification pattern assigns a new task to an existing product element or environmental attribute, thereby unifying two tasks in a single component.

The defrosting filament in an automobile windshield also serves as a radio antenna.
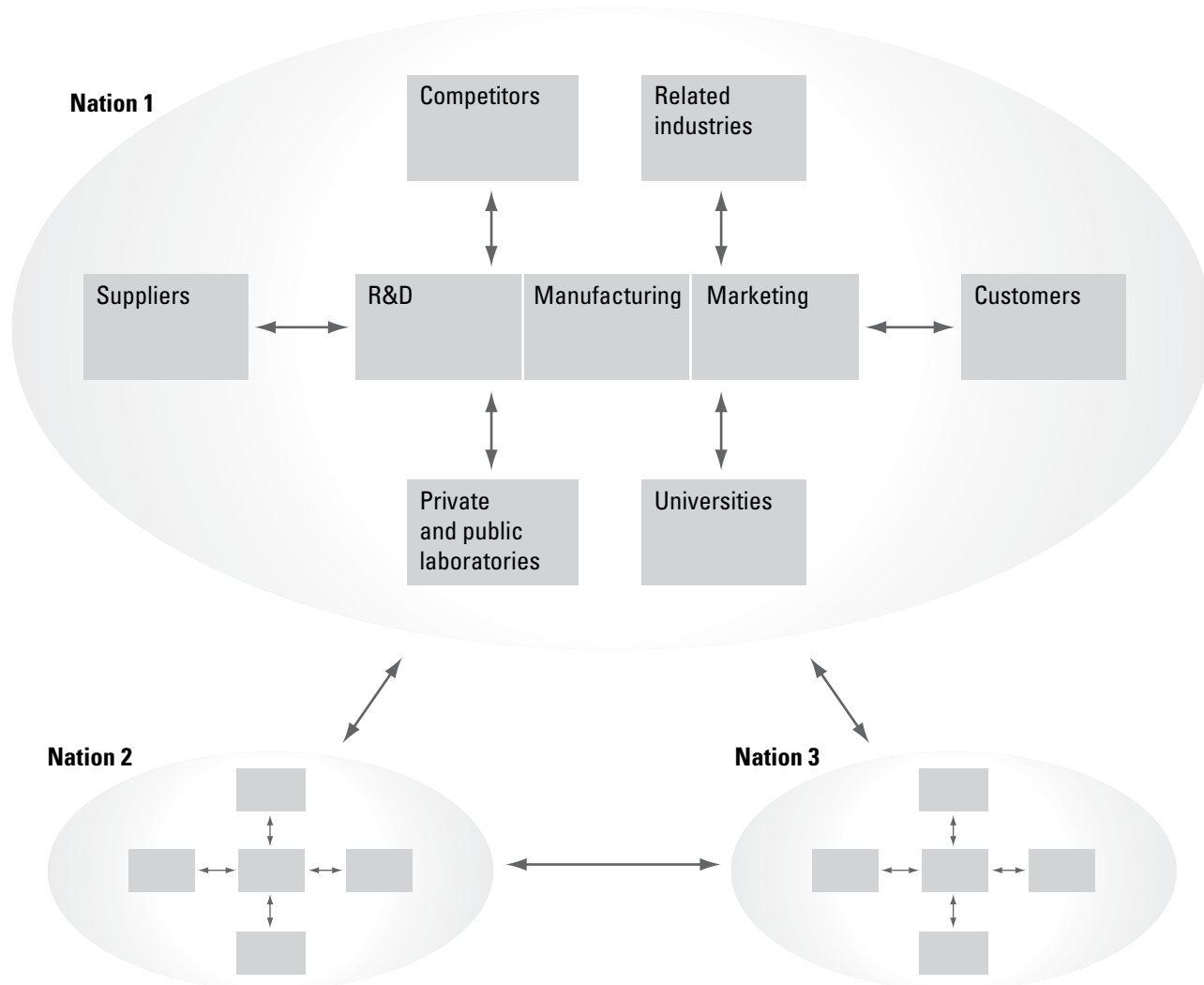
Functional Sources of Innovation

after Eric von Hippel (1988)

Functional sources answer the question of where innovations come from: Do they come from within the firm or from outside the firm? If from within, where exactly within the firm? Functional sources of innovation given by von Hippel include 1) a firm's own internal value chain functions;

2) its external value-added chain of suppliers, customers, and complementary innovators; 3) university, government, and private laboratories; 4) competitors and related industries; and 5) other nations or regions.

Environmental factors
Technological change
Regulation/deregulation
Customer expectations
Social/demographic
Political/legal
Globalization

Nation 1

Competitors

Related industries

Suppliers

R&D Manufacturing Marketing

Customers

Private and public laboratories
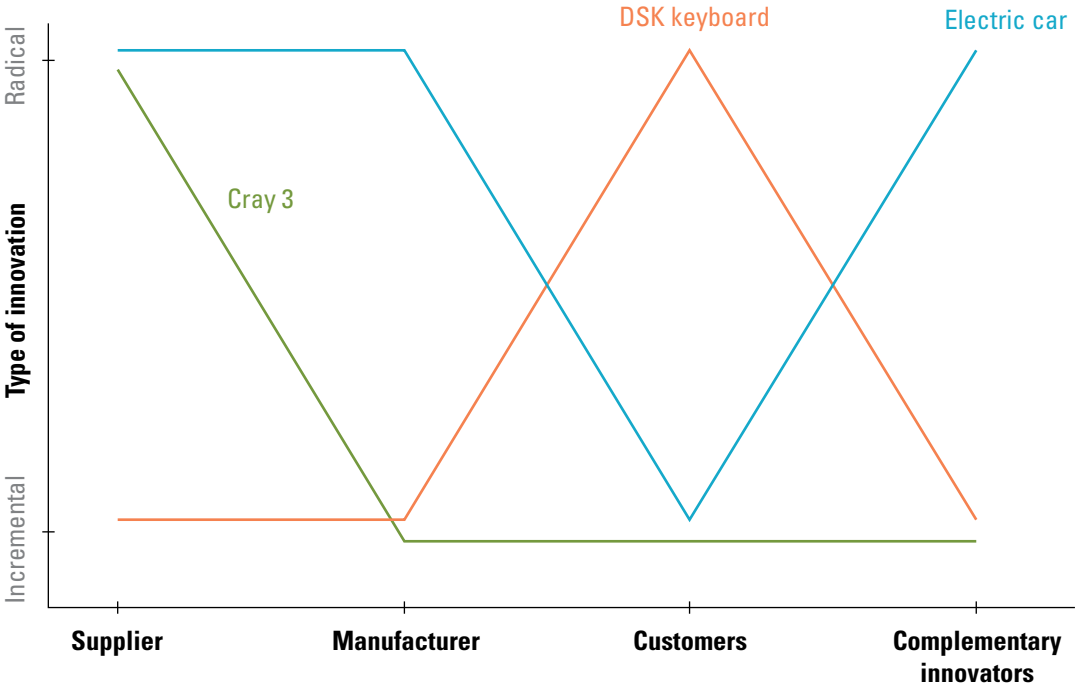
Universities

Nation 2

Nation 3

Value-Added Chain

after Allan Afuah (2002)

An innovation "has implications not only for the firm but also for its suppliers, customers, and complementary innovators." Afuah models the value-added chain using several examples, tracking the innovation (incremental to radical) that is added by each market player.

Model of Innovation

after Gary Hamel (2000)

According to Gary Hamel, founder of the consulting firm Strategos, the unit of analysis for innovation is a business concept. He emphasized the building of a business model around a new idea in order to yield measurable results. The model below shows the components of a business model, including core strategy and strategic resources. Hamel stated that, for an organization to be innovative, its members must set high expectations, be open to new ideas, and work for a cause that reaches beyond a simple business goal.

Business Concept / Model Components:

	Customer Benefits		Configuration of Activities		Company Boundaries

Customer Interface		*Core Strategy*		*Strategic Resources*		*Value Network*
Fulfillment & Support		Business Mission		Core Competencies		Suppliers
Information & Insight		Product / Market Scope		Strategic Assets		Partners
Relationship Dynamics		Basis for Differentiation		Core Processes		Coalitions
Pricing Structure						

Wealth Potential:

Efficient	*Unique*	*Fit*	*Profit Boosters*
			Increasing Returns
			- Network Effects
			- Positive Feedback Effects
			- Learning Effects
			Competitor Lock-out
			- Preemption
			- Choke Points
			- Customer Lock-in
			Strategic Economies
			- Scale
			- Focus
			- Scope
			Strategic Flexibility
			- Portfolio Breadth
			- Operating Agility
			- Lower Breakeven

Strategic Innovation Process Model

after Allan Afuah (2002)

