15.905 Technology Strategy

Co-evolution of technological innovation and demand opportunity

Michael A M Davies

4 April 2007

Agenda for today, Monday 2 April 2007

~13:05	• Lexar Media
~14:05	• Co-evolution of technological innovation and the demand opportunity

The process of *theory*-building

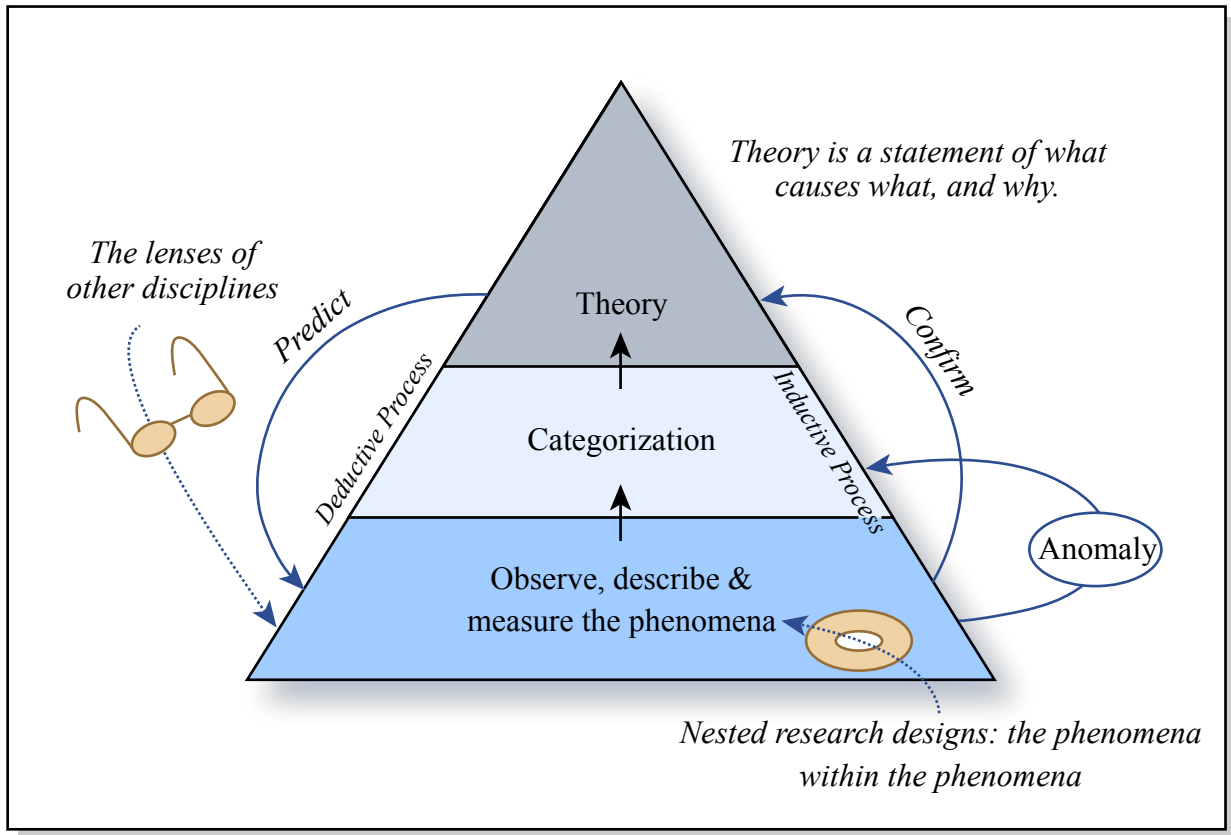


Image by MIT OCW.

Technologies and technological innovation

- Technologies emerge
  - can be push - supply, driven by new knowledge - or pull - demand, driven by demand opportunity
- Learning takes place
  - either or both of over time, or as a result of accumulated experience
  - driven by what's possible - technological feasibility - and by what's worthwhile - commercial viability
- Over time, performance improves and unit costs fall
  - along which *parameters*
  - at what rate
  - locally, or causing system change

Parameter

noun

1. one of a set of measurable factors…that define a system and determine its behaviour…[1]
2. a factor that restricts what is possible or what results[1]
3. a distinguishing characteristic or feature[1]

1: American Heritage® Dictionary, © 2000 Houghton Mifflin

Envelope

noun

1. the technical limits within which an aircraft or electronic system may be safely operated[1]
2. the maximum operating capability of a system (especially an aircraft)[2]

1: Random House Unabridged Dictionary, © Random House Inc. 2006
2: WordNet®, © 2005 Princeton University

