Who am I?

- John Musacchio
- New Assistant Professor in ISM
  - Joined January 2005
- PhD from Berkeley in Electrical Engineering

Experience
- 2 ½ years at a high tech Start-Up
  - Helped design a chip-set for computer-networking switches
- Other experience at large companies: GE, Bell Labs etc.
My Research Interests

- Game Theory and Economics in Computer Network Pricing
- Performance Modelling of Networks.
What is this class about?

Information Technology

- Layers
- Open vs Proprietary Standards
- Systems, Components, Interoperability
- Important eBusiness Technologies
  - Web Services, XML

Economics of Information and IT
- Costly to produce, cheap to reproduce.
- Network effects, lock in.

Strategies
- Pricing, standard setting, partnering, etc.
What is this class about?

Complementor:

You:

Complementor:

Split?

$
Unique Features

Complements

- Different manufacturers
- Strategy for complementors as well as competitors
- Compatibility as strategic choice
- Standards and interconnection
Net Neutrality

A tussle between complementers:

- Should ATT be allowed to charge Google for carrying its content (beyond charging for the access link)
Network Effects

Technology A

Technology B
Network Effects

Value depends on number of users
Examples?

Positive feedback
- Fax (patented in 1843)
- Internet (1980s)

Indirect network effects
- Software

Expectations management
- Competitive pre-announcements
Lock-in

[Diagram showing a person chained to a printer with an ink cartridge and a new printer, symbolizing lock-in effect due to high costs of ink cartridges.]
Lock-In and Switching Costs

Example: Stereos and LPs
  - Costly switch to CDs

Systems lock-in: durable complements
  - Hardware, software, and wetware
  - Individual, organizational, and societal
Information

Anything that can be digitized
- Text, images, videos, music, etc.
- a.k.a. content, digital goods

Unique cost characteristics

Unique demand characteristics
Cost structure

Expensive to produce, cheap to reproduce
High fixed cost, low marginal cost

- Not only fixed, but sunk
- No significant capacity constraints
- Particular market structures
  - Monopoly
  - Cost leadership
  - Product differentiation (versioning)
Rights Management

Low reproduction cost is two-edged sword

- Cheap for owners (high profit margin)
- But also cheap for copiers

Maximize value of IP, not protection

Examples

- Library industry
- Video industry
Consumption Characteristics

Experience good

- Browsing
- Always new
- Reputation and brand identity

Overload

- Economics of attention
- Hotmail example
- Broadcast, point-to-point, hybrid
Information Rules: A Strategic Guide to the Network Economy (Hardcover)

by Carl Shapiro (Author), Hal R. Varian (Author)

Reading Material:

Journal Articles
- From Harvard Business Review and other journals

Case Studies
# Tentative Lecture Plan

<table>
<thead>
<tr>
<th>Class</th>
<th>Date</th>
<th>Lecture Topics</th>
<th>Reading Homework Due: posting to class comment thread required for papers in <strong>bold</strong></th>
<th>Homework Assignments and Due Dates</th>
</tr>
</thead>
</table>
| 1     | 4/9   | - IT History and Evolution  
- Basic Porter Analysis  
- Start Technology Layering | a. Varian and Shapiro (VS), Chapter 1, The Information Economy  
b. HBS IT History case study |                                   |
| 2     | 4/16  | - Finish Technology Layering  
- Economics of Information: pricing, versioning, bundling | a. VS Chapter 2, Pricing  
b. VS Chapter 3, Versioning  
c. Porter, HBR, *Strategy and the Internet* | - **Problem Set 1 assigned:** pricing and versioning |
<p>| 3     | 4/23  | Web services, service oriented architectures  | <strong>HBS ebXML case study</strong> | - <strong>Project 1 assigned:</strong> web programming |</p>
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topic</th>
<th>Weekly Reading</th>
</tr>
</thead>
</table>
| 4    | 4/30  | - Industry and Technology Structure - Lock-In Effects                | a. VS Chapter 5, Recognizing Lock-In  
b. VS Chapter 6, Managing Lock-In  
c. HBR With Friends Like These: The Art of Managing Complementors |
|      |       |                                                                      | Problem Set 1 due                                                               |
| 5    | 5/7   | Network Effects                                                     | a. VS Chapter 7, Networks and Positive Feedback  
b. HBS Winner-Take-All in Networked Markets |
# Tentative Lecture Plan