In order to achieve its goals, a firm, according to Afuah, scans its environment and other sources of innovation for opportunities and threats to exploit. After analysis of its ability to exploit those opportunities and threats, the firm devises business and innovation strategies that drive the firm toward its goals.
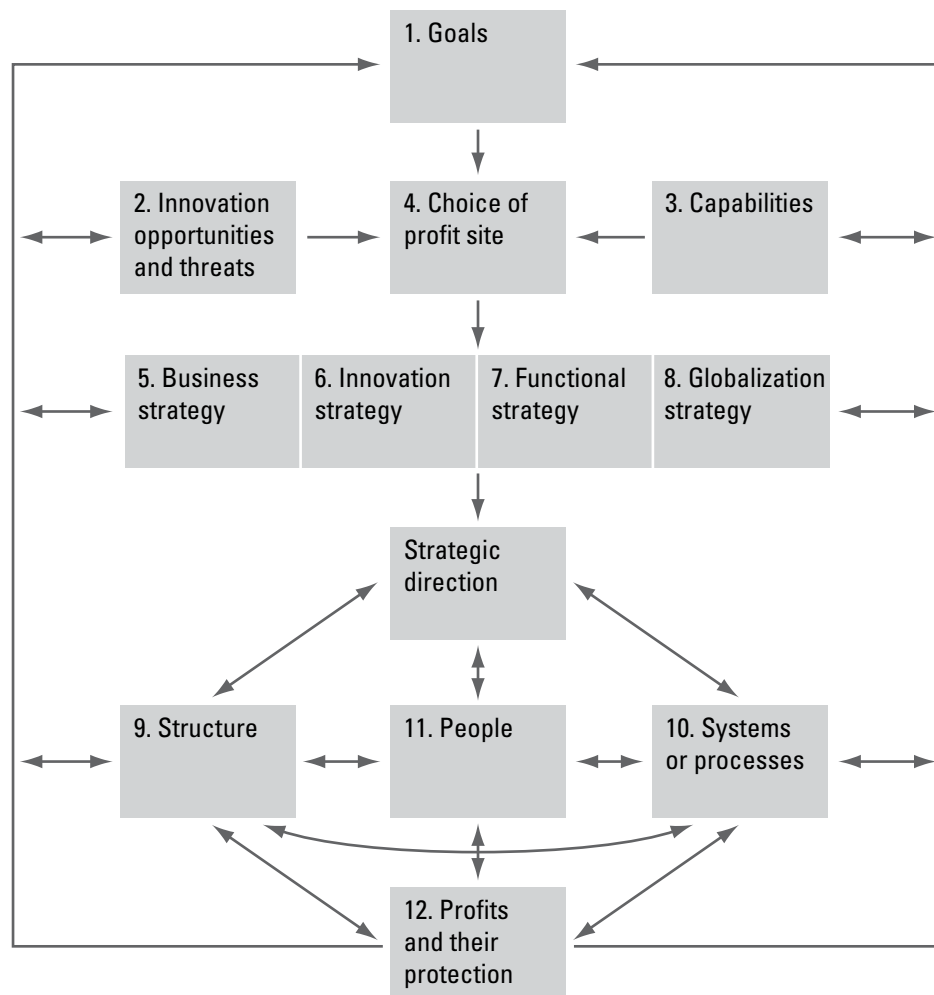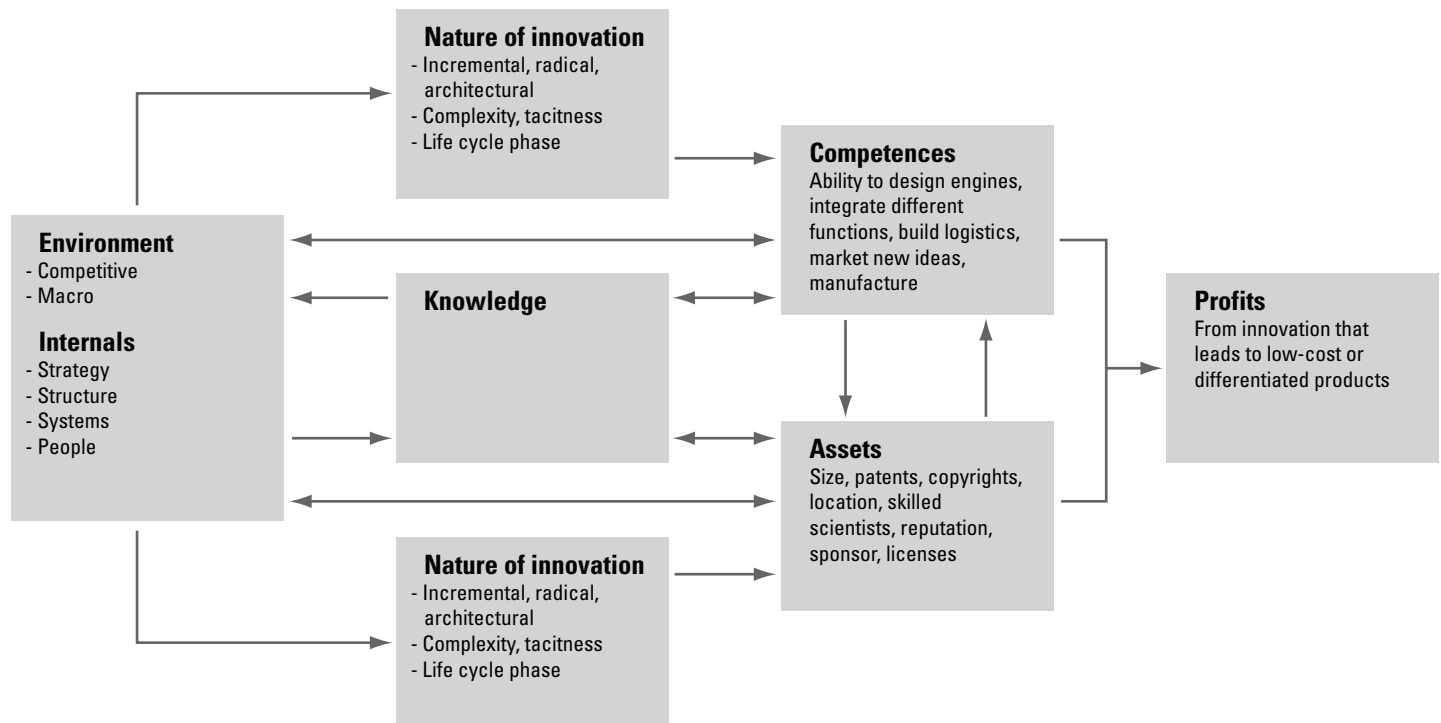
Profit Chain

after Allan Afuah (2002)

The profit chain model shows how a firm uses new knowledge to offer new products or services at a lower cost than its competitors, or to offer differentiated products at premium prices that more than compensate for the extra cost of differentiation. A firm relies on its capabilities to use the available knowledge for productive purposes.
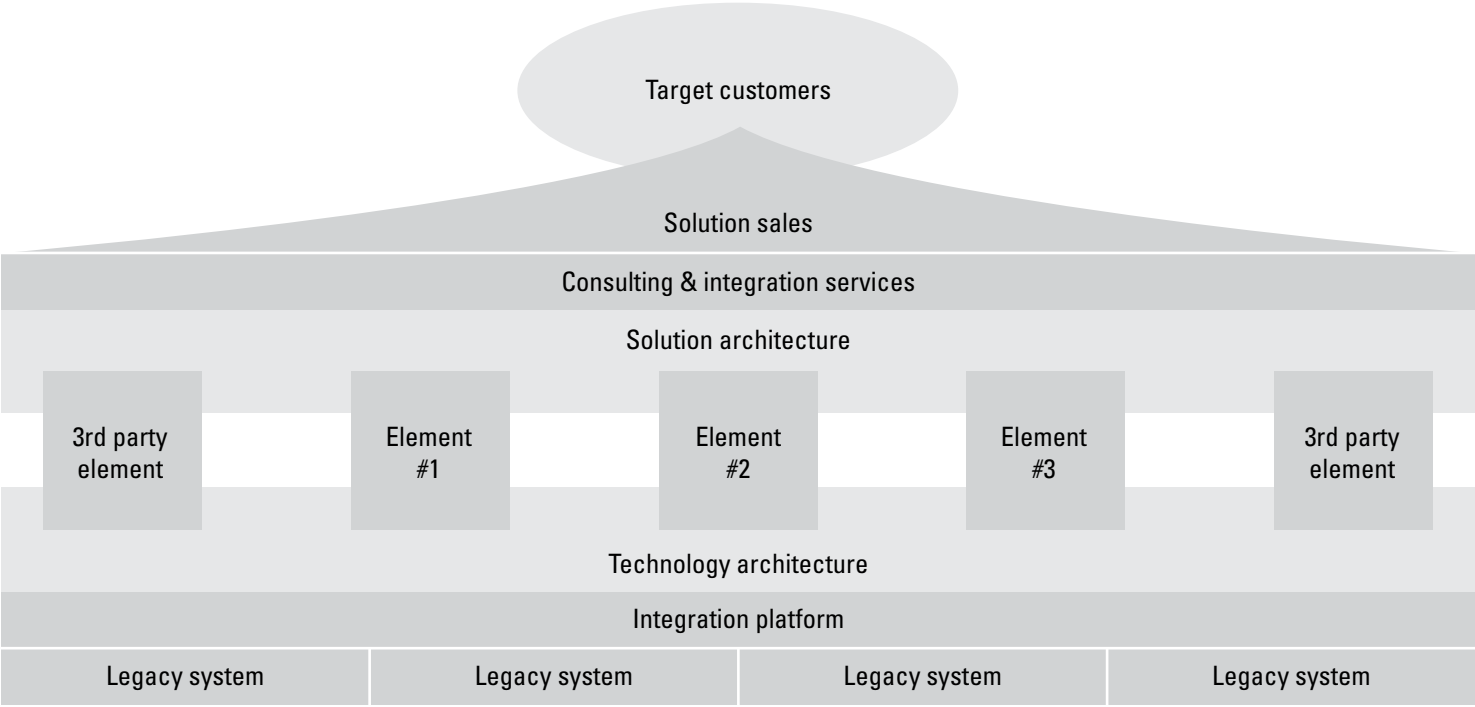
Nature of innovation
- Incremental, radical, architectural
- Complexity, tacitness
- Life cycle phase

Environment
- Competitive
- Macro

Internals
- Strategy
- Structure
- Systems
- People

Knowledge

Competences
Ability to design engines, integrate different functions, build logistics, market new ideas, manufacture

Assets
Size, patents, copyrights, location, skilled scientists, reputation, sponsor, licenses

Nature of innovation
- Incremental, radical, architectural
- Complexity, tacitness
- Life cycle phase

Profits
From innovation that leads to low-cost or differentiated products

Complex-Systems Model

after Geoffrey A. Moore (2005)

In Moore's Complex-Systems Model, vendors seek to grow their customer base, with no more than a handful of transactions per customer per year, but with a very high average transaction price. It is organized around a small number of target customers making large but infrequent purchases.

Firms provide consulting and integration services and align their offerings to a given market segment's needs. Businesses with the Complex-Systems Model include Boeing, Goldman Sachs, and IBM.

Target customers

Solution sales

Consulting & integration services

Solution architecture

| 3rd party element | Element #1 | Element #2 | Element #3 | 3rd party element |

Technology architecture

Integration platform

| Legacy system | Legacy system | Legacy system | Legacy system |

Volume-Operations Model

after Geoffrey A. Moore (2005)

In Moore's Volume-Operations Model, vendors seek to enlarge their customer base, with consumers carrying out many transactions per year at an average price of a few dollars per transaction. Customers are not the focal point in the Volume-Operations Model. The focus is the means of production that can generate differentiated offerings of high volumes at low cost. Businesses of this type include Dell, Nike, and Verizon.

Brand Advertising

Customers

Customers

Customers

Customers

Customers

Customers

Offer

Offer

Offer

Offer

Technology

Offer

Offer

Offer

Offer

Shared infrastructure

Distribution channel

Promotions
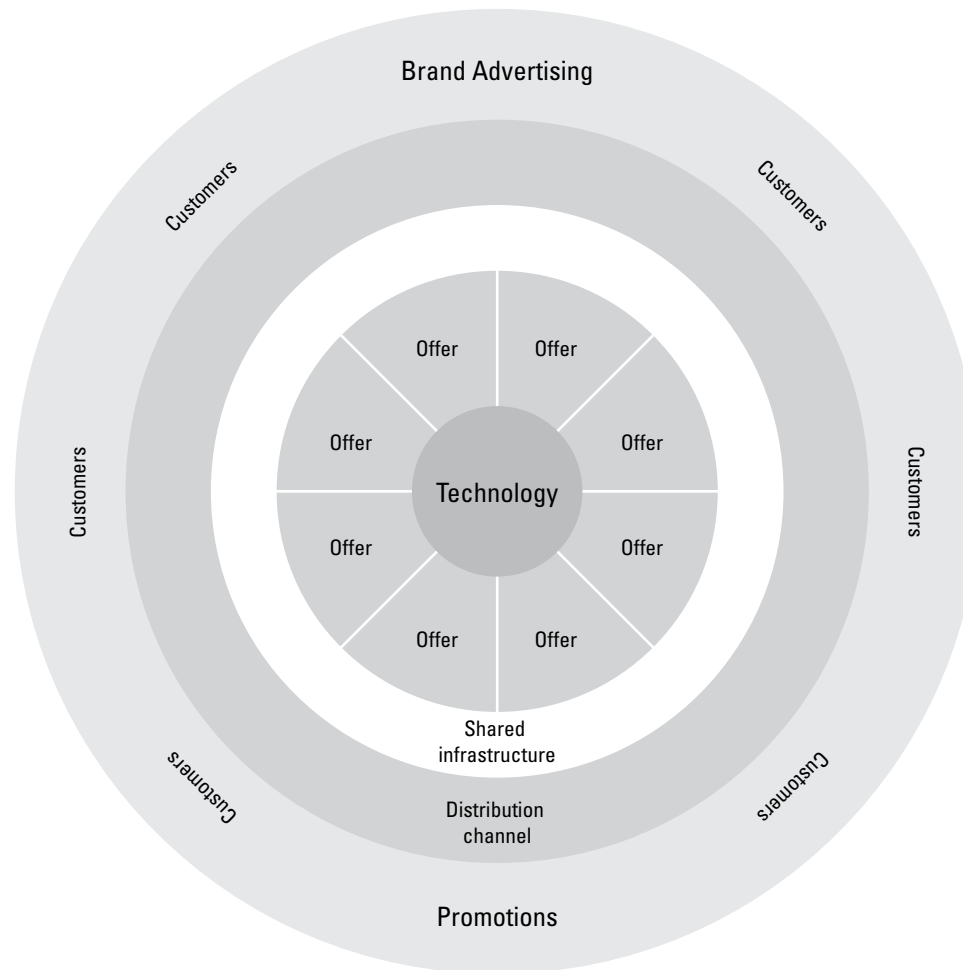
Innovation as Invention Widely Distributed

after Chris Conley (2006)