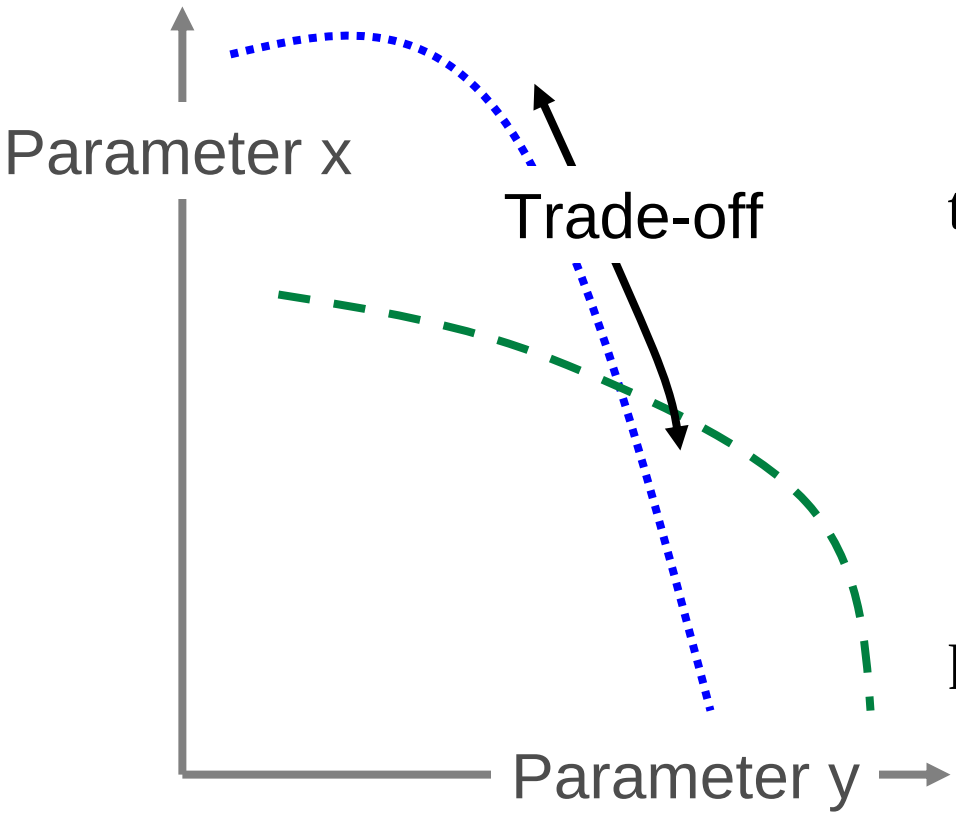
Trade-off

noun

1. the exchange of one thing for another of more or less equal value, especially to effect a compromise[1]
2. an exchange of one thing in return for another, especially relinquishment of one benefit or advantage for another regarded as more desirable[1]

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

Technology envelopes and trade-offs



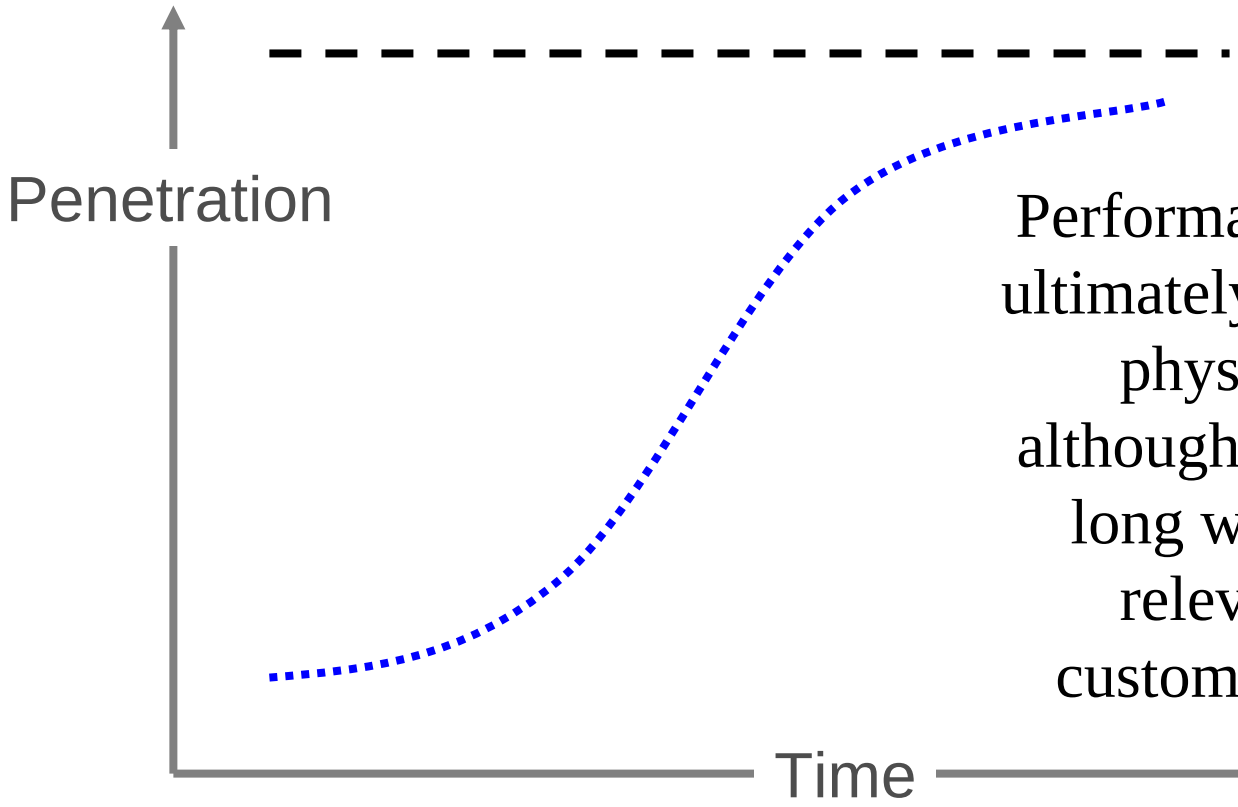
Technologies are characterized by performance envelopes, the limits of what can be done with them, and the trade-offs amongst parameters for them

