Computer Mediated Transactions

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Outline

- Waves of innovation
  - Combinatorial innovation
  - What are implications for commerce?
- Computer mediated transactions
  - There is now a computer between most buyers and sellers
  - What are the implications for business?
- Collaborative computing
  - There is now a computer in most offices
  - What are the implications for work?

Waves of innovation

- Huge innovation on web in the last 15 years
  - Web pages, search engines, wikis, docs, maps ...
    - Why has there been so much innovation?
    - Why has it been so rapid?
- Examples of combinatorial innovation
  - Set of component technologies that can be combined and recombined to create new innovations
    - 1800: Interchangeable parts
    - 1900: Gasoline engine
    - 1960: Integrated circuits
    - 1995-now: Internet
  - Shumpeter (1935), Usher (1929), Weitzman (1998), and others...
  - Often process takes years, or decades to play itself out, but this time it was very rapid

But this time…

- Component parts are all bits!
  - Protocols: TCP/IP, HTTP, CGI, Flash …
  - Languages: HTML, XML, Java, JavaScript ...
  - Software: LAMP (Linux, Apache, MySQL, Python)...
- Bits/protocols/languages can be combined to make…
  - Web pages,wikis, auctions, exchanges, video streaming, VOIP, search engines…
  - No time-to-manufacture, no inventory problems, no delivery problems
  - Bits can be shipped around the world in seconds, and innovators can work in parallel exploring combinations
- Result: extremely rapid evolution and technological progress
- Question: what are implications for commerce?

Computer mediated transactions

- A computer is now involved in almost every economic transaction
  - Even cash registers are just PCs with a special interface
  - B2B and web-based transactions are even more powerful due to direct connection to a database
  - Original intent of computer mediation was just accounting
  - But the record of transactions has other uses
  - *How does the availability of computer-mediated transactions affect economic activity?*

What are implications?

- What do computer mediated transactions enable?
  - Better contracts
  - Data extraction and analysis
  - Controlled experimentation
  - Personalization and customization

Better contracts

- Contracts are fundamental to commerce
  - Simplest form: “I will do X if you will do Y”
    - Exchange of goods, services, labor, ...
  - Major problem: monitoring the contract
    - Sometimes performance can be directly observed
    - But often the quality of goods, service, actions, effort may not be observed
    - Large literature in contract theory and mechanism design
  - Where do computers come in?
    - Make more things observable and hence contractable
    - Historically, advances in “information technology” have often enabled better measurement and monitoring
    - Computers move this capability to a new level

Computer as accountant

Francesco di Marco Datini

- Since the computer serves as intermediary it can not only serve as an accountant but also be used to verify contractual performance
- Allows us to structure more elaborate contracts and potentially improve economic efficiency

Computer as monitor

Francesco di Marco Datini

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Computer as verifier

Francesco di Marco Datini

- Since the computer serves as intermediary it can not only serve as an accountant but also be used to verify contractual performance
- Allows us to structure more elaborate contracts and potentially improve economic efficiency
- Accounting + computers = better monitoring = potentially better contracts

Rental cars

- Assume...
  - Insurance for rental cars would cost less if renters drove more slowly
  - Drivers would be willing to drive more slowly if they paid less for rental car
  - But contract can not be made since driving speed can't be observed
- But now...
  - Contract is feasible due to vehicle monitoring technology
  - Everyone is made better off (in this model)

Historical examples

- Mediterranean shipping 3300 BC
- Cash registers 1883
- Semi trucks 1980s
- Video stores 1990s
- Online advertising 2000s

Mediterranean shipping 3300 BC

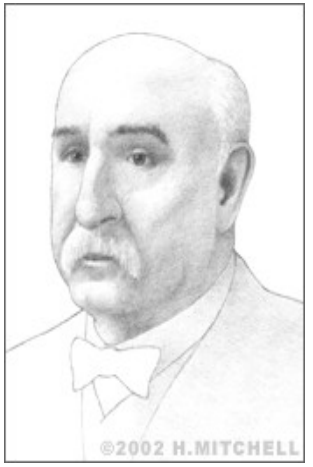
- How do you ensure that your full shipment is received at other end of voyage...with no written language?

- Answer
  - Match clay tokens (*bullae*) to jars of oil loaded on ship
  - Seal tokens in clay envelope, stamp clay with seal
  - Bake in kiln, send with shipment
  - At other end of journey, recipient breaks open the envelope and compares tokens to jars on ship
  - Later, inscribe marks on bullae as record of what is inside, which may have led to writing

Examples of bullae 3300 BC

How do you ensure employees don't steal?