Chris Conley, Associate Professor at Illinois Institute of Technology's Institute of Design, laid out innovation in a matrix bordered by "Quality of invention" and "Extent of diffusion." Quality of invention and extent of diffusion are not necessarily measured in discrete units. In addition,

there are inventions of poor quality that are widely adopted, as well as inventions of good quality that are not widely adopted. To be considered an innovation, an invention must be of good quality and have a wide extent of diffusion.

	Narrow — Extent of diffusion — **Wide**	
Good	A good idea, but not widely adopted, e.g., the wheel in pre-Columbian Mesoamerica	Innovation: A good idea, widely adopted, e.g., perspective, electric lighting
Poor	A poor idea that never went anywhere, e.g., Tesla's notion of transmitting electricity through the air	A poor idea widely adopted, e.g., arguably VHS was lower quality than Betamax; Lysenko's promotion of vernalization (chilling seeds) in Soviet agriculture

Quality of invention

10 Types of Innovation

after Vijay Kumar of Doblin Group

The Doblin Group established 10 types of innovation that each falls into one of four categories: finance, process, offering, and delivery. Each category focuses on a different aspect of the business: increasing revenue, supporting existing and new processes, designing offerings, and improving interactions with consumers.

Finance

1   Business model—
How you make money

Dell revolutionized the personal computer business model by collecting money before the consumer's PC was even assembled and shipped (resulting in net positive working capital of seven to eight days).

2   Networks and alliances—
How you join forces with other companies for mutual benefit

Consumer goods company Sara Lee realized that its core competencies were in consumer insight, brand management, marketing, and distribution. Thus it divested itself of a majority of its manufacturing operations and formed alliances with manufacturing and supply chain partners.

Process

3   Enabling process—
How you support the company's core processes and workers

Starbucks can deliver its profitable store/coffee experience to customers because it offers better-than-market compensation and employment benefits to its store workers—usually part-time, educated, professional, and responsive people.

4   Core processes—
How you create and add value to your offerings

Wal-Mart continues to grow profitably through core process innovations such as real-time inventory management systems, aggressive volume/pricing/delivery contracts with merchandise providers, and systems that give store managers the ability to identify changing buyer behaviors and respond quickly with new pricing and merchandising configurations.

Offerings

5   Product performance—
How you design your core
offerings

The VW Beetle (in both its original and its newest form) took the market by storm,
combining multiple dimensions of product performance.

6   Product system—
How you link and/or
provide a platform for
multiple products

Microsoft Office bundles a variety of specific products (Word, Excel, PowerPoint, etc.) into
a system designed to deliver productivity in the workplace.

7   Service—
How you provide value to
customers and consumers
beyond and around your
products

An international flight on any airlines will get you to your intended designation. A flight on
Singapore Airlines, however, nearly makes you forget that you are flying at all, with the
most attentive, respectful, and pampering pre-flight, in-flight and post-flight services you
can imagine.

Delivery

8   Channel—
How you get your
offerings to market

Legal problems aside, Martha Stewart has developed such a deep understanding of her
customers that she knows just where to be (stores, TV shows, magazines, online, etc.)
to drive huge sales volumes from a relatively small set of "home living" educational and
product offerings.

9   Brand—
How you communicate
your offerings

Absolut conquered the vodka category on the strength of a brilliant "theme and variations"
advertising concept, strong bottle and packaging design, and a whiff of Nordic authenticity.

10   Customer experience—
How your customers feel
when they interact with
your company and its
offerings

Harley Davidson has created a worldwide community of millions of customers, many
of whom would describe "being a Harley Davidson owner" as a part of how they
fundamentally see, think, and feel about themselves.

When does innovation arise?

at anytime (change brings more change)
Throughout the life of a community or organization
Throughout the life of a discipline (an art or science)

Before a market exists, when a market is young, when a market is mature, when a market is in decline

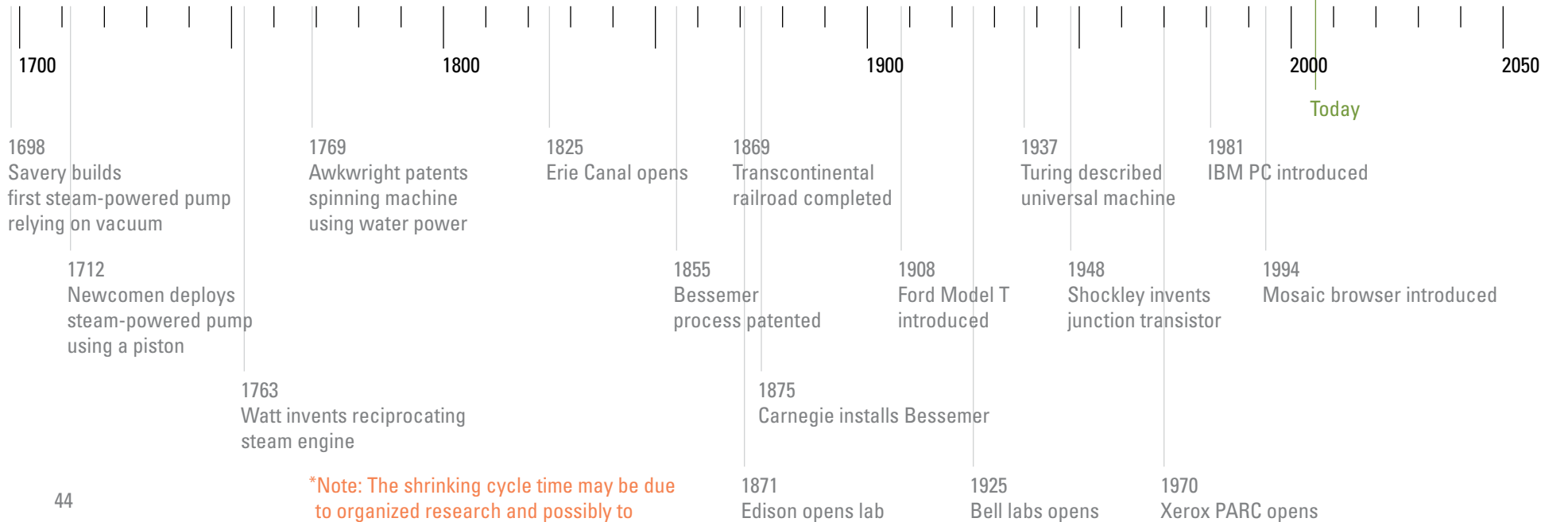# Technology Development Eras

after Joseph Schumpeter

Austrian economist Joseph Schumpeter described technological developments in terms of "waves of innovation," where each wave brings the beginning and end of a new economy. The model suggests we consider the following: 1) how new technologies replace older ones and how we represent that phenomenon; 2) the large-scale technological trends that define social, business, and technology history; 3) what the next big trend might be, given that it has probably already begun even if we have not identified it; and 4) the time that passes between the invention of a technology and its widespread application.

1
1780–1840
First industrial revolution
- iron making
- cotton spinning
- water power
- steam power

2
1840–1900
Second
- steel making
- railroads

3
1900–1950
Third
- electrification
- internal combustion

4
1940–1980
Fourth
- petrochemicals
- plastics
- electronics
- computing

5
1980–2020
Fifth
- personal computers
- internet

6
What comes next?

Time between peaks almost 60 years

shrinks to about 40 years*

1700

1800

1900

2000

2050

Today

1698
Savery builds
first steam-powered pump
relying on vacuum

1712
Newcomen deploys
steam-powered pump
using a piston

1763
Watt invents reciprocating
steam engine

1769
Awkwright patents
spinning machine
using water power

1825
Erie Canal opens

1855
Bessemer
process patented

1871
Edison opens lab

1869
Transcontinental
railroad completed

1875
Carnegie installs Bessemer

1908
Ford Model T
introduced

1925
Bell labs opens

1937
Turing described
universal machine

1948
Shockley invents
junction transistor

1970
Xerox PARC opens

1981
IBM PC introduced

1994
Mosaic browser introduced

*Note: The shrinking cycle time may be due
to organized research and possibly to
one or more "network effects."

44

Utterback-Abernathy Model

after Abernathy and Utterback (1978)

William Abernathy and James Utterback proposed that successful organizations invest heavily in product R&D early in the product maturing period and shift investment to process technology as time passes. As the dominant design of a new product emerges, organizations focus on minimizing cost rather than varying product features. In their model the rate of innovation is high for product innovation in the beginning of product maturity and gradually declines, while the rate of process innovation increases midway into product maturity.