Different technologies have different envelopes and trade-offs

Technologies compete with each other for potential applications

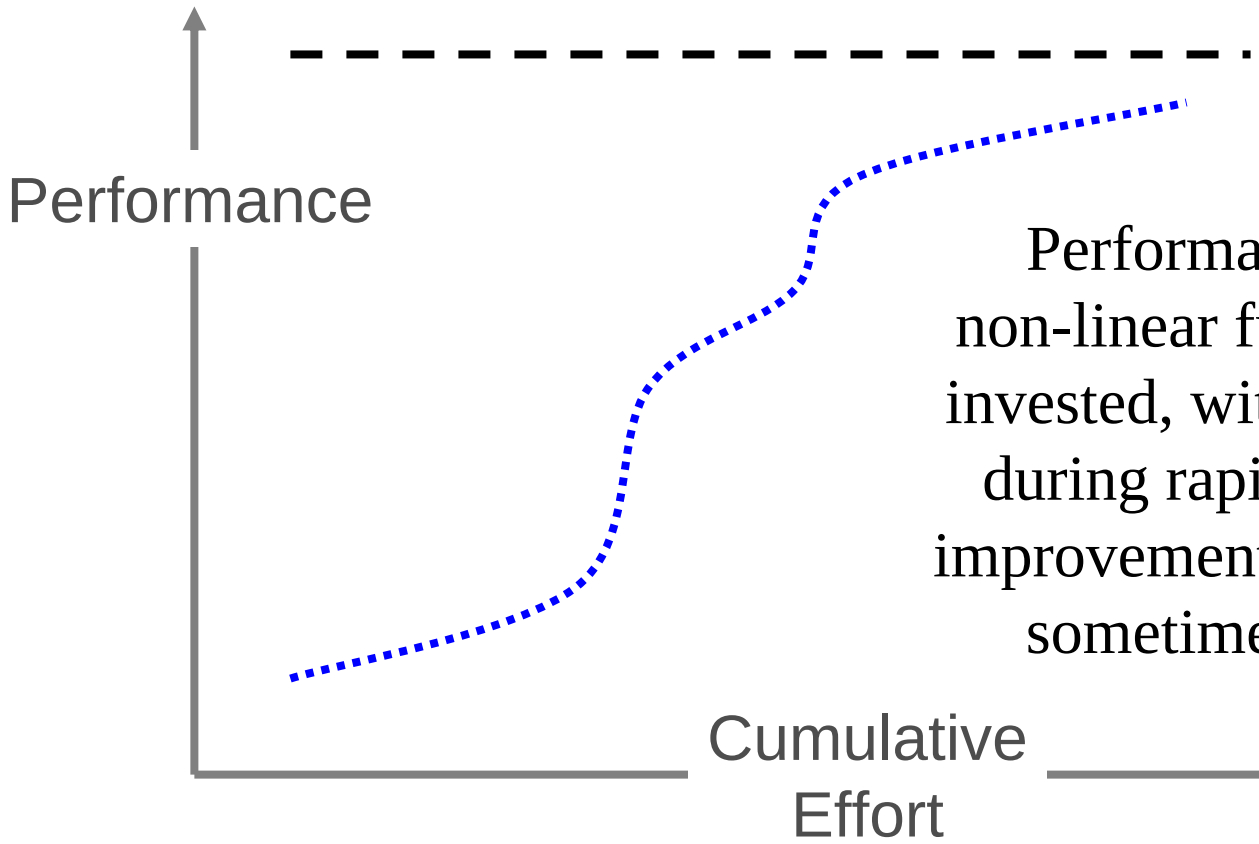
- At any time, there are typically a range of competing technologies that are candidates for each application
- Each of these technologies can be characterized in terms of its key *parameters*
- Each technology typically has a performance *envelope*, which defines the trade-offs inherent in the technology
- Over time, technologies follow an *innovation trajectory*, a vector or function that describes how they have evolved and may evolve, either over time or in response to effort invested in their development
  - rate of change
  - **direction**

Innovation trajectories



Performance tends to be ultimately constrained by physical limits - although these may be a long way off, or not relevant to what customers want done