- From cash register
  - Answer: put a bell on it
  - 1883 patent to James Ritty and John Birch for the “Incorruptible Cashier”
  - Paper tape + bell recorded transactions
- From truck
  - Put a “vehicular monitoring system” on it
  - Improves gas mileage, logistics, and honesty!
  - Hubbard (2000)



Video store rentals

- Originally store purchased video tapes from studio, rented to customers
  - But price was high, so store only bought a few
  - Much unhappiness among all parties
- Revenue sharing model
  - Distributor *gives* videos to store at nominal price
  - Each time one is rented, revenue is shared according to pre-specified formula
  - Dana and Spier (2001), Mortimer (2008),
- But need verifiable way to count the transactions
  - Use bar codes, computers, and network
  - Each party to the transaction can verify correctness on a daily basis

Align incentives in online advertising

- Publisher has space for ad impression on page, wants to sell it to the highest bidder
- Advertiser doesn't care about ad impressions, wants clicks = visitors and sales
- Answer
  - Value per impression = value per click x clicks per impression = VPC x CTR
  - CTR is the “exchange rate” you can use to convert one to the other. How to estimate?
  - Huge statistical/machine learning problem
  - Aligns incentives between publisher, advertiser and user
- Revenue sharing
  - Publisher and ad provider can share revenue from click

Example

- Advertiser
  - Joe's Jets and Moe's Models both want keyword “jet airplane” but there is space for only one ad
  - Joe is willing to pay a lot per click since he makes high profit selling jets
  - But Moe gets a lot more clicks than Joe because more people buy models than real jets
- Publisher
  - What publisher cares about is expected revenue = price per click x expected number of clicks
- Ad network
  - Tries to estimate expected number of clicks, which (typically) allows it to make a better choice of which ad to show
  - So all major search engines estimate CTRs for ad ranking, allowing publishers to sell impressions and advertisers to buy clicks

Computer mediated transactions make advertising accountable

- A purchase can be linked back to a click or an impression, making advertising accountable
  - ...at least on a statistical basis
  - Allows for optimization and tuning of purchase process
- Examples
  - Search advertising
  - Contextual advertising
  - Display advertising
  - Mobile advertising
  - TV, radio, print more difficult due to lack of feedback

Data extraction and analysis

- Since online transactions are computer mediated, can study data for patterns
  - Which converts better [diamond] or [diamonds]?
  - How do clicks vary over time of day?
  - What keywords perform best?
  - What advertiser characteristics predict success?
- Build predictive and causal models
  - Formulate hypotheses
  - Build models and estimate parameters
- But you don't stop there...

Controlled experimentation

- Data from computer mediated transactions allows for measurement
  - But it takes controlled experimentation to determine causality
  - Online applications allow for controlled experiments and continuous improvement
  - “Process kaizen” in 1980s now becomes “product kaizen”
  - 6,000 experiments in 2009, 500 improvements on search alone
  - Data vs HiPPO

Customization and personalization

- Computer mediated transactions allow for “mass customization” whereby transactions can be optimized for individuals
- Purchases, searches, social interaction, etc.
- Most web ads are dynamically assigned
- Challenges
  - Benefits of personalization v privacy considerations
  - However interests are not diametrically opposed
    - Intended use: provide better services to users
    - Unintended use: fraud, extortion, embarrassment
    - Better security, information, transparency, user control can go a long way in aligning interests

But advertising is just the beginning...