Rate of Innovation (y-axis)

Process Innovation

Product Innovation

Time or Product Maturity
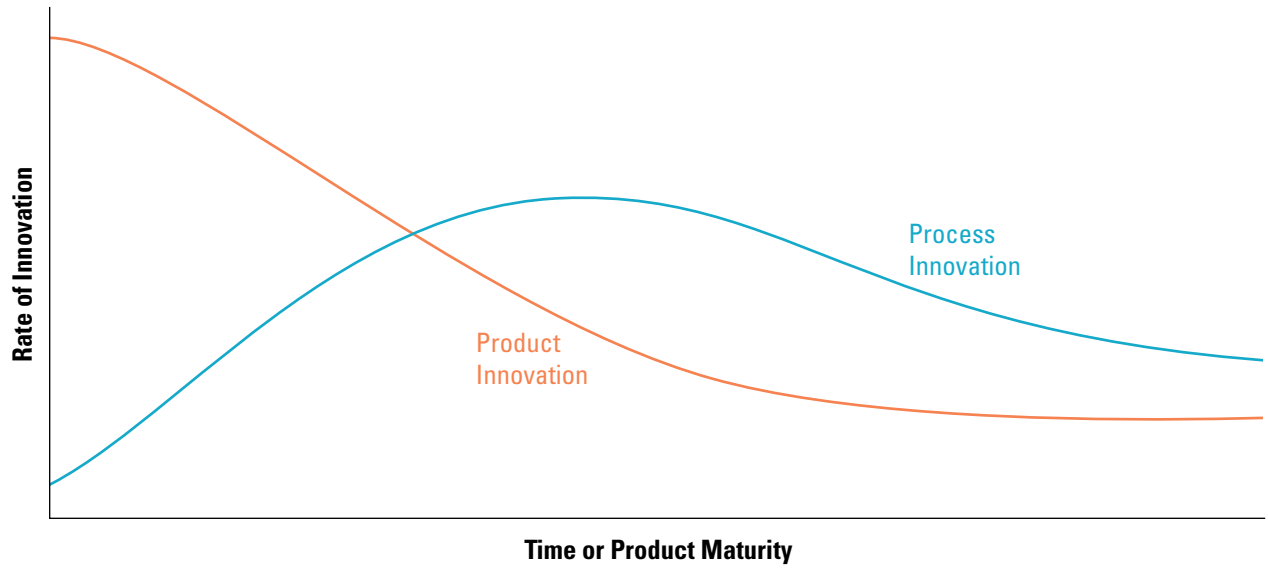
Competitive emphasis on	**Fluid pattern** Functional product performance	**Transitional pattern** Product variation	**Specific pattern** Cost reduction
Innovation stimulated by	Information on users' needs and users' technical inputs	Opportunities created by expanding internal technical capability	Pressure to reduce cost and improve quality
Predominant type of innovation	Frequent major changes in products	Major process changes required by raising volume	Incremental changes with cumulative improvement in productivity and quality

Eras of Technological Innovation

after Institute for the Future (2005)

The IFTF developed a framework relating innovations and the societal trends that result from them. The framework separates roughly the last 20 years into three eras of innovation, each of which occurs when "a technology begins to influence and change society in a fundamental way."
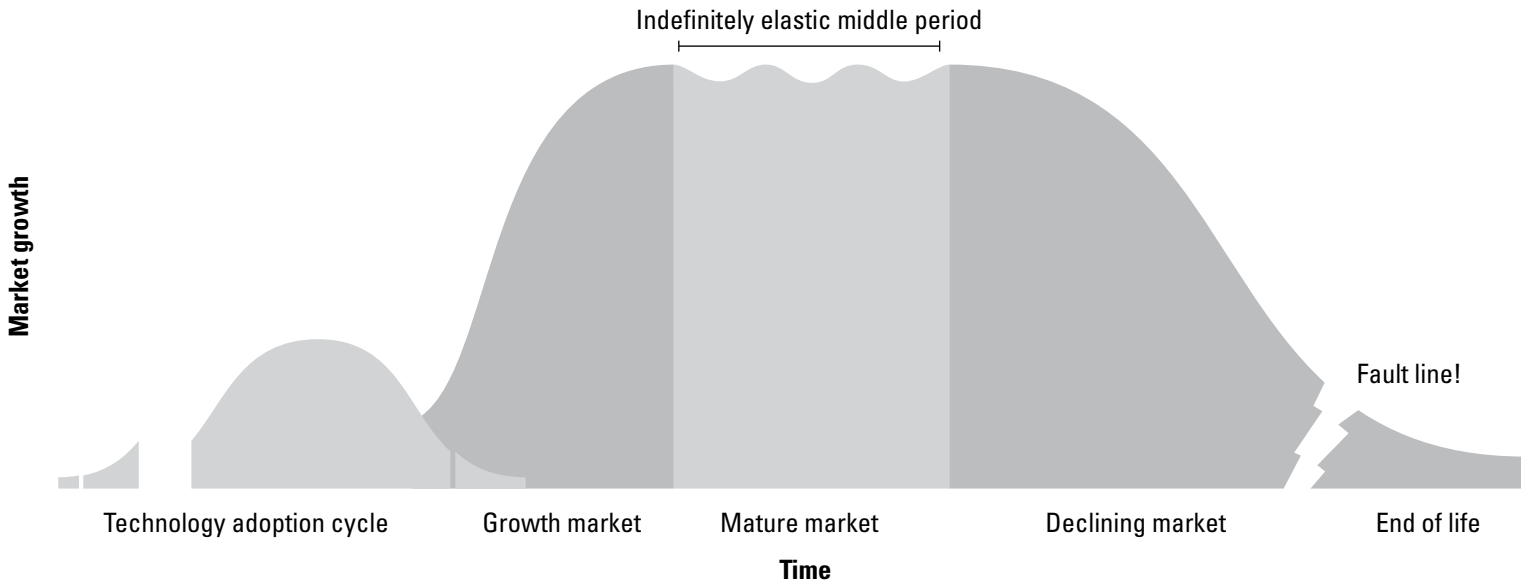
sensing
awareness,
perception,
attention

communications
connectivity,
access

computing
processing,
transforming

1980s   1990s   2000s   2010s
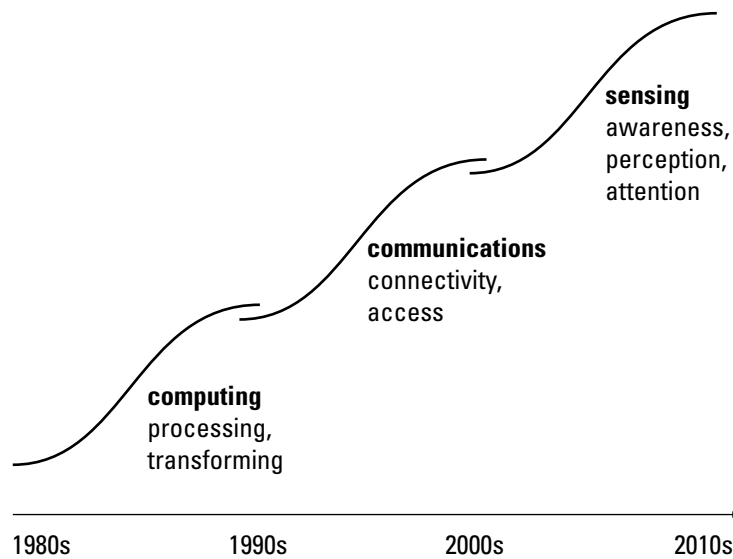
Category-Maturity Life Cycle

after Geoffrey A. Moore (2005)

The Category-Maturity Life Cycle encompasses a market from the time a technology is adopted to the time it meets its "end of life." It begins with the Technology Adoption Life Cycle, continues to the Growth Market where it experiences rapid growth, proceeds through the Mature Market phase of indefinite length, and passes through a Declining Market into End of Life. According to Moore, this last phase is the "classic time to take a company private" or to merge with other firms to take advantage of emerging opportunities.

Indefinitely elastic middle period

Market growth

Fault line!

Technology adoption cycle   Growth market   Mature market   Declining market   End of life

Time

Technology-Adoption Life Cycle

after Geoffrey A. Moore (2005)

At the beginning of the Category-Maturity Life Cycle, a technology must go through the Adoption Life Cycle. The metaphors that Moore uses represent each phase: Early Market describes the period when the disruptive technology is new and is being explored; the Chasm represents the period when it has lost its novelty but has not yet been fully accepted; after the Chasm is crossed, the Life Cycle enters the Bowling Alley phase, where one by one, like pins in a bowling alley, niches begin adopting the technology; then, like a Tornado, the new technology takes the main market by storm, until finally it becomes a commonly used and adopted technology and situates itself along Main Street of technology.

Main street

Tornado

Chasm

Early market

Bowling alley
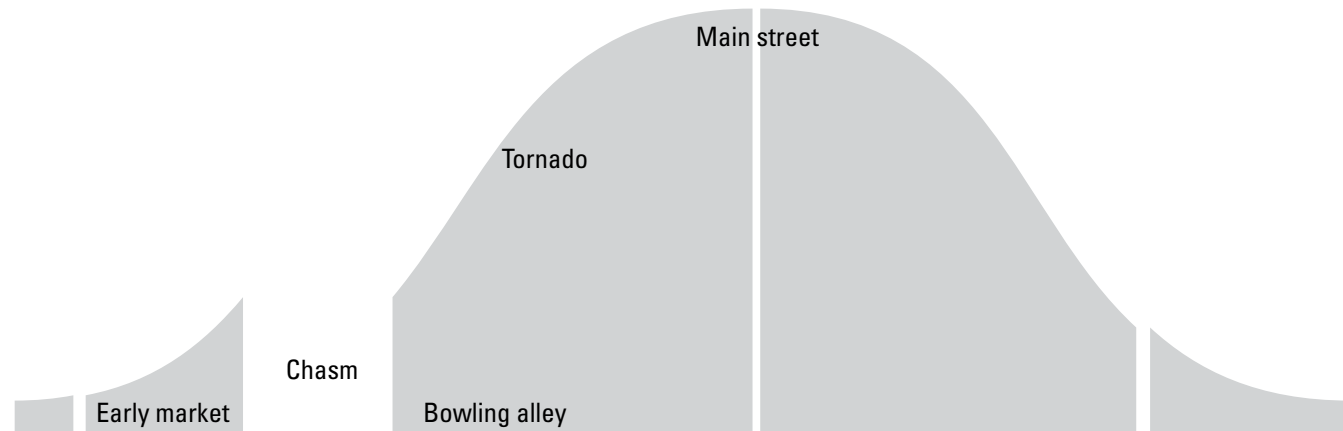
Underlying Drivers in Growth Markets

after Geoffrey A. Moore (2005)

Consumers respond differently to new technology. Moore divides those responses into five types, ranging from the Techies with their "Just try it!" attitude to the Skeptics with their motto of "Just say no!" Each category and technology represents a new opportunity for consumers to respond differently from a previous technology.

Techies:
Just try it!

Visionaries:
Get ahead
of the herd!

Pragmatists:
Stick with the herd!

Conservatives:
Stick with
what's proven!

Skeptics:
Just say no!
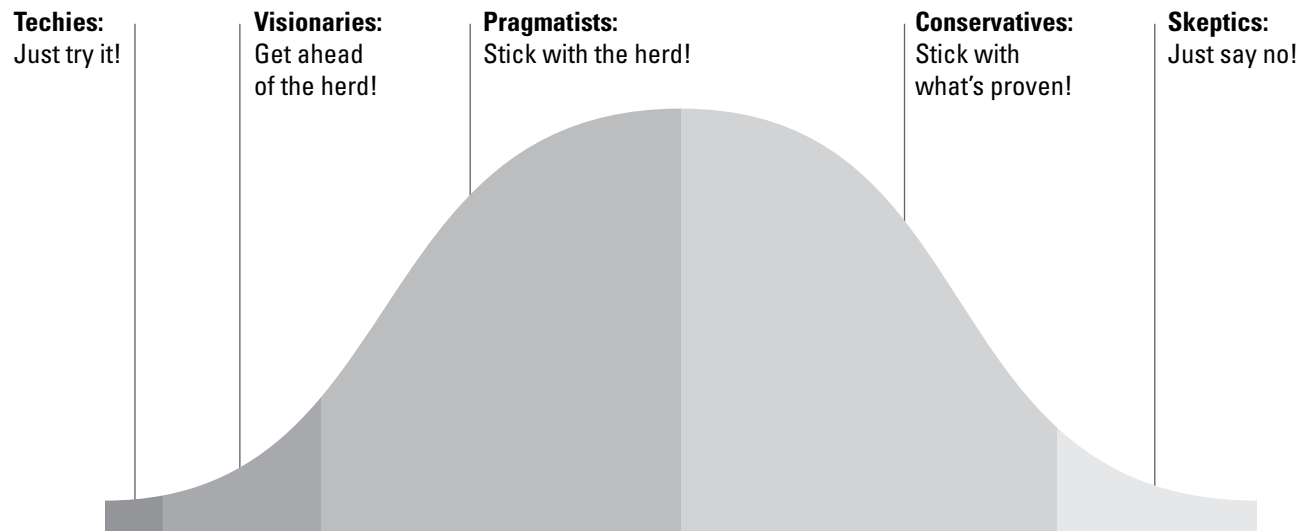
14 Types of Innovation

after Geoffrey A. Moore (2005)

While disruptive innovation is the most immediately re-called type of innovation, Moore argues that there are more types of innovation that occur along the category-maturity life cycle. He divides the category life cycle into four zones: product leadership zone, customer intimacy zone, operational excellence zone, and category renewal zone. Each zone offers opportunities for firms to innovate based on the maturity stage of their technology.