Innovation trajectories



Performance is often a non-linear function of effort invested, with rapid progress during rapid growth, slow improvement in maturity, and sometimes slowdowns

The rate at which performance improves can vary dramatically

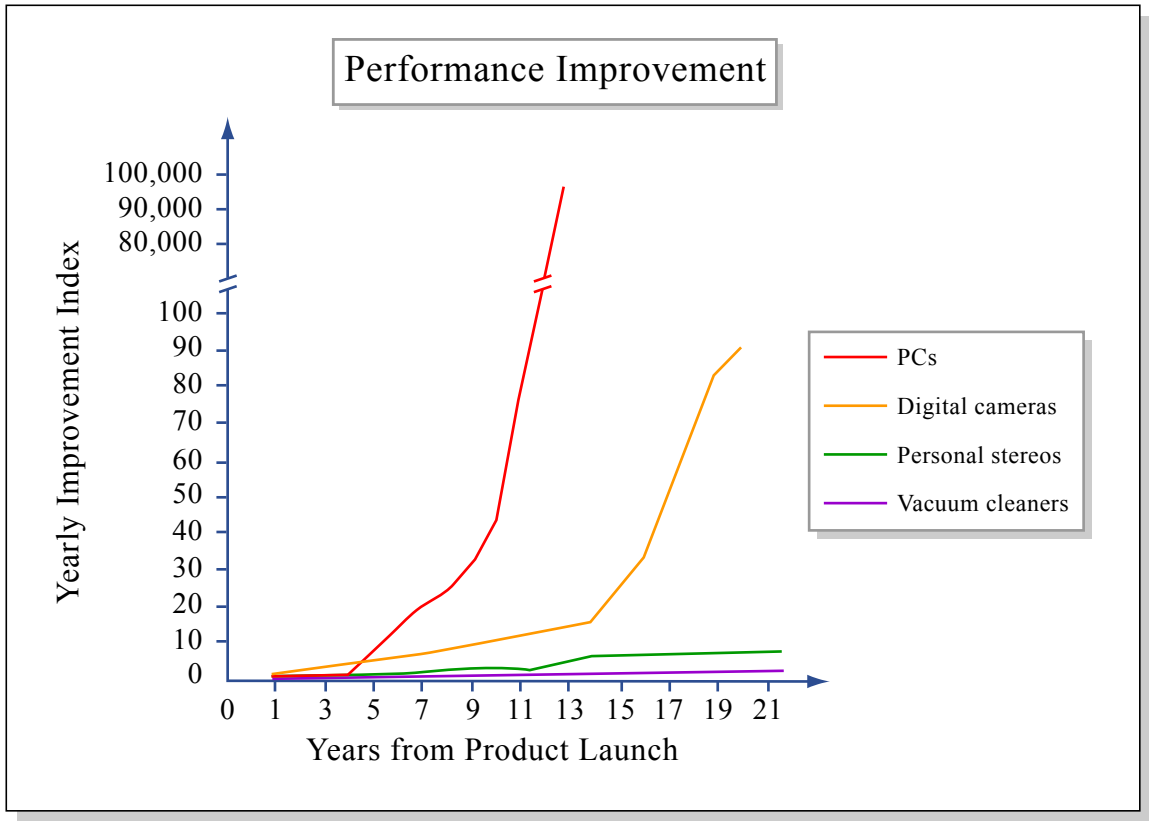


Image by MIT OCW.

Users' needs are diverse, and they change over time, and in response to technological innovation