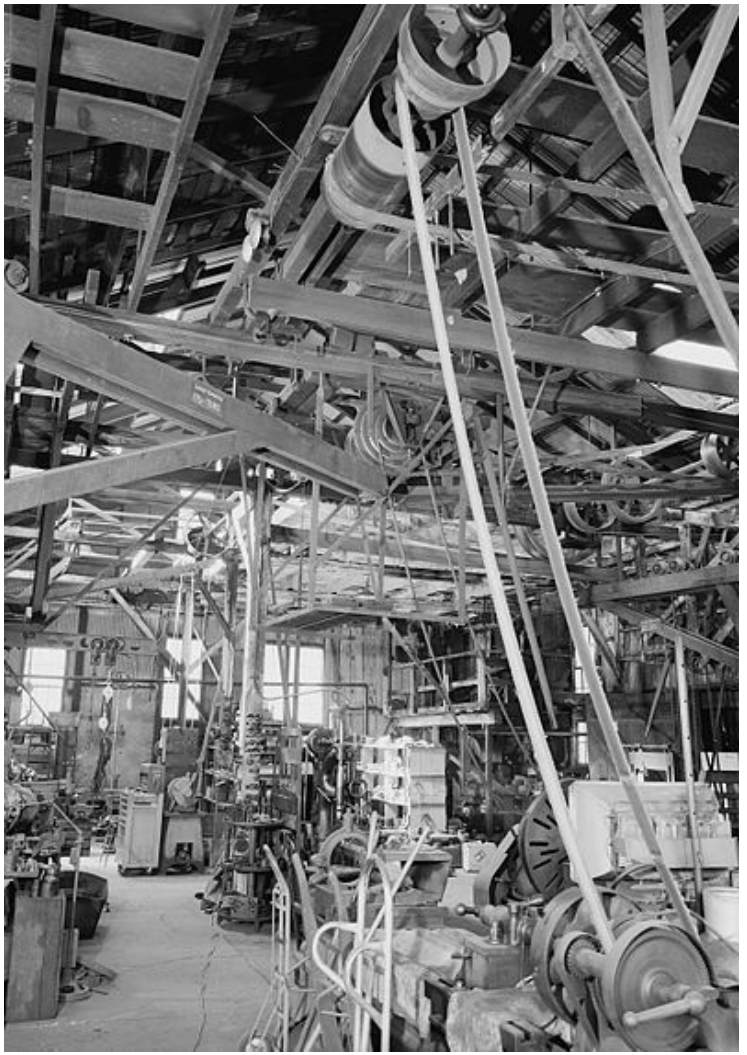
- Computer mediated transactions make advertising accountable
- But computer mediated transactions also allow for other kinds of optimization
  - Logistics and transportation optimization
  - Customer feedback and interaction
  - Product design and evolution
  - Recommender systems
- Improves business processes across the board
- What are implications for worker-to-worker transactions?

“The computer and the dynamo”

- Paul David (1990) on the productivity of electricity
  - In early 1800s waterwheels powered plants
  - All machinery connected to central shaft
  - Clustered machinery by type as in model

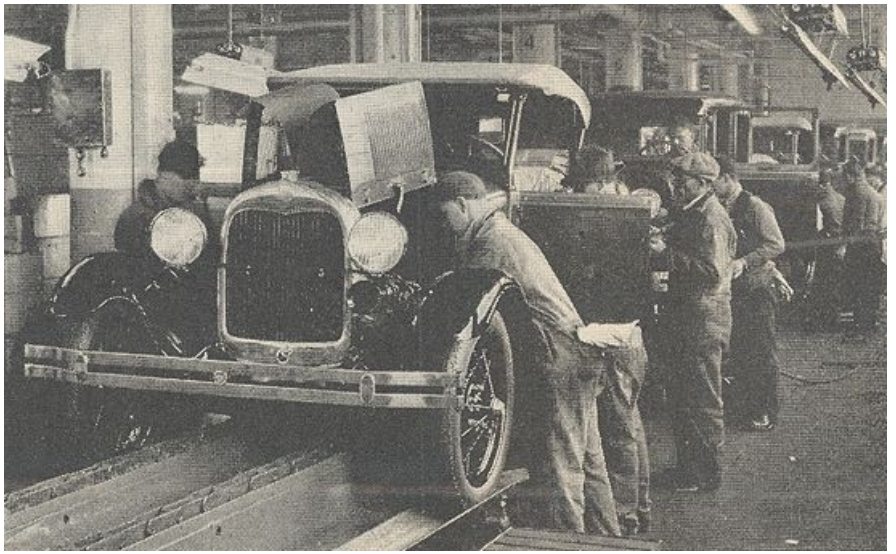
Improvements in power

- Steam and then electric motors used same design
- Miniaturization of electric motor made it possible to power each machine separately
- Allowed for rearrangement of production...but no one did it. ``We've always done it this way."
- Henry Ford and the assembly line offered the breakthrough
- Allowed for dramatic increases in productivity



Henry Ford and mass production

- Ford realized that he could rearrange production and assembly so as to optimize production
- Put the machines where they were needed, not where they “had always been”



Knowledge workflow

- Assembly of mechanical parts
  - Assembly lines: optimize the flow of physical product through factory in 1909
- Assembly of ideas
  - Collaborative computing: optimize the flow of ideas through the organization in 2009
    - Separation, distribution and optimization of tasks
    - Multiauthored documents to facilitate collaboration
    - Version tracking and control
    - Overcome barriers of distance
      - Outsourcing specialized tasks (McKinsey)
      - Adam Smith's pin factory for knowledge work
      - ...and on a global scale

Enabled by “cloud computing”

- Evolution of computing
  - Mainframe
    - Data was in one place but access was controlled
  - Networked workstation
    - Data in work group, direct access
  - Personal computer
    - Direct access, data mostly on single computer or LAN
  - Network computing
    - Data on network, direct access but mostly for download
  - Cloud computing
    - Direct access, data lives in cloud
    - Store once, read everywhere, write anywhere via the Web
    - Access from any device, at any time, by any authorized user