Product leadership zone

1 Disruptive — Creates new market categories based on a discontinuous technology change or a disruptive business model. — Oracle created a portable database that ran on many different computers and offered easy reporting.

2 Application — Develops new markets for existing products by finding unexploited uses for them, often by combining them in novel ways. — An entrepreneur took World War II synthetic rubber to market as a toy called Silly Putty.

3 Product — Focuses on existing markets for existing products, differentiating through features and function that current offers do not have. — Applied Materials introduced a multi-chamber semiconductor manufacturing device that integrated multiple steps of water fabrication within a single environment.

4 Platform — Interposes a simplifying layer to mask an underlying legacy of complexity and complication, thereby freeing a next generation of offers to focus on new value propositions. — Sony's video game machines provide a platform for independent developers.

Customer intimacy

5 Line-extension — Makes structural modifications to an established offer to create a distinctive subcategory. — Tylenol branched out from pain killers to products for allergy and sinus, cold, arthritis, and other ailments.

6 Enhancement — Continues the trajectory begun by line extensions, driving innovation into finer elements of detail, getting closer to the surface of the offer with less impact on the underlying infrastructure. — Kimberly Clark and Procter & Gamble have dominated the disposable diaper categories by adding to their products tape, Z fold, and elastic to increase convenience.

7 Marketing — Focuses on differentiating the interaction with a prospective customer during the purchase process. — Avon developed a sales channel with their "Avon calling" campaign in the 1950s.

8 Experiential — Bases value not on differentiating the functionality but rather the experience of the offering. — Cirque du Soleil redefined the notion of circus with its visual and philosophical productions.

Operational excellence

9   Value-engineering

Extracts cost from the materials and manufacturing of an established offer without changing its external properties.

Southwest built a fleet with a single standard plane, simplified pricing and seat selection, and focused on point-to-point round-trip itineraries to reduce costs.

10   Integration

Reduces the customer's cost of maintaining a complex operation by integrating its many disparate elements into a single centrally managed system.

LEGOS sold its plastic bricks at a premium by marketing them in kits that integrated into toys.

11   Process

Focuses on improving profit margins by extracting waste not from the offer itself but from the enabling processes that produce it.

McDonald's engineers every process, from procuring and cooking to hiring, training, and terminating.

Category renewal

12   Value-migration

Redirects the business model away from a commoditizing element in the market's value chain toward one richer in margins.

Wal-Mart migrated power from branded consumer goods to high-volume discount retailer. It reduced costs with industry-standard bar codes and RFID-enabled inventory tracking.

13   Organic

Uses internal resources to reposition itself into a growth category.

Nokia, formerly of paper and pulp products, rubber manufacturing, and cable, entered the electronics sector with coaxial cable for computer networks.

14   Acquisition

Solves problem of category renewal externally through merger and acquisition.

Gateway acquired eMachines, the low-cost leader in retail PCs, and allowed their management to control the company and improve its operating efficiency.

Core-Concept Analysis Framework

after Geoffrey A. Moore (2005)

Moore's core-context analysis framework analyzes how resources should be allocated between core development and context development. While the core is the essence of a firm that helps it distinguish itself from its competitors, the context is the aspect that brings in revenue. Therefore funneling resources from context development to core development to create differentiation presents a risk for a firm. Moore believes that innovation is most likely to occur when resources are allocated to core development while still maintaining competitive differentiation.

	Core Process creates differentiation that wins customers	**Context** All other processes
Mission-Critical Process shortfall creates serious and immediate risk	Processes which create a distinct competitive advantage and carry the greatest risk and reward, e.g., next generation product line, new marketing campaign, entering new market	Processes which are critical to success, but do not differentiate a company from its competitors, e.g., financial transactions, employment agreements, computer security
Non-Mission-Critial All other processes	Processes which focus on the core offering, but are contained to minimize risk, e.g., R&D, pilot projects, laboratory experiments	Processes which no longer require intensive management, and can be offloaded or outsourced, e.g., quality control, statistical process control, and service-level agreements

Risk

Differentiation

Cycle of Innovation

after Geoffrey A. Moore (2005)

The Cycle of Innovation follows the flow of resources from beginning and maturation to decline of an innovation. According to Moore, innovation begins in the non-mission-critical quadrant of the core development half of the framework. Once the innovation is ready for deployment, more resources are poured in to bring it to market.

As the innovation matures, resources shift to maintaining differentiation of the technology by improving the development process. The last phase of the cycle, before beginning anew, is that of repurposing resources for the generation of another innovation.

	Core	**Context**
Mission-Critical	**Deploy** differentiation at scale	**Manage** mission-critical processes at scale
Non-Mission-Critial	**Invent** differentiated offering	**Extract** resources to repurpose for core

Fund next innovation
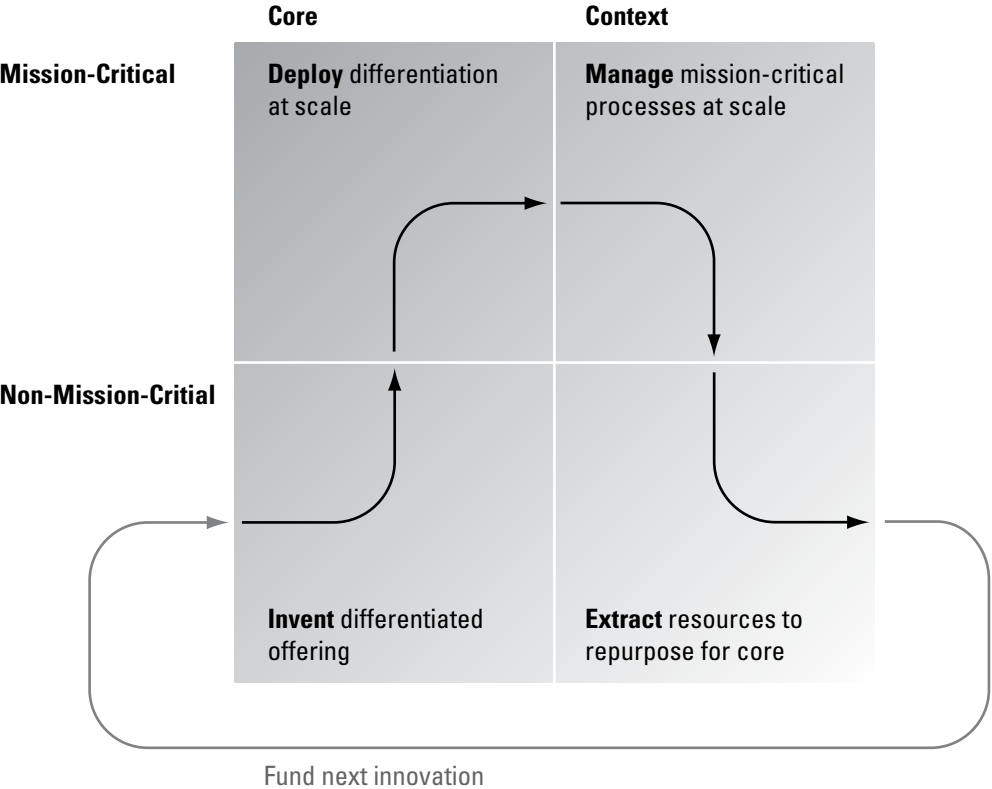
Lead User Curve

after von Hippel et al. (1999)

The Lead User Curve maps market trends as the change in the number of people who use a particular product over time. When there is a need for a product, lead users create solutions. As time passes, commercial products of those solutions become available, and early adopters begin to feel the same need for the product. This increases the number of people who need and adopt the product. As more time passes the routine users also come to need and adopt those products, causing the market trend to stabilize.
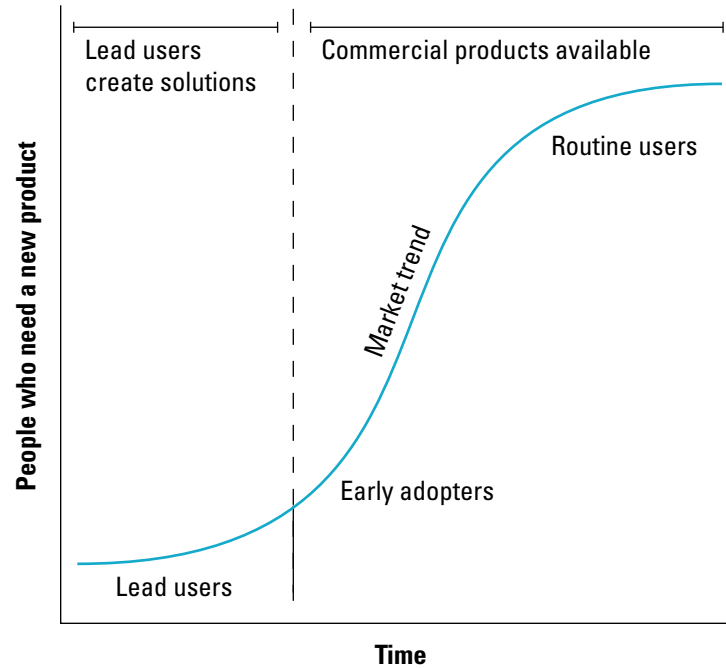
S-Curve

after Richard N. Foster (1986)

Richard N. Foster was a director at McKinsey & Company management consulting firm when he published his theory on the S-curve. The S-curve shows the relationship between the amount of effort put into improving a product or process and the results one gets back from that investment.

The technological progress starts at infancy, proceeds through a period of explosive return on investment, and then gradually enters maturation by tapering off to a stable level of performance.