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>Topic</th>
<th>Readings/Assignments</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5/14</td>
<td>Game Theory and Online Auctions</td>
<td>Edelman et al.: auction paper</td>
<td>Project 1 due</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Problem Set 2 assigned: game theory and auctions - Final Project assigned</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Game Theory and Online Auctions</td>
<td>HBS Google</td>
<td></td>
</tr>
</tbody>
</table>
| 8 | 5/28  | - Cooperation - Waging a Standards War          | a. VS Chapter 8, Cooperation and Compatibility  
b. VS Chapter 9, Waging a Standards War | Problem Set 2 due                        |
| 9 | 6/4   | eCommerce Business Topics                      | a. VS Chapter 4, Rights Management  
b. VS Chapter 10, Information Policy  
c. HBS Alibris  
d. HBS LinkedIn |                                            |
|-- | TB    | Final Exam Day (Final Project is due in lieu of Final Exam) |                                                                                     | Final Project due                         |
|   | D     |                                                 |                                                                                     |                                            |
Evaluation

- Homework assignments 15%
- Participation 10%
- Discussion Forum 10%
- Project 1 25%
- Final Project 40%
Project 1

Objective:
- To gain familiarity with current e-business technology

Task:
- A simple programming project involving the exchange of XML messages over the web.

Details:
- To be announced soon!
Final Project

Objective
- Demonstrate a working understanding of class concepts.

Task:
- Write a paper in groups of 2-3
Final Project
Choice 1:

- Propose a new information technology product or service.
- Propose how you will make the product or service commercially viable:
  - Discuss the competitive landscape
    - the competitors (if any), potential substitutes, your suppliers and complementors.
    - What are the strengths and weaknesses of these players?
  - Propose a revenue model
    - Product vs. service?
    - Licensing? Dual? Freeware? Etc?
    - Razor and blades?
Final Project (Choice 1 cont’d)

- How will you cope or take advantage of network effects, lock-in, etc?
- What will be your stance on standards and interoperability?
  - Proprietary vs. open standards.
  - Open or closed source?
- How will you create barriers to entry?
Final Project

Choice 2:

- Analyze a market with existing players
  
  - Discuss the competitive landscape
  - the competitors (if any), potential substitutes, your suppliers and complementors.
  - What are the strengths and weaknesses of these players?

  - What revenue models do the players in the market use?

  - How do the players cope or take advantage of network effects, lock-in, etc?
What are their stances on standards and interoperability?
- Proprietary vs. open standards.
- Open or closed source?

How do they create barriers to entry?

Make predictions - Will the market tip to one dominant player? Will the present dominant firm lose their position.
Participation

- We will have a lot of classroom discussion over the course of the quarter.
  - especially when we read case studies!
- This is an opportunity for you to
  - think through ideas.
  - give feedback.
  - learn from your classmates.
- We will evaluate your participation.
Discussion Forum

- Approximately once per week, Geoff will post a discussion question/topic

- Everyone must post at least one thoughtful reply or response to someone else’s reply

- The forum will be hosted on UCSC's webct system.

- We will put a link to it on the class homepage:
  - [http://www.soe.ucsc.edu/classes/ism211/Spring07/](http://www.soe.ucsc.edu/classes/ism211/Spring07/)
Where are we, and how did we get here?

- Let's survey the history of IT over the past few decades!

The History of IT from 1960-2000
The author (Nolan) breaks down history into 3 eras:
- Data Processing Era
- Micro Era
- Network Era

A logical division, but not universal
- Messerschmitt divides into 4 phases
  - Centralized, Time shared, de-centralized, networked
The Data Processing Era (1960-1980)

- By 1960 economy dominated by large, multi-divisional, hierarchical businesses
  - Corporate Office
  - Divisional operating units in different markets

- Example: GE
  - Corporate office in Connecticut
  - Lighting in Cleveland
  - Locomotives in Erie
  - ...

- Within each division many “functional departments”
  - Accounting, Finance, Engineering, etc.
The Data Processing (DP) Era (1960-1980)

- Needed to keep track of massive amounts of data for
  - Payroll
  - Payments to customers and suppliers,
  - etc.
The Data Processing (DP) Era (1960-1980)

- Meanwhile computers were developed for scientific and defense purposes
The Data Processing (DP) Era (1960-1980)

- These large companies purchased mainframe computers
  - to manage the data processing.
  - They were slow, enormous, and expensive, by today’s standards.
  - But, they did make it possible to process the enormous volume of data, and transactions in a huge corporation
Commercial computing evolved...