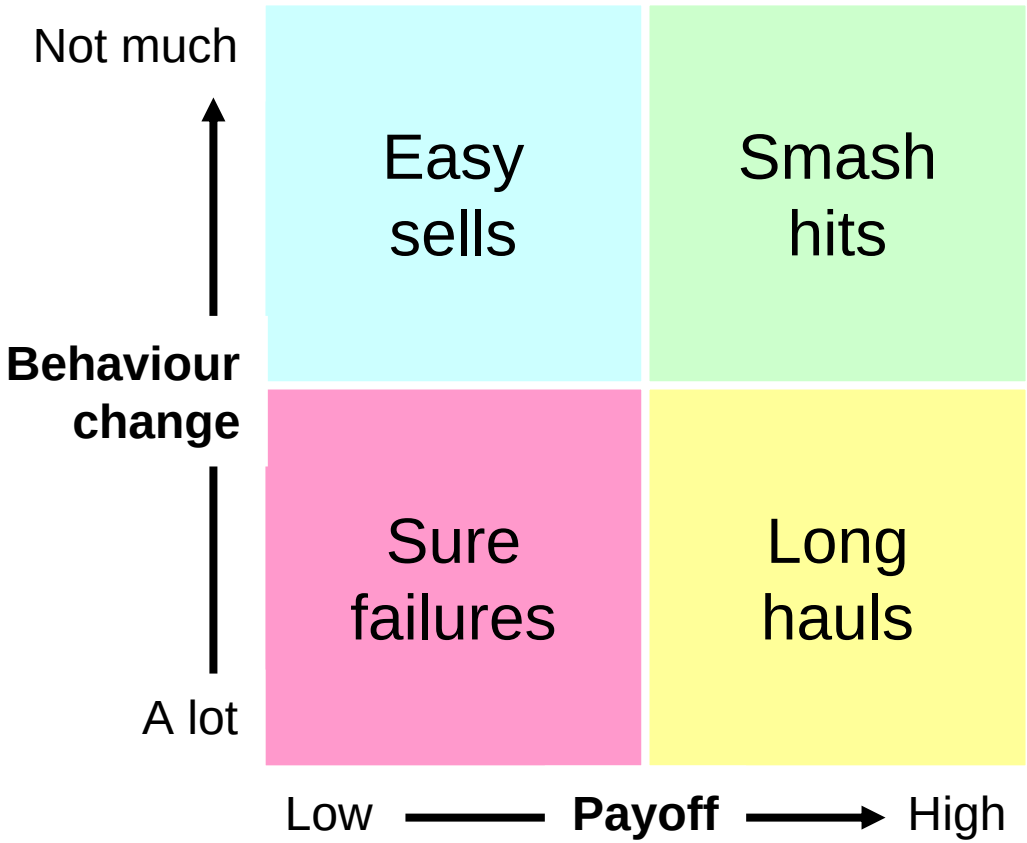
- Heterogeneous - actual or potential users and customers have a range of different needs - jobs they want done - and value they put on getting those jobs done
  - may be related to demographic characteristics
  - but not necessarily, so that in many cases other bases of segmentation may be more useful
- Exogeneous - what users and customers want changes over time in response to, amongst other things, their own changing circumstances and broad societal shifts
- Endogeneous - users and customers' beliefs and behaviour also change in response to technological innovation - new possibilities

But it's not easy to get them to adopt novel products that embody innovative technologies

- Most customers most of the time are loath to change their behaviour
  - requires investment of time and effort
  - involves uncertainty and can induce anxiety
- And are (necessarily) unfamiliar with novel products
- Novel products almost always involve trade-offs
- They evaluate products based on **perceived** value, relative to products they already use to do a job, and are overly sensitive to dis-benefits - "loss aversion"
- At the same time, businesses (full of technologists) tend to underestimate the switching costs, and overestimate the potential benefits

John Gourville, "Eager Sellers and Stony Buyers", Harvard Business Review, June 2006, pages 98-106

So we find ourselves with eager sellers and stony buyers



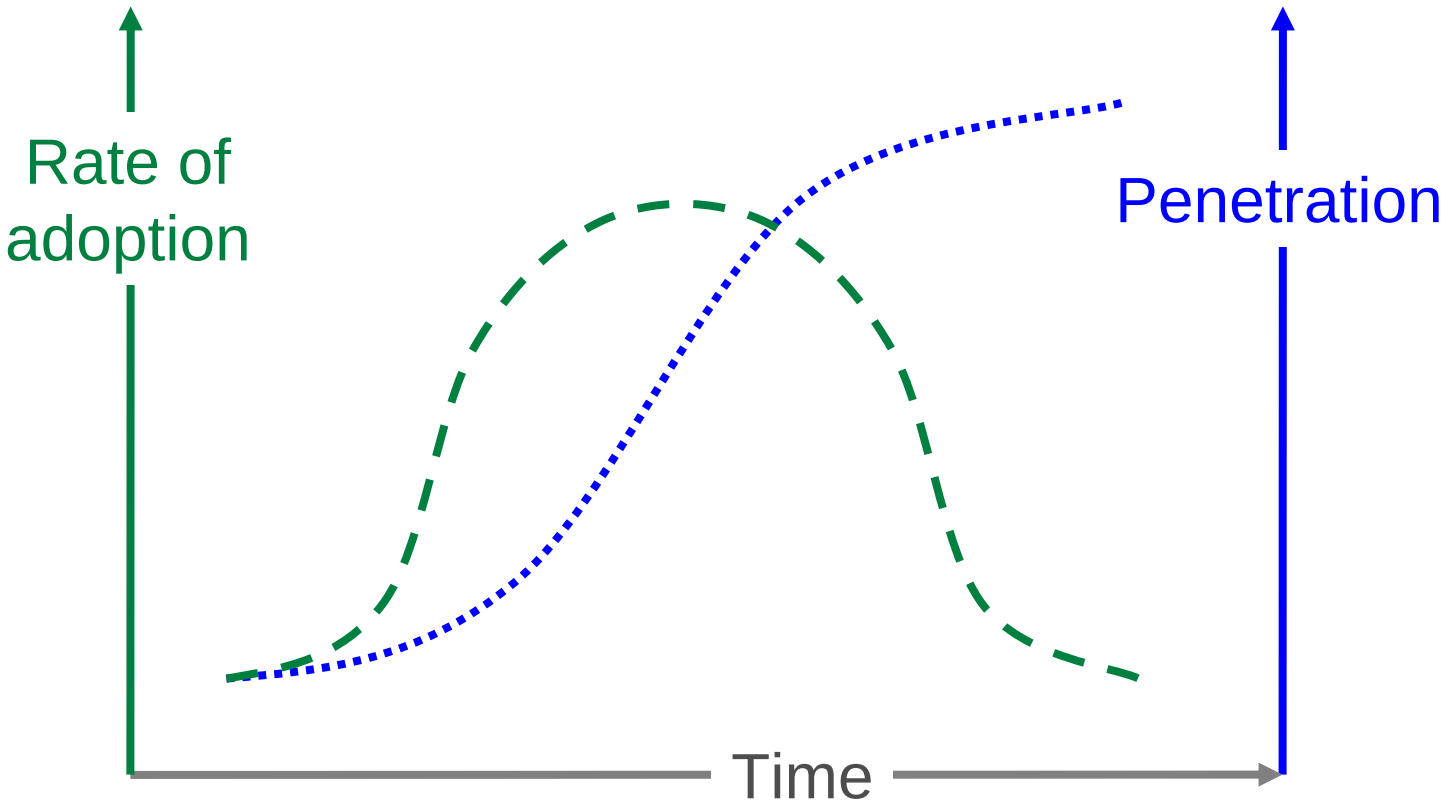
John Gourville, "Eager Sellers and Stony Buyers", Harvard Business Review, June 2006, pages 98-106