Performance (vertical axis) / Effort (funds) (horizontal axis)
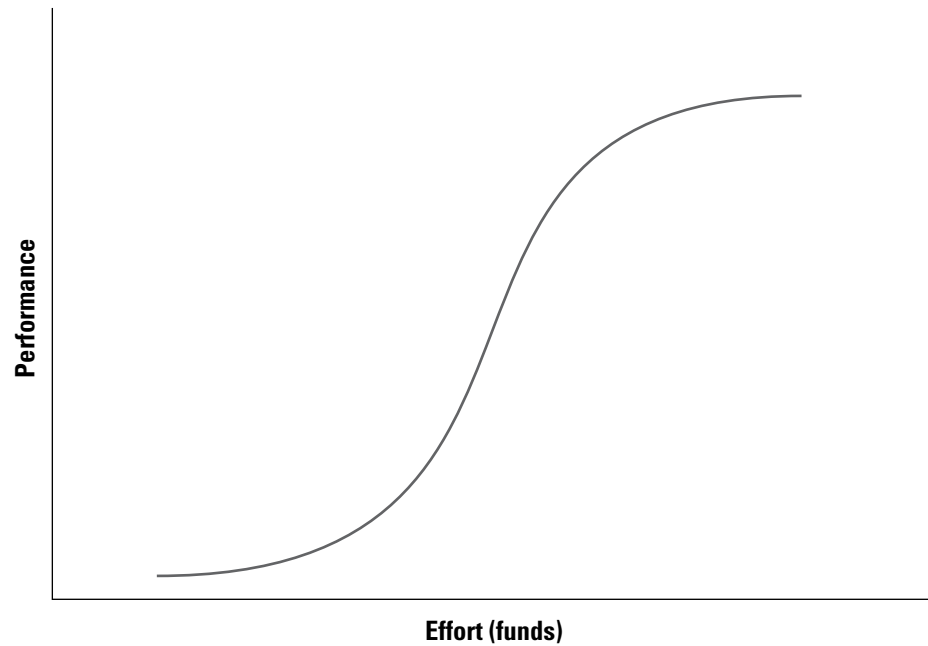
Where does innovation occur?

within a community (not alone)

An organization, a discipline, a business, a market, a polis (at all levels)

in a value system (with its deterrents and rewards and tolerance for risk)

in a mythos (e.g., the myth of progress)

in a language (e.g., English, the argot of engineers, the patois of IBM, the slang of surfers)

3 Levels of Innovation

after Parrish Hanna (2006)

A user experience designer who has worked for IBM and has consulted with Samsung, Parrish Hanna developed a tri-level model of innovation. He said that companies "achieve tactical product innovation, [foster] strategic (game-changing) innovation, and build a culture to nurture and sustain innovation." The model outlines the contexts in which organizations innovate.

culture to nurture, sustain innovation

strategic (game-changing) innovation

tactical product innovation
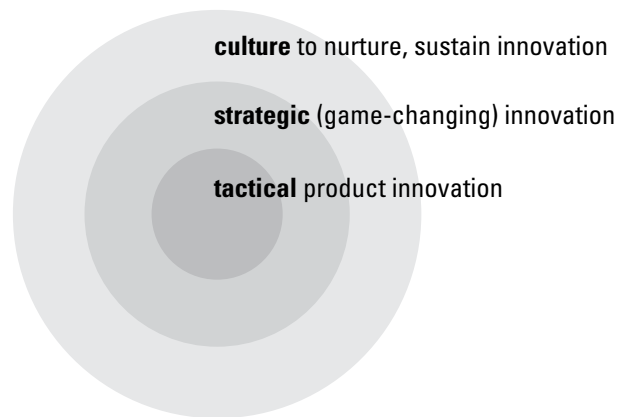
Innovation Types

after Govindarajan and Trimble (2005)

Govindarajan and Trimble define four types of innovation, all of which differ in the expense of a single experiment, the length of each experiment, and the ambiguity of results. The differences between the innovation types influence such issues as who should lead or participate in an innovation, how much resources to allocate, how to assess progress, and when to end the development process.

Innovation type	Expense of single experiment	Length of each experiment	Ambiguity of results
Continuous process improvement	Smallest	Shortest (could be days)	Clearest
Process revolution			
Product/service innovation			
Strategic innovation	Largest	Longest (could be years)	Most ambiguous

3 Orders of Creativity

after Michael Geoghegan (2002)

In his conversation with Paul Pangaro about language and the ability of organizations to change and regenerate, Michael Geoghegan delineated three orders of creativity: invention, discovery, and efficiency. In the invention phase, change arises out of new language and resources that are used to recognize invention. In the discovery phase, change results from finding new ways to create value in the form of products and services. In the efficiency phase, change comes from developing more efficient ways to make those new products and services.

Recognising invention

Profiting from discovery

Developing efficiencies
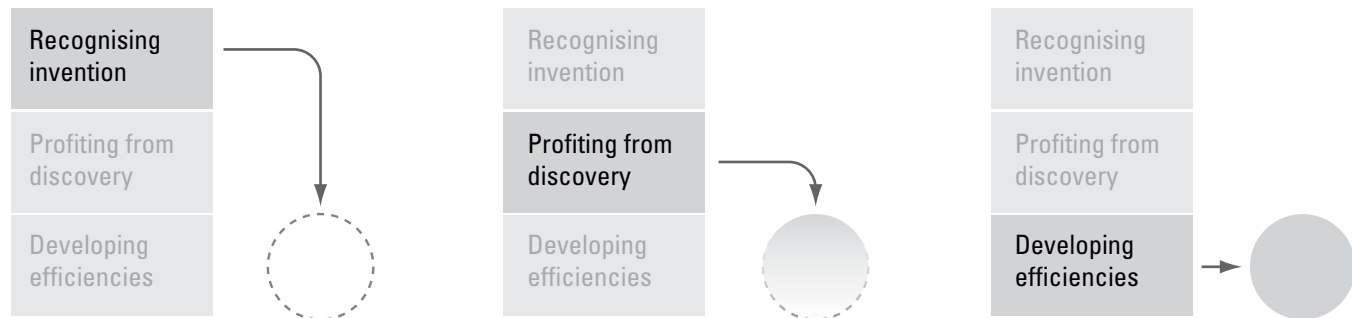
They provide resources to recognize invention, which opens up new domains of language. In these new domains, profitable discoveries may be made.

They provide the necessary conditions for discovering and marketing products and services that emerge from these new domains.

Then, they develop more cost-effective ways of producing and delivering these new products and services.

3 Orders of Change

after Michael Geoghegan (2002)

Geoghegan identified change as a way to define new elements, whether they be domains, systems, or efficiencies. Change, according to Geoghegan, takes place only in the context of what does not change.
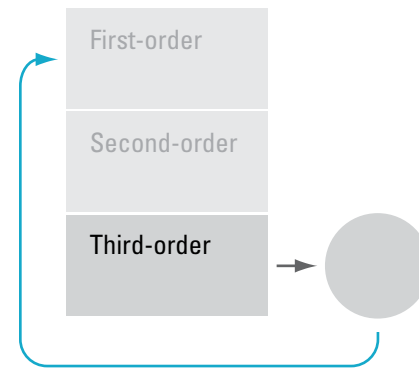
These orders of change correlate with the orders of creativity (invention, discovery, and efficiency) and ultimately affect the efficiency of a system in a new domain.
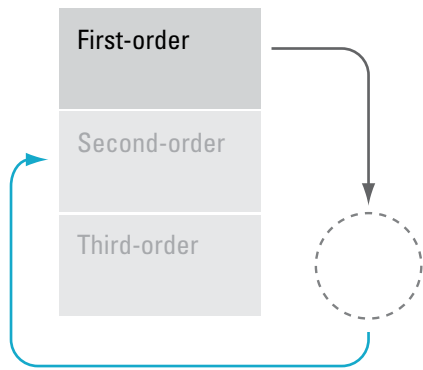
First-order change creates new domains and new generative languages.
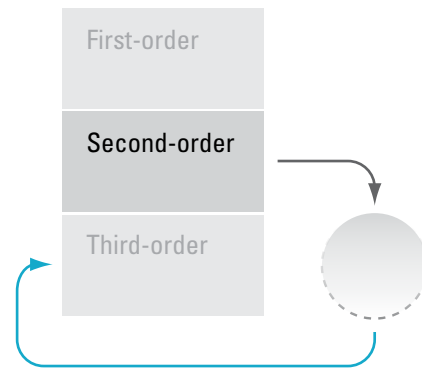
Second-order change affects system rules within a new domain.

Third-order change seeks increased efficiency within that system.

Efficiency may lead to surplus, which makes it possible to support the discovery of new invention.

Value Chain Evolution Theory

after Christensen et al. (2004)

The Value Chain Theory suggests that companies should integrate vertically to control activities within the value chain that drive performance along dimensions most important to customers. Integrating gives companies the ability to expand their capabilities. At the same time, unpredictable "interdependencies" can frustrate firms that try to focus on a single piece of a product's or service's value chain.
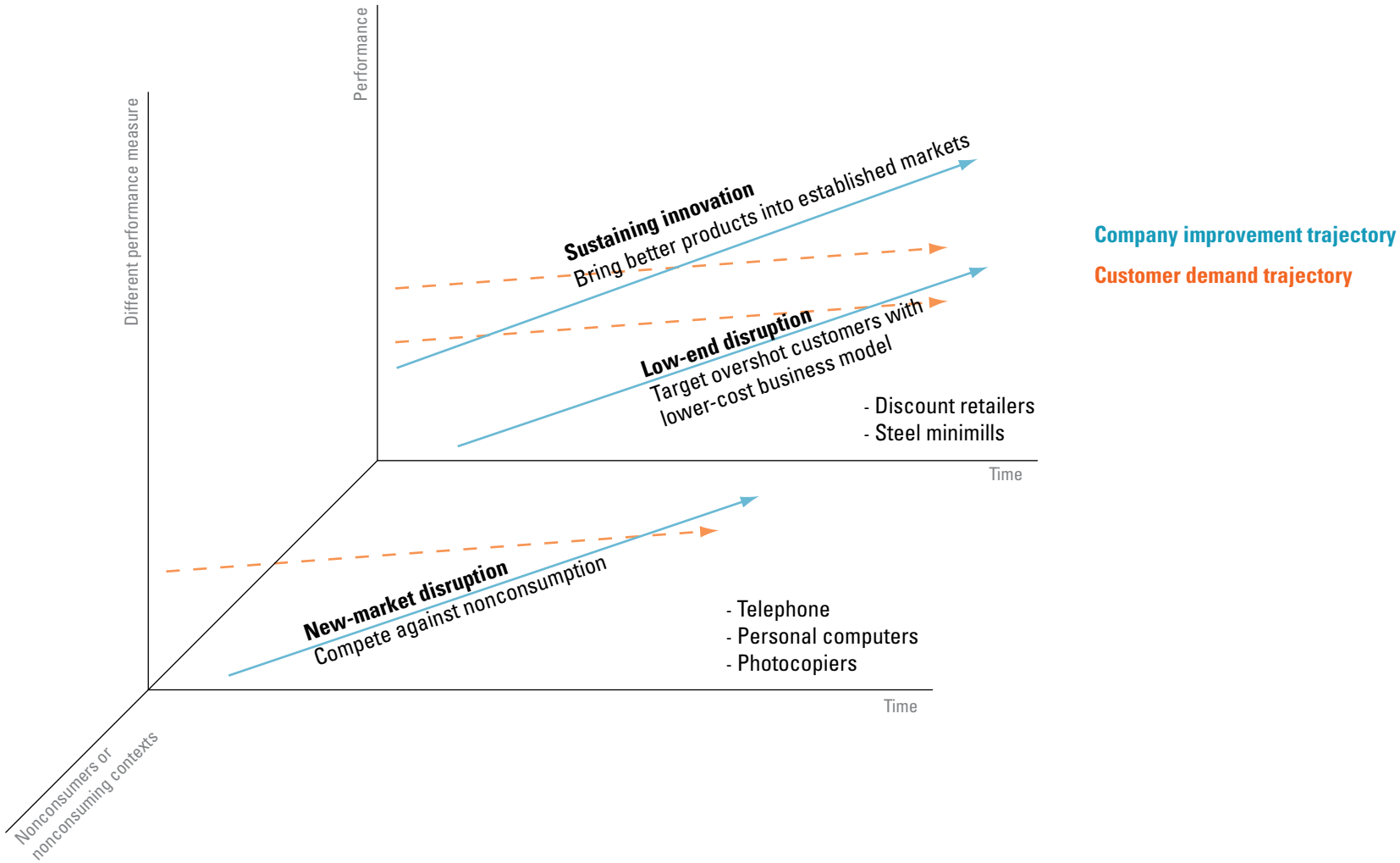
Company improvement trajectory

Steep scale; highly differentiable

Design/assembly makes the money

Beat competitors with speed, responsivness and customization

Customer demand trajectory

Flat scale; low differentiability

Ability to make money migrates to subsystems and the back end

Beat competitors with functionality

Performance (y-axis)

Time (x-axis)

Interdependent architectures

Modular architectures

Disruptive Innovation Theory

after Christensen and Raynor (2003)

Disruptive innovation theory proposes that, initially, disruptive innovation is not good enough to meet the performance requirements of the core market. Disruptive innovators, however, aggressively move up-market through constant improvement to pursue more attractive profit margins, ultimately meeting the needs of competitors' customers and increasing market share.

