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.

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

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

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

Reading Material:

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>Date</th>
<th>Class</th>
<th>Lecture Topic</th>
<th>Reading Homework Due</th>
<th>Homework Assignment and Due Date</th>
</tr>
</thead>
</table>
| 1    | 4/9   | - IT History and Evolution
      | a. Varian and Shapiro (VS), Chapter 1: The Information Economy
      | b. HBS IT History case study |
| 2    | 4/16  | - Finish Technology Learning
      | a. VS Chapter 2: Pricing
      | b. VS Chapter 3: Versioning
      | c. Porter, HBR, Strategy and the Internet |
| 3    | 4/23  | Web services, service oriented architectures
      | HBS XML/XML case study |

Homework Assignments and Due Dates:

- Reading Homework Due; posting in class comment thread required for papers in bold
- Project 1 assigned: web programming
## Evaluation

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

## Final Project

**Objective:**
- Demonstrate a working understanding of class concepts.

**Task:**
- Write a paper in groups of 2-3

## 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

### 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
    - 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?

Final Project Paper (choice 2 continued)

- 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/

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

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" such as Accounting, Finance, Engineering, etc.

Needed to keep track of massive amounts of data for:
- Payroll
- Payments to customers and suppliers,
- etc.

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)

Data Processing Era (1960-1980)
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

Data Processing 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

**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


- 1981 – IBM introduces its PC!
  - Intel develops CPU
  - Microsoft develops operating system
- IBM PCs were rapidly adopted by the commercial market.

**Build up to the Micro Era**

- 1977 – Apple introduces a successful microcomputer


- 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)

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>Company Name</th>
<th>Sales per Employee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975 (rank)</td>
<td>1990 (rank)</td>
<td>1997 (rank)</td>
</tr>
<tr>
<td>1 1Q General Electric</td>
<td>$94,215,000</td>
<td>$98,081,000</td>
</tr>
<tr>
<td>10 1Q Coca-Cola</td>
<td>120,397,000</td>
<td>122,934,000</td>
</tr>
<tr>
<td>9 2Q Pepsi Co</td>
<td>141,574,000</td>
<td>144,280,000</td>
</tr>
<tr>
<td>8 2Q Exxon</td>
<td>458,112,000</td>
<td>469,180,000</td>
</tr>
<tr>
<td>7 2Q Intel</td>
<td>392,246,000</td>
<td>394,438,000</td>
</tr>
<tr>
<td>6 2Q IBM</td>
<td>48,669,000</td>
<td>48,918,000</td>
</tr>
<tr>
<td>5 2Q Philips</td>
<td>52,014,000</td>
<td>52,357,000</td>
</tr>
<tr>
<td>4 1Q IBM</td>
<td>54,247,000</td>
<td>54,521,000</td>
</tr>
<tr>
<td>3 2Q AT&amp;T</td>
<td>53,526,000</td>
<td>53,880,000</td>
</tr>
<tr>
<td>2 1Q Procter &amp; Gamble</td>
<td>44,727,000</td>
<td>45,000,000</td>
</tr>
</tbody>
</table>

Source: Standard & Poor’s Compustat. Market values are the 1997 December 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."1

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%!1

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

1Deloite and Touche

Data and information

by

David G. Messerschmitt

Copyright notice

©Copyright David G. Messerschmitt, 2000.
This material may be used, copied, and distributed freely for educational purposes as long as this copyright notice remains attached. It cannot be used for any commercial purpose without the written permission of the author.

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
  "010110110110110"
  "0000011"
  "1101101101011010111011010110"  
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

ASCII

<table>
<thead>
<tr>
<th>Alphabet</th>
<th>Hex</th>
<th>Binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;&gt;</td>
<td>x37</td>
<td>00110111</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x38</td>
<td>00111000</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x39</td>
<td>00111001</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x3A</td>
<td>00111010</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x3B</td>
<td>00111011</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x3C</td>
<td>00111100</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x3D</td>
<td>00111101</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x3E</td>
<td>00111110</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x3F</td>
<td>00111111</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x40</td>
<td>01000000</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x41</td>
<td>01000001</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x42</td>
<td>01000010</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x43</td>
<td>01000011</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x44</td>
<td>01000100</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x45</td>
<td>01000101</td>
</tr>
<tr>
<td>&lt;&gt;</td>
<td>x46</td>
<td>01000110</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)
**Color picture**

A color picture can be represented by three monochrome images…

At the expense of three times as many bits

**Terminology**

![Diagram of information and data processing]

**Representation needs to be standardized**

![Diagram showing the relationship between information, data, and representation]

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

Communicate data to another user or organization

**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

**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 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

Replication of information requires knowledge of representation

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 Bowls on average.
- The best team usually wins.

Architecture

by

David G. Messerschmitt
What is Architecture?

How do you architect a solution?

A system is decomposed into interacting subsystems.

Each subsystem may have a similar internal decomposition.

System examples

Let's quickly look at some system decomposition examples:
- Quick tour of information technology systems

Time sharing

Point-to-point wire (no network)

ASCII terminal (no graphics)

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

- Local-area network
- Server/Mainframe

**Three-tier client/server**

- Client
- Enterprise data server
- Application 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
- Intra-Industry Rivalry
- Bargaining Power of Suppliers
- Strategic Business Unit
- Bargaining Power of Buyers
- Substitute Products and Services

---

**Porter Competitive Model**

*Education Industry – Universities*

- Potential New Entrants
- Intra-Industry Rivalry
  - SBU: UCSC
  - Rivals: UC campuses, CSU, Private universities, Community Colleges
- Bargaining Power of Suppliers
  - Faculty
  - Staff
  - Equipment and Service Suppliers
  - Alumni
  - Foundations
  - Governments
  - IT Vendors
- Substitute Products and Services
  - Internet Distance Learning
  - Computer-Based Training
  - Company Education Programs
- Bargaining Power of Buyers
  - Students
  - Parents
  - Businesses
  - Employers
  - Legislators

---

**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?

```
Suppliers
| Dentist (Alice) |
---|---|
Buyers
| Bob’s Dentist Office |
```

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
| Hygienists |
---|---|
Buyers
| Staff |
```

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