Over time, however, successful innovations diffuse amongst users and get widely adopted

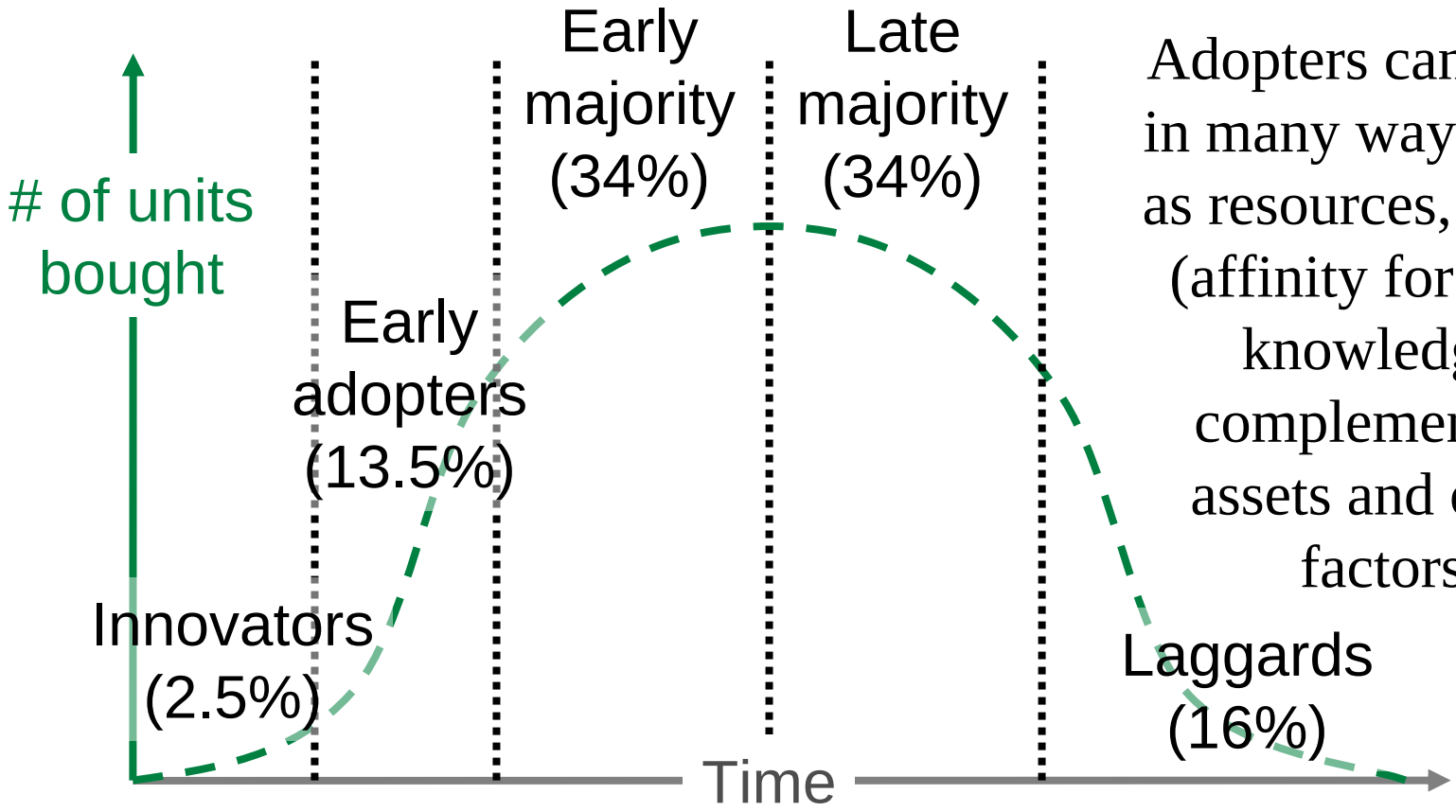
- *Probit* adoption
  - potential users or customers weigh costs and benefits
  - heterogeneity of preferences means that different users or customers adopt at different times
- *Epidemic* adoption
  - adoption limited by availability of information
  - as potential users and customers become aware of what it does and how to use it, they will adopt
- *Information cascades* and *path dependence*
  - a technology becomes established, it works and is better, and its features well known, legitimizing it
  - once established, network effects take over