Performance

Different performance measure

Sustaining innovation
Bring better products into established markets

Company improvement trajectory

Customer demand trajectory

Low-end disruption
Target overshot customers with lower-cost business model

- Discount retailers
- Steel minimills

Time

New-market disruption
Compete against nonconsumption

- Telephone
- Personal computers
- Photocopiers

Time

Nonconsumers or nonconsuming contexts

R&D Strategy for Customer-Centric Innovation

after Larry Selden and Ian C. MacMillan (2006)

Customer-centric innovation (CCI) was designed to deliver results that met or exceeded market expectations. Selden and MacMillan describe the process as focusing on sustained and profitable top-line growth, which in turn raises market capitalization. CCI centers around customer R&D that gathers information about companies' customers, what their needs and wants are, and how the companies can earn more market share by developing new products for existing customers or extending the customer-base.

Phase 3a Stretch capabilities	Phase 2a Extend capabilities	Phase 1 Establish and develop the core	Phase 2b Extend segments	Phase 3b Stretch segments
Offensive				
Identify new capabilities that attend to needs in other life capsules of the existing segments, subsegments, or new halos.	Extend existing capabilities to attend to additional needs of the core segments and subsegments.	Identify core customer segments and develop mutually beneficial value propositions that exceed the buyers' expectations.	Identify halo segments that are similar to core customers and that can be served with very similar capabilities	Identify new segments unrelated to the core, but where current capabilities can be deployed.
Defensive				
Pay close attention to disruption threats from competitors; scan for indications of shifts in customers' needs or growing dissatisfaction with the value propositions on the market.				

Resources, Processes, and Values Theory

after Christensen (1997)

The theory of resources, processes, and values states that those three elements define a firm's strengths as well as weaknesses and blind spots. Resources (what a firm has), processes (how a firm works), and values (what a firm wants to do) enable a firm to respond to sustaining innovations. They do not, however, prepare a firm to adequately respond to an unexpected disruptive innovation.

	Resources	Processes	Values
Description	Things or assets that organizations can buy or sell, build or destroy.	Established ways companies turn resources into products or services.	The criteria by which prioritization decisions are made.
Examples	- People - Technology - Products - Equipment - Information - Cash - Brand - Distribution channels	- Hiring and training - Product development - Manufacturing - Planning and budgeting - Market research - Resource allocation	- Cost structure - Income statement - Customer demands - Size of opportunity - Ethics

Abernathy-Clark Model

after Abernathy and Clark (1985)

Abernathy and Clark stated that an innovation can either support or destroy two types of capabilities: technological capabilities and market capabilities. Their model defines four different types of innovation and suggests that market capabilities can be just as important as technological knowledge.

	Preserved	**Technological capabilities**	Destroyed
Preserved		**Regular**	**Revolutionary** GE's market capabilities were instrumental during the transition from X-rays to CAT scans to MRI.
Market capabilities			
		Niche	**Architectural**
Destroyed			

Henderson-Clark Model

after Henderson and Clark (1990)

Henderson and Clark suggested that, since products are made up of components connected together, building them must require two kinds of knowledge: knowledge of the components, called component knowledge, and knowledge of the links between them, called architectural knowledge. Despite pioneering the xerography technology, Xerox spent many years developing a good, small plain-paper copier.

RCA was never the leader in the portable transistor radio market despite its experience in the components of transistor radios. Since an innovation can enhance or destroy either one of those knowledge types, the Henderson-Clark model distinguished four possible types of innovation according to its effect on component and architectural knowledge.

	Enhanced	**Architectural knowledge**	Destroyed
Enhanced	**Incremental**		**Architectural**
Component knowledge	**Modular**		**Radical**
Destroyed			

Innovation Chain

after Horst Rittel (1964)

Horst Rittel, in a faculty seminar delivered at University of California, Berkeley, stated that science offers issues for basic research, and that other researchers obtain their stimuli from the results of basic research. The results of research and their applications lead to development, which in turn leads to design. This process is, in a way, a self-stimulating system. Rittel claims that innovation enters this process and changes it.
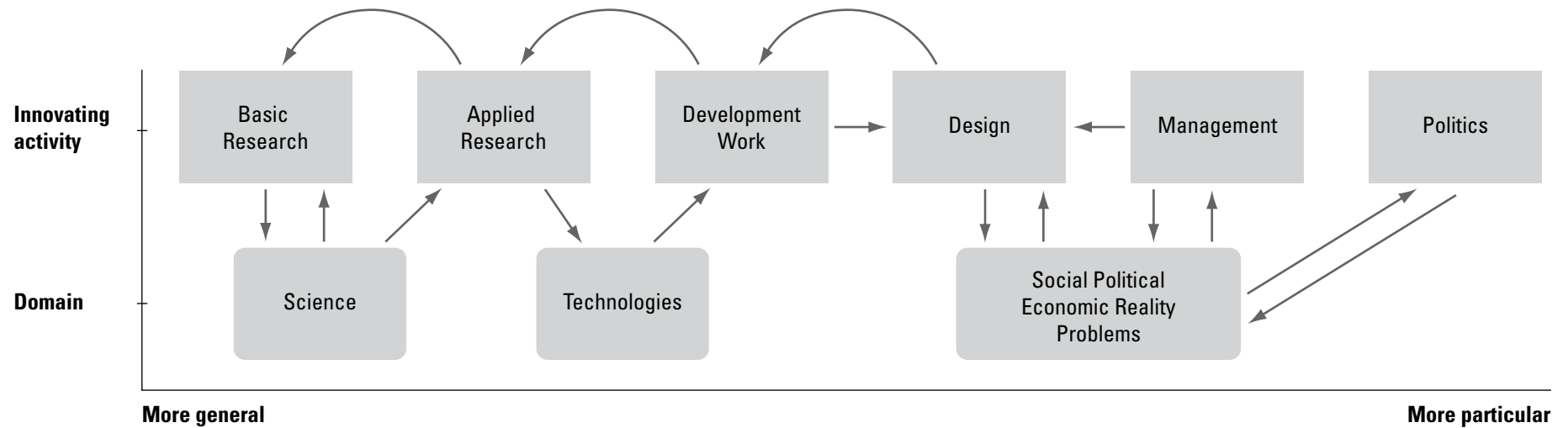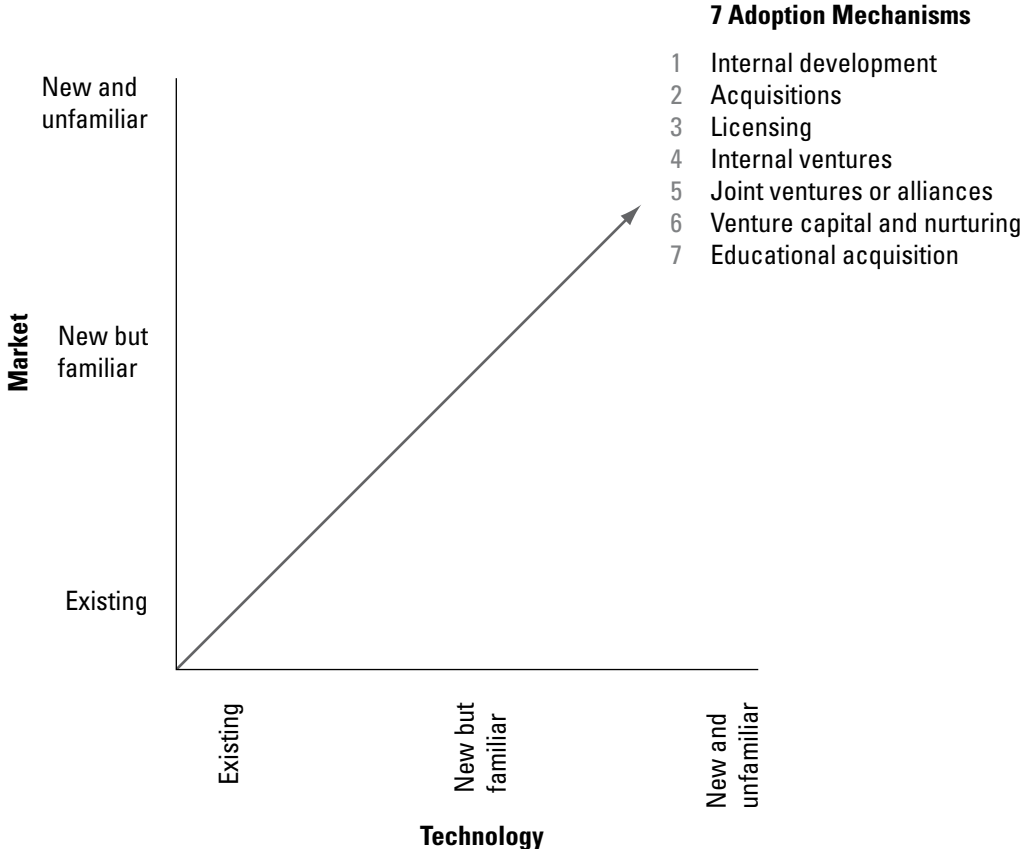
Familiarity Matrix Model

after Roberts and Berry (1985)

The likelihood of a firm adopting an innovation successfully depends on how familiar the firm is with the technology that supports the innovation and the market that the innovation impacts. Roberts and Berry identified seven adoption mechanisms—internal development, acquisitions, licensing, internal ventures, joint ventures or alliances, venture capital and nurturing, and educational acquisition—that a firm can use to adopt the technology, depending on how radical the innovation is to the firm. The more unfamiliar the innovation, the more a firm should look outside its boundaries for assistance.