1954 -- IBM 650 dominates commercial market

- Leased for $3,250 per month (over $22,000 per month in today’s dollars!)
IBM 360

1964 - IBM 360,

- Interoperable peripheral and computer family
- Great improvement over previous generation
- A massive development effort by IBM
- Ensured IBM's dominance in the 60s and 70s
Data Processing Era (1960-1980)

- "You never got fired for buying IBM."
- Average market share of 68% in the 70s.

Meanwhile
- Digital introduces the mini-computer (1960s)
- UNIX operating system developed (1969)
- Bob Metcalfe invents Ethernet (1973)
DP Era (1960-1980)

- Technology Evolution
  - First - Stand Alone Mainframes
  - Next - Dumb terminals attached to mainframe
  - (“Time-Shared” Phase in Messerschmitt’s terminology)
The information resource manager was known as the *Data Processing (DP) manager*. 
- Charged with supporting the business
- Not with changing how the business was run
DP Era (1960-1980)

- IS evolved from supporting lower functions to higher level functions
  - Low: Inventory, Purchasing, Scheduling
  - Medium: Productions Operations Management
  - High: Corporate wide planning
DP Era (1960-1980) -- Annual Budgeting

- Budgeting was an important function made easier by computers.
- Accounting of:
  - Revenues, Expenditures, Assets, Liabilities
  - Generate Profit and Loss Statement

- Before computers:
  - Was difficult to do once a year

- After computers,
  - Could “close the books” more often
  - Could break down profits and losses to each level of the corporate hierarchy
Capital Budgeting

- Analyze return and risk of expenditures intended to generate revenue over multiple accounting periods
  - Examples: New building, or factory
- Before computer
  - Calculations could become complicated
- After computer
  - Very easy
- Consequence: Every level of the organization could be held accountable for their ROI
Better budgeting and resulting accountability lead to consistent earnings growth.
Build up to Micro Era

- 1974 - Xerox PARC develops first computer with a mouse. They don’t commercialize it!

- 1974 - Altair PC for hobbyists

- 1975 - Bill Gates and Paul Allen Found Microsoft
Build up to the Micro Era

- 1977 - Apple introduces a successful microcomputer

- **1981 - IBM introduces its PC!**
  - Intel develops CPU
  - Microsoft develops operating system

- IBM PCs were rapidly adopted by the commercial market.

- PCs threatened the DP manager
  - Easier to manage one central mainframe than a PC on every employee's desktop!
  - Data not Centralized.
    - The numbers on my PC are right, the ones on your PC are wrong!
  - Security Risks.

- DP managers put restrictions on PCs
- Users defied them!

- Users wanted the convenience of word processing, CAD, etc...
- Vendors marketed direct to the users instead of the DP managers.
- Example: Spreadsheets
Spreadsheet Example

- **VisiCalc (1979)**
  - First Spreadsheet
  - For Apple II computer
- **Lotus 1-2-3 (1983)**
  - Mimicked VisiCalc
  - For IBM PC
- **Excel (1985)**
  - Microsoft
  - Surpassed Lotus when Windows took off.

- Management realized the importance of bringing order to the chaos
- Coined the term Chief Information Officer (CIO) in the 80s
Beginning of Internet

- 1969 - ARPANET linked scientists
- 1977 - TCP/IP used to link networks to ARPANET
- 1984 - the term Internet comes into use
- 1985 - NSF takes over management of Internet Backbone
- 1990 - WWW (Tim Berners-Lee at CERN)
- 1991 - HTML
- 1993 - Mosaic Browser (Marc Andreesen and Eric Bina)
The Network Era (1995 - ?)

- After chaos of Micro Era, organizations converged on Client Server networked architectures
  - Client PC allowed user to have direct access to her own computer
  - Server housed organizational data
- Because of Success of Internet technologies...:
  - UNIX, HTML, TCP/IP
- ...IT managers used these technologies for internal networks - “intranets"
The Network Era (1995 - ?) - Internet Phenomenon

- Internet built on open standards
  - Different than control-oriented development philosophy
  - Benefits: Scalable, Extensible, ...
- Lots of vendors selling Interoperable equipment
  - More decisions to make than the DP manager of the 1960s!
  - Many companies started and flourished.
Cisco

- 1984 Founded by Leonard Bosack and Sandra Lerner (Stanford IT Staff)
- Developed a Router
  - A device to forward data packets from one network to another
- By 1998, Cisco had a market value of $100 billion!
Netscape