Paul Geroski, "Models of technology diffusion", Research Policy, 2000 pages 603-625

Diffusion of innovations

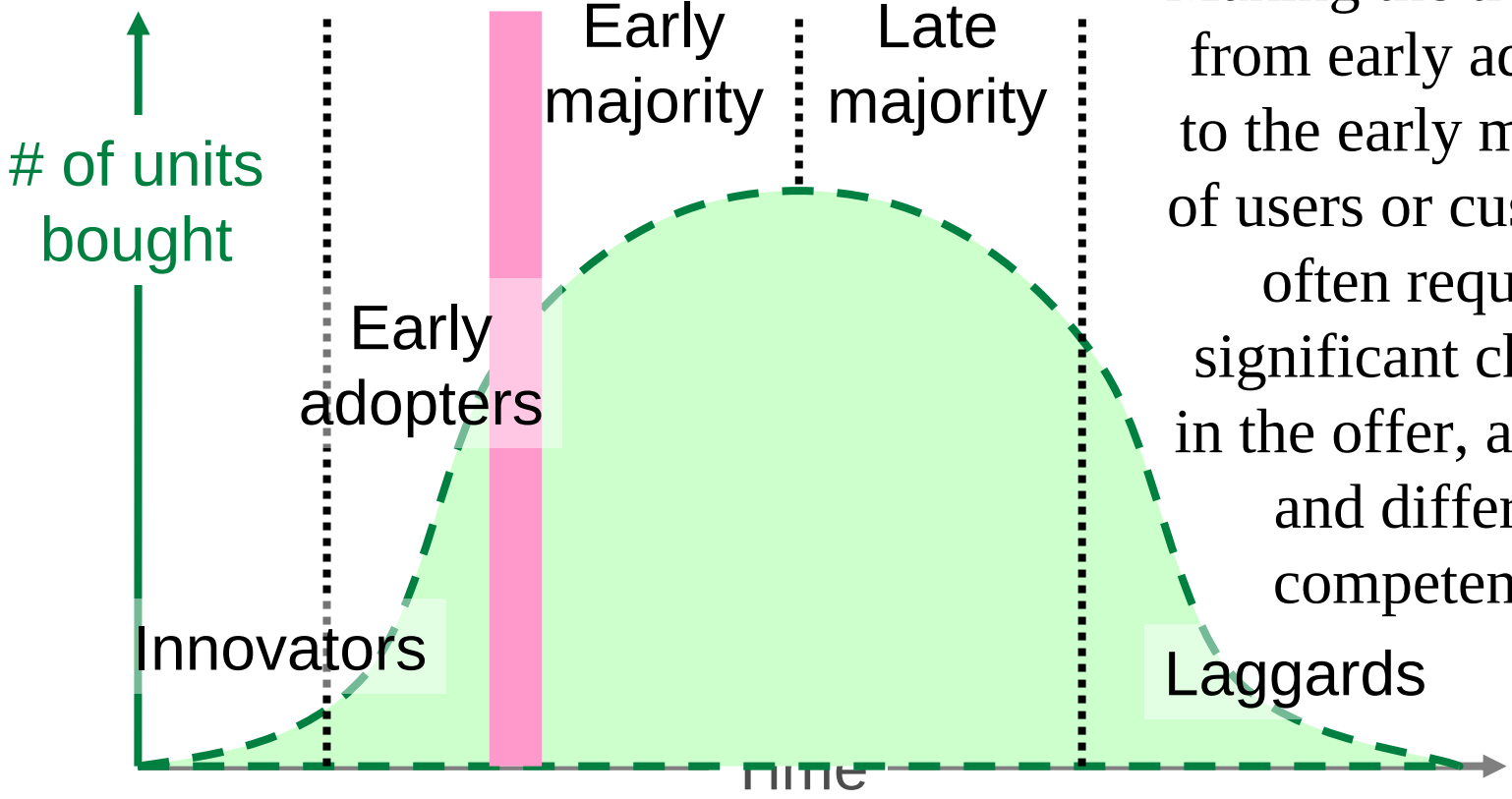


Everett Rogers' segmentation



Adopters can differ in many ways, such as resources, values (affinity for risk), knowledge, complementary assets and other factors

Geoffrey Moore's chasm focuses on *psychographic* characteristics of users or customers