Infrastructure for rent

- Barriers to entry for online businesses have been dramatically reduced
  - Can purchase computation in data center, storage on demand, development environment and database services from cloud computing providers
  - Turns fixed cost into variable cost
  - Allows you to smoothly scale your business to meet customer growth
  - Pushes “combinatorial innovation” to a new level
    - Not only innovation is combinatorial, but now actual deployment!
    - Can foster a huge burst of creative activity

Micromultinationals

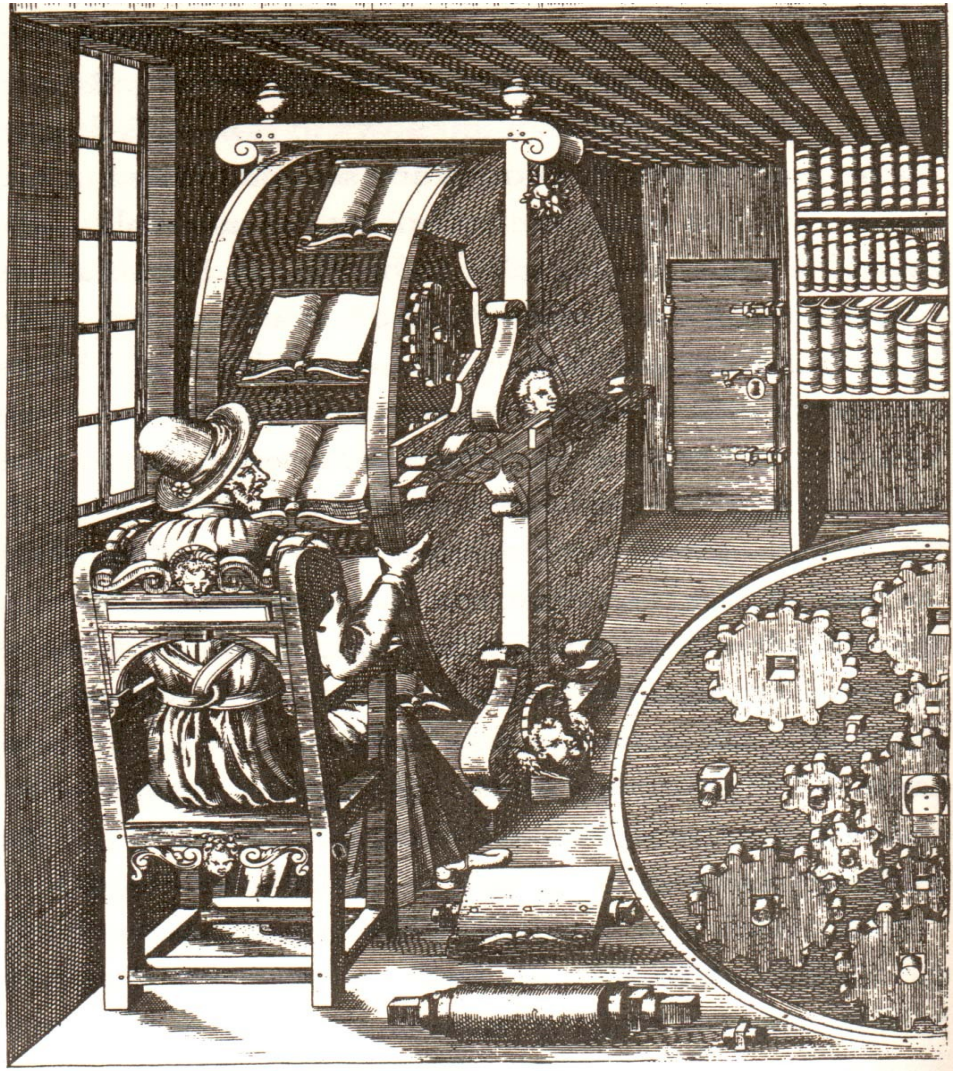
- Cheap communications
  - SMEs now have access to communications technology that only the mega-multinationals could afford a decade ago
  - Email, webpages, wikis, VOIP, wireless, collaborative computing, cloud computing
  - Opens doors to small business around the world
- Combinatorial innovation
  - Businesses can be born international
  - Fosters huge parallel innovation in both technology and commerce
  - This is only the beginning...

The End

Appendix

- Various unused slides below

Early attempt to optimize knowledge work with hypertext...



Bookwheel, from Agostino Ramelli's
Le diverse et artificiose machine, 1588.

Disassembly line