7 Adoption Mechanisms

1   Internal development
2   Acquisitions
3   Licensing
4   Internal ventures
5   Joint ventures or alliances
6   Venture capital and nurturing
7   Educational acquisition

Market

New and unfamiliar

New but familiar

Existing

Existing   New but familiar   New and unfamiliar

Technology

Process to Predict Industry Change

after Christensen et al. (2004)

According to Christensen et al., predicting industry changes involves identifying signals of change, evaluating competitive battles, and making strategic choices that influence the outcome of competitive battles. By identifying potential "attackers" and "incumbents," firms can determine the types of technologies and competitors that will bring about innovative changes in the market.

1. Signals of change
Are there signs that someone is capitalizing on opportunities for change?

2. Competitive battles
What is the likely result of head-to-head battles between industry combatants?

3. Strategic choices
Are firms making decisions that increase or decrease their ultimate chances of success?
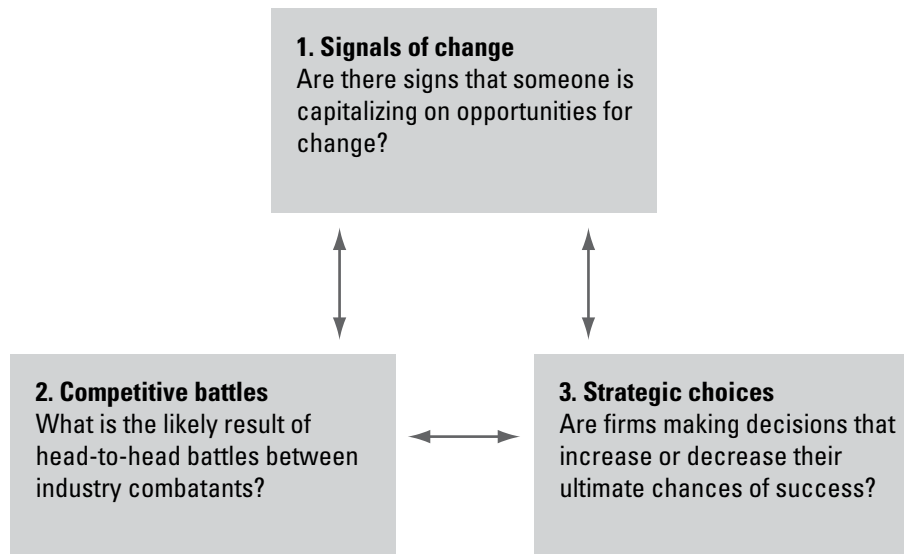
Incremental-Radical Dichotomy Model

after Tushman and Anderson (1986)

Incumbent firms and new entrants to a market can react differently to innovations. A radical innovation can render existing knowledge obsolete, while incremental innovation can build on existing knowledge. The incremental-radical dichotomy shows the advantages and disadvantages for each type of firm depending on the type of innovation that is affecting the firm.

	Incremental innovation (competence enhancing) Knowledge required to exploit the innovation builds on existing knowledge	**Radical innovation** (competence destroying) Knowledge required to exploit the innovation is very different from existing knowledge, rendering existing knowledge obsolete
Incumbent	- More willing to invest since such investments allow existing products to stay competitive in the market - Tend to dominate since required knowledge builds on what they already have	- May be reluctant to invest for fear of cannibalizing its existing products if, in doing so, it advances the date of introduction of the innovation - Existing capabilities may be useless and be a handicap to the introduction and development of the innovation
New entrant	- Would have to build knowledge from scratch	- Have less to lose, since they have no products to sell in that market - Do not have the burden of the old knowledge and can go on unencumbered to build capabilities for the innovation and exploit it

Why is innovation desirable?

typically differentiation
to stand out from competitors

to create advantage

out of profit, greed, altruism   to create a new business
or fear to save an old business

The Need for a Model of "Why"

Individuals and organizations innovate to create new value—a new product, a new service, a new way of thinking. The desire to innovate can come from an obsession with solving a problem. Businesses have the primary "problem" of differentiating themselves from their competitors. The solution to this problem comes in the form of innovative offerings and processes. Coming up with these solutions can bring the business more revenue. Transposed to the realm of science and society, coming up with the solution can bring glory and fulfillment for the innovators as well as a heightened sense of satisfaction for those who benefit from that innovative solution.

The desire to create new value can come from characteristics of both the individual and the organization—obsession, fear, greed, altruism, anxiety. This desire can establish new domains within which new systems with more efficient creation methods can be found. The sources of desire can differ among innovators, but the object of the desire remains the same: to create value that is new and better than what had previously been accepted as the status quo.

References

Abernathy, W.J., and K.B. Clark	**"Mapping the Winds of Creative Destruction."** *Research Policy* 14 (1985): 3–22.
Abernathy, W.J., and J.M. Utterback	**"Patterns of Innovation in Technology."** *Technology Review* 80, no. 7 (1978): 40–47.
Adner, Ron	**"Match Your Innovation Strategy to Your Innovation Ecosystem."** *Harvard Business Review* 84, no. 4 (2006): 98–107.
Afuah, Allan	***Innovation Management: Strategies, Implementation, and Profits.*** 2nd ed. New York: Oxford University Press, 2002.
Baldwin, Carliss Y., Christoph Hienerth, and Eric A. von Hippel	**"How User Innovations Become Commercial Products: A Theoretical Investigation and Case Study."** MIT Sloan Research Paper No. 4572-06, 2006.
Christensen, Clayton M.	***The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail.*** Boston: Harvard Business School Press, 1997.
Christensen, Clayton M., and Michael E. Raynor	***The Innovator's Solution: Using Good Theory to Solve the Dilemmas of Growth.*** Boston: Harvard Business School Press, 2003.
Christensen, Clayton M., Scott D. Anthony, and Erik A. Roth	***Seeing What's Next: Using Theories of Innovation to Predict Industry Change.*** Boston, Harvard Business School Press: 2004.
Conley, Chris	Personal correspondence, 2006.
Doblin Group	**"Ten Types of Innovation."** Doblin Group, http://www.doblin.com/ideas/TenTypesOverview.html

References (continued)

Drucker, Peter F.	***Innovation and Entrepreneurship: Practice and Principles.*** 1st ed. New York: HarperBusiness, 1993.
Esmonde, Peter	***Notes on the Role of Leadership and Language in Regenerating Organizations.*** Sun Microsystems, Inc., 2002.
Ettlie, John E.	***Managing Innovation: New Technology, New Products, and New Services in a Global Economy.*** 2nd ed. Burlington, MA: Elsevier Butterworth-Heinemann, 2006.
Felde, Nathan	Personal correspondence, 2006.
Fey, Victor, and Eugene Rivin	***Innovation on Demand: New Product Development Using TRIZ.*** Cambridge: Cambridge University Press, 2005.
Foster, Richard	***Innovation: The Attacker's Advantage.*** New York: Summit Books, 1986.
Govindarajan, Vijay, and Chris Trimble	***Ten Rules for Strategic Innovators: From Idea to Execution.*** Boston: Harvard Business School Press, 2005.
Hamel, Gary	***Leading the Revolution.*** Boston: Harvard Business School Press, 2000.
Hanna, Parrish	Personal correspondence, 2006.
Hargadon, Andrew	***How Breakthroughs Happen: The Surprising Truth About How Companies Innovate.*** Boston: Harvard Business School Press, 2003.

Hargadon, Andrew, and Robert I. Sutton	**"Building an Innovation Factory."** In *Harvard Business Review on Innovation*, 55–76. Boston: Harvard Business School Press, 2001.
Henderson, R., and K.B. Clark	**"Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms."** *Administrative Science Quarterly* 35, no. 1 (1990): 9–30.
Johansen, Bob	**"Foresight to Insight to Action."** Institute for the Future, http://www.iftf.org
Kanter, Rosabeth Moss	***The Change Masters.*** New York: Simon and Schuster, 1983.
Kaufman, Michael	**"Notes from the Innovation Edge."** Innovation Labs, 2006.
Kelley, Tom, and Jonathan Littman	***The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm.*** New York: Currency, 2001.
Kelley, Tom, and Jonathan Littman	***The Ten Faces of Innovation: IDEO's Strategies for Defeating the Devil's Advocate and Driving Creativity Throughout Your Organization.*** New York: Currency, 2005.
Kim, W. Chan, and Renée A. Mauborgne	**"Knowing a Winning Business Idea When You See One."** In *Harvard Business Review on Innovation*, 77–102. Boston: Harvard Business School Press, 2001.
Kuhn, Thomas S.	***The Structure of Scientific Revolutions.*** 2nd ed. Chicago: The University of Chicago Press, 1970.

References (continued)

Kumar, Vijay	**"Innovation Planning Toolkit."** MetaDesign, San Francisco. 24 May 2005.
Kumar, Vijay, and Brandon Schauer	**"Innovation Toolkit: Scenario Planning Workshop."** MetaDesign, San Francisco. 24 May 2005.
MacMillan, Ian C., and Rita Gunther McGrath	**"Discovering New Points of Differentiation."** In *Harvard Business Review on Innovation*, 131–152. Boston: Harvard Business School Press, 2001.
Maupin, C.J.	***I Learned a Lot at the Anti-conference, but I'm Not Sure Exactly What.*** Stone Yamashita Partners, 2006.
Moore, Geoffrey A.	***Dealing with Darwin: How Great Companies Innovate at Every Phase of Their Evolution.*** New York: Penguin Group, 2005.
Peters, Tom	***The Circle of Innovation: You Can't Shrink Your Way to Greatness.*** New York: Vintage, 1999.
Rittel, Horst	**"The Universe of Design."** Faculty Seminar, College of Environmental Design. Spring 1964.
Roberts, E.B., and C.A. Berry	**"Entering New Businesses: Selecting Strategies for Success."** *Sloan Management Review* 26, no. 3 (1985): 3–17.
Schrage, Michael	***Serious Play: How the World's Best Companies Simulate to Innovate.*** Boston: Harvard Business School Press, 2000.

Selden, Larry, and Ian C. MacMillan	**_Manage Customer-Centric Innovation—Systematically._** _Harvard Business Review_ 84, no. 4 (2006): 108–116.
Tatsuno, Sheridan M.	**_Created in Japan._** New York: Harper Business, 1990.
Thomke, Stefan	**"Enlightened Experimentation: The New Imperative for Innovation."** In _Harvard Business Review on Innovation_, 179–205. Boston: Harvard Business School Press, 2001.
Tushman, M.L., and P. Anderson	**"Technological Discontinuities and Organizational Environments."** _Administrative Science Quarterly_ 31 (1986): 439–465.
von Hippel, Eric	**_The Sources of Innovation._** Reprint ed. Oxford: Oxford University Press, 1995.
von Hippel, Eric, Stefan Thomke, and Mary Sonnack	**"Creating Breakthroughs at 3M."** In _Harvard Business Review on Innovation_, 31–53. Boston: Harvard Business School Press, 2001.
	An Adventure Inside the World's Largest Innovation Lab. GE + Stone Yamashita Partners, 2005.
	"A Crunch of Gears." _The Economist._ (2001).
	Harvard Business Review on Innovation. 1st ed. Boston: Harvard Business School Press, 2001.
	"Technological Innovation Eras Drive Societal Changes." Prepared for NTT DoCoMo. Institute for the Future, 2005.

Alphabetical Index

Alphabetical Index (continued)