Making the transition from early adopters to the early majority of users or customers often requires significant changes in the offer, and new and different competences

The rate at which new technologies diffuse can vary widely

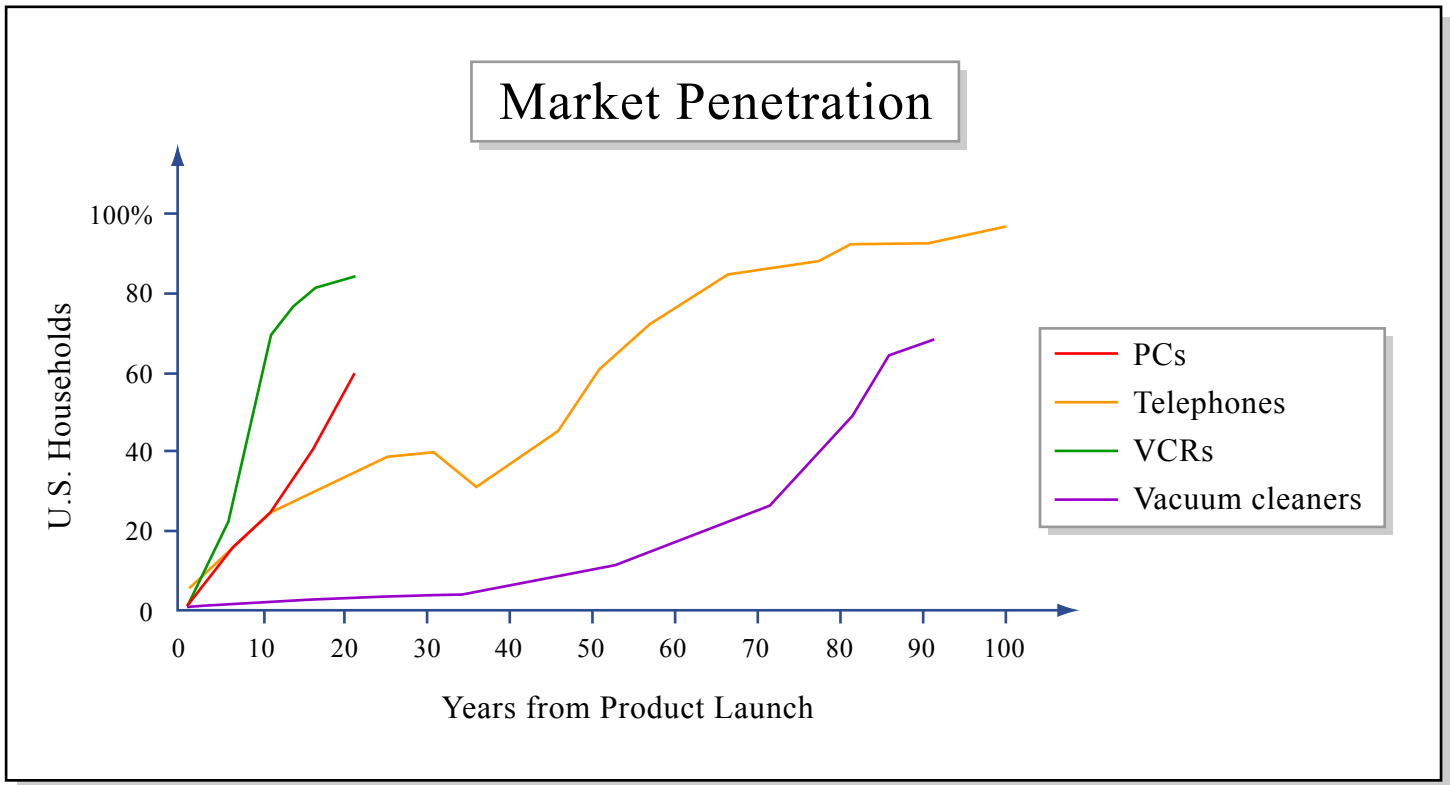


Image by MIT OCW.

Together, these two phenomena often result in a characteristic industry life-cycle

	Early ferment	Dominant design emerges	Incremental innovation	Maturity	Eclipse or renewal
Demand Opportunity	Lead users, early adopters - high payoff, low switching costs	Early mainstream - usability, cost more important	Mainstream customers - soft factors, aesthetics	Saturation, segmentation, customization	
Business Ecosystem	Many entrants - diverse business models	Decisive battles for leadership	Intensifying competition, early consolidation	Fierce competition, consolidation around majors and minors	
Technological Infrastructure	Make it work - innovate on performance, diverse integrative designs	Figure out the optimal architecture, drive down costs, make it easy to use	Broaden the offer, rationalize the portfolio, build up complementary assets	Develop broad portfolio, build platforms, search for new options	

Dominant design

- After a technological innovation and a subsequent era of ferment, a basic architecture that becomes the accepted market standard
- Dominant designs may not be better than alternatives nor innovative
- They have the benchmark features to which subsequent designs are compared