- Founded by Marc Andreessen and Jim Clark
- Browser based on Original Mosaic
- IPO in 1995
  - First day went from $28 -> $75!
  - The company's revenues doubled every quarter in 1995!
- Excitement triggered the dot-com boom.
  - Hundreds of companies started, most didn’t survive...
The network era

- The network era permitted new ways of doing business
  - Employees could check on their benefits with a web browser
  - Customers could “self-serve” themselves
    - In 1998, 70% of Cisco’s $800 million of service revenue was provided over Internet, by allowing customers to access their intranet.
  - Wal-Mart used point of sale data to drive supplier replenishment (CRP)
The network era

- Amazon sold books with minimal inventories.
- Levi Strauss used geo-demographic database to match supply and demand in each store.
- ...and many more examples!
Information Resource Management

- **Strategic realization**
  - *Information* is the resource to be managed not just *data*.
  - Need to get information into the hands of workers, so workers can be more productive.
## Result: Organizational Performance Improvement

<table>
<thead>
<tr>
<th>Market Value Rank</th>
<th>1978</th>
<th>1986</th>
<th>1997</th>
<th>Company Name</th>
<th>Sales per Employee</th>
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<td>3</td>
<td></td>
<td>Microsoft</td>
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<td>5</td>
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<td>Procter &amp; Gamble</td>
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<td>Bristol-Myers Squibb</td>
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<td>467</td>
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<td>Wal-Mart Stores</td>
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<td>70</td>
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<td>15</td>
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<td>American Int'l Group</td>
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</table>

Source: Standard & Poor’s Compustat. Market value ranks and SPE reflect calendar year-end values.
The Network Era (1995 - ?) - Internet Phenomenon

- For IT manager -- Enormous challenge to manage networks of thousands of computers!
The Network Era (1995 - ?) - Internet Phenomenon

“The Technology leader of Tomorrow must be a business leader with all of the management skills of any other senior executive...

The CIO has gone from being a corporate god in the 1980s to the chief blame taker in the 1990s when IT initiatives often have failed to deliver their promised productivity gains.”

1Sifonis and Goldberg, “Changing Role of the CIO,” Information Week, March 24 1997
The Network Era (1995 - ?) - Internet Phenomenon

- In 1996 the CIO turnover rate was 17.7%!\textsuperscript{1}

- Take Away: Managing IT in the Network Era is difficult, but if you do it right the rewards can be huge!

\textsuperscript{1}Deloite and Touche
Data and information

by
David G. Messerschmitt
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Key concept

The key commodity manipulated by information technology is information.
To be manipulated in a computing/networking environment, information must be represented by data.

What is information?
Information

From a user (human) perspective...
...recognizable patterns that influence you in some way
(perspective, understanding, behavior...)

In the computing infrastructure, information has a somewhat different connotation as structure and interpretation added to data
Data

A bit is “0” or “1” — the atom of the information economy

Data is a collection of bits, like

- “0101110111010110”
- “0000011”
- “1110111010110101011011010”

Note: the terms data and information are not always used consistently!
Representation

- Take the place of the original
- Equivalent to, in the sense that the original can be reconstructed from its representation
- Often the original can only be approximately reconstructed, although it may be indistinguishable to the user
  - e.g. audio or video
<table>
<thead>
<tr>
<th>Alphabet</th>
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<th>Binary</th>
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<tr>
<td>&lt;D&gt;</td>
<td>/x44</td>
<td>01000100</td>
</tr>
</tbody>
</table>

Note that this representation is not unique…

….this one happens to be a standard (ANSI X3.110-1983)
A picture

This picture conveys information

This information is represented in this computer, but how?
Representation of picture: image

Expanding a small portion of the picture, we see that it is represented by square pixels.

....300 tall by 200 wide.....

....with a range of 256 intensities per pixel

300 • 200 • 8 bits = 480,000 bits (but it can be compressed)
A color picture can be represented by three monochrome images…

At the expense of three times as many bits
Terminology

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Representation needs to be standardized

Information

If the representation is not standardized, the information is garbled!

Data

Communicate data to another user or organization

Data

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Regeneration

- Make a precise copy of the data (copy bit by bit)
- If you know the representation, this is equivalent to making a precise copy of the information
- Each such precise copy is called a generation
- process is called regeneration

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Replication of information

Anything that can be regenerated can be replicated any number of times.

This is a blessing and a curse.
Analog information cannot be regenerated

Analog information can be copied, but not regenerated

We will never know exactly what the original of this Rembrandt looked like
Discrete information can be regenerated

Regeneration can preserve data (but not its original physical form)

Regeneration is possible for information represented digitally (which is tolerant of physical deterioration)

0 + noise $\approx$ 0

1 + noise $\approx$ 1
Replication of information requires knowledge of representation.

Every .xxx DOS file is a representation.

Replication preserves the integrity of the data, but that is not sufficient.

Replication of information also presumes knowledge of its representation.

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Implications

Digitally represented information can be preserved over time or distance in its precise original form by occasional regeneration

- digital library
- digital telephony

Replication of data is easy and cheap
Implications (con’t)

- Replication of information requires knowledge of the structure and interpretation
  - Standardization or some other means
- Extreme supply economies of scale
- You can give away or sell and still retain
- Unauthorized replication or piracy relatively easy
Classify these

- “XV”, “SF”, 34, “CN”, 16
- The 49-ers won Super Bowl XV by a score of 34 to 16.
- The National Football Conference wins 17 out of 20 Super Bowl’s on average.
- The best team usually wins.

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Architecture

by
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What is Architecture?

How do you architect a solution?
A system is decomposed into interacting subsystems. Each subsystem may have a similar internal decomposition.
Three elements of architecture

Decomposition
Organization
Functionality
Responsibility
Interaction
Cooperation

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System examples

Let’s quickly look at some system decomposition examples

- Quick tour of information technology systems
Time sharing

ASCII terminal
(no graphics)

Point-to-point wire
(no network)

Mainframe
(database and application server)
Two-tier client/server
Three-tier client/server

- Client
- Application server
- Enterprise data server
System integration

Architecture

-> subsystem implementation

-> system integration

Bring together subsystems and make them cooperate properly to achieve desired system functionality

- Always requires testing
- May require modifications to architecture and/or subsystem implementation
Emergence

Subsystems are more specialized and simpler functionality

Higher-level system functionality arises from the interaction of subsystems

Emergence includes capabilities that arise purely from that interaction (desired or not)

- e.g. airplane flies, but subsystems can’t
Why system decomposition?

- Divide and conquer approach to containing complexity
- Reuse
- Consonant with industry structure (unless system is to be supplied by one company)
- Others?
Porter Competitive Model?

- **What is it?**
  - A model to help understand the competitive environment in which a company operates.

- **What are the “5 forces”?**
  - Intra-Industry Competition
  - Bargaining power of Suppliers
  - Bargaining power of Customers
  - Substitutes
  - Threat of New Entrants.
Porter Competitive Model
(Identify the Industry and the Specific Market Being Evaluated)

Potential New Entrants

Bargaining Power of Suppliers

Intra-Industry Rivalry
Strategic Business Unit

Bargaining Power of Buyers

Substitute Products and Services
Intra-Industry Rivalry
SBU: UCSC
Rivals: UC campuses, CSU, Private universities, Community Colleges

Bargaining Power of Buyers
- Students
- Parents
- Businesses
- Employers
- Legislators

Bargaining Power of Suppliers
- Faculty
- Staff
- Equipment and Service Suppliers
- Alumni
- Foundations
- Governments
- IT Vendors

Potential New Entrants
- Foreign Universities
- Shift in Strategy by Universities or Companies

Substitute Products and Services
- Internet Distance Learning
- Books and Videotapes
- Computer-Based Training
- Company Education Programs

Porter Competitive Model
Education Industry - Universities
Example: Usefulness of Porter Model

- Bob wants to start a dentist office
  - However, bob did not go to dental school
  - Bob will hire the dentist and other staff
  - Is this a good model?

<table>
<thead>
<tr>
<th>Suppliers</th>
<th>Bob’s Dentist Office</th>
<th>Buyers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dentist (Alice)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

New Entrants

Substitutes

No! Dentist has too much bargaining power, she could always go into business for herself.
Example: Usefulness of Porter Model

Suppose Alice, who is a dentist, opens an office

- **Suppliers**
  - Staff
  - Hygienists

- **Intra-industry rivals**
  - SBU: Alice’s Dentist Office
  - Other local dentist offices

- **New Entrants**
  - Dental School Graduates
  - Dentists moving in from other regions

- **Substitutes**
  - Alternative Medicine?

- **Buyers**
  - Public in general
  - Insurance companies
  - Those wanting cosmetic dentistry