#### "The Innovators" The Age of the Digital Revolution

#### "How a Group of Hackers, Geniuses and Geeks Created the Digital Revolution."





















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Session 7



#### Session 7

 To be Online: Information, actions, activities or entertainment accessible by means of a computer, phone, handheld device over digital networks.

• The Web

• Spoiler alert: Sixty years in coming!

#### Factoids



- Email remains the most popular application, with over a billion and a half users spanning the globe and communicating across the traditional barriers of time and space.
- At first, his email messaging system wasn't thought to be a big deal. When Ray Tomlinson showed it to his BBN colleague Jerry Burchfiel, Tomlinson said "Don't tell anyone! This isn't what we're supposed to be working on."
- For more information than you can absorb go to the Internet Hall of Fame: http://internethalloffame.org.

# The Average Joe Begins to Connect to the Internet

- AT&T had a near lock on their phone system. You could not connect anything to it, even in your own home, unless it was a Western Electric approved product or a service that you leased from AT&T.
- After bitter unsuccessful litigation in the early 1970s by AT&T to protect their system, inexpensive non-AT&T modems [modulators/demodulators] become available and more technically capable.
- The FCC formally removed restriction in 1975 allowing consumers to connect to the telephone system through the use of standard connectors and defined signal parameters.

#### The breakup of the Bell System

- As a result of a Federal anti-trust lawsuit, the AT&T Corporation on January 8, 1982, negotiated and agreed with US DOJ that it would relinquish control of the Regional Bell Operating Companies [RBOCs].
- Up until that point the 20 RBOCs provided the majority of the local <u>urban</u> telephone service in the United States.
- This effectively took the monopoly that was the Bell System and split it into 7 entirely separate RBOCs that would continue to provide "local" telephone service.
- AT&T would continue to be a provider of long distance service, while the now independent RBOCs would no longer be directly supplied with equipment from AT&T's subsidiary — Western Electric.
- Significance: This open local and national competition for digital transmission services

#### The Hayes Smart-Modem 1981

At first, available modems were expensive and clunky.



- Then competition and standardization propelled prices down and performance up.
- The modem made computer digital signals look like voice signals.
- At first there were only attached intermediate audio hook-ups, then computer manufacturers eventually provided standardized inputs/outputs.



# Dial Up

- The modems called legitimate local phone numbers and transmitted digital data in analogue form to an Internet Service Provider [ISP].
- The ISP interfaced with the digital world. Digital responses came back to the ISP and were converted to analogue for transmission over the local telephone line to your home.
- When you connected, you tied up the phone Line. Your sister, who had a normal social life, was annoyed that potential calls offering her dates were blocked by her nerdy brother.
- Local telephone service capacity was calculated on short voice calls. Now there was more traffic on the lines than anticipated.
- There was a service that answered while you were on line and flashed a note on the computer screen that there was an incoming call that you could answer; if it was important.

#### **Telephone Connections**

Initially telephones were hard wired to the wall jack.

• Then there were four pin connectors for extension phones.



• Then there was the RJ-12 snap-in connector.





### Digital Subscriber Line (DSL)— The Internet Break Through



**Bell Laboratories** 

- DSL technologies provided internet access to homes and businesses by transmitting digital data <u>over existing telephone lines</u>. DSL service is delivered simultaneously with <u>voice telephone service</u> on the same telephone line. This is possible because DSL uses higher <u>frequency bands</u> for data than those used for voice.
- Consumer DSL services bit rates typically ranges from 256 Kbit/s to over 100 Mbit/s in the direction to the customer (<u>downstream</u>).
- A 2012 survey found that "DSL continues to be the dominant worldwide broadband access technology" with >364.1 M subscribers.
- The theoretical foundations of DSL, like much of communication technology, can be traced back to Dr. Claude [Boolean Logic Fame] Shannon's seminal 1948 paper: A Mathematical Theory of Communication.
- A Bell patent was filed in 1979 for the use of [1] existing telephone wires for [2] both telephones and data terminals that were connected to [3] a remote computer via [4] a digital data carrier system.

#### **Stuart Brand and The Well**



- In 1984 just as modems and personal computers were becoming available. Stuart Brand, a writer, best known as editor of the <u>Whole Earth Catalog</u> organizes a prototype on-line community - The Well.
- He founded a number of other organizations, including the <u>Global Business Network</u>, and the <u>Long</u> <u>Now Foundation</u>.
- The Well was open a to all subjects, but you had to identify yourself.

"You own your own words, you are accountable for what you are posting."

• It was OBE'ed by others, but it still around.

#### America On Line





• William von Meister







• Jim Kimsey

Pathological Entrepreneur Western Union Mailgram Service The Source AOL Cable and Wireless (in the US) Quest Communications MCI

Super Salesman AOL's Free floppies Venture Capitalist

Hard Nose Manager Control Video Corporation First CEO of AOL Washington Real Estate

#### The Odd Triumvirate Succeeds

- The undisciplined idea generator von Meister, the strategic planner Case and the rough edge commando Kimsey.
- Initially they developed networks based on specific computer brands: Quantum for Commodore and Applelink for Apples, etc.
- Then in 1984 CBS, IBM and Sears launched Prodigy.
- They realized that they needed a system that was computer independent. Case came up with the name American on Line. The others did not like it. Case prevailed. It was 'Jobs' like— it was simple, unintimidating and sappy.
- Business Model: Case "firebombed" the nation with free two month subscription discs. Insert disc, register and go!
- An AOL voice-over Says "Welcome!" and "You've got mail."
- Case said that they developed a community.
- He recently commented, "Now People call it social media."

# **CompuServe (CompuServe Information Service)**



- Running prior to and in parallel with AOL was CompuServe, the first major commercial online service in the United States.
- It dominated the field during the 1980s and remained a major player through the mid-1990s, when it was sidelined by the rise of services such as AOL with monthly subscriptions rather than hourly rates.
- Eventually AOL purchased a large portion of CompuServe.



# AOL Time Warner

Email Chat rooms Instant messaging Games Educational products

In 1997 <u>half</u> of US households with internet capacity had AOL

**Acquires Netscape** 

From a Fortune Magazine article The landscape of mergers and acquisitions is littered with business flops, some catastrophic, highly visible disasters that were often hugely hyped before their eventual doom.

January 10, 2015, marks the 15th anniversary of one such calamity when media giants AOL and Time Warner combined their businesses in what is often described as the worst merger of all time.

But what happened then will happen again, and ironically for the exact same reasons.
•Untested assumptions are taken as facts.
•Few opportunities exist for inexpensive, low-commitment testing.

Leaders are convinced they have the answers and not willing to change course.
Huge up-front investment, rather than a staged or sequenced flow of resources.
Massive uncertainty and a sense of time<sub>15</sub> pressure.

#### **Mark Zuckerberg and Facebook**



Together with his college roommates and fellow Harvard University students Eduardo Saverin, Andrew McCollum, Dustin Moskovitz, and Chris Hughes, Zuckerberg launched Facebook from Harvard University's dormitory rooms in 2004.

The group then introduced Facebook onto other campuses nationwide and moved to Palo Alto, California shortly afterwards.

In 2007, at the age of 23, Zuckerberg became a billionaire as a result of Facebook's success.

#### The number of Facebook users worldwide reached a total of one billion in 2012.

Zuckerberg was involved in various legal disputes initiated by others from Harvard, who claimed they visualized the system first.

#### **Internet as Transport to Social Media**

- Facebook
- Tweeter
- Tumblr
- Linkedin
- Instagram

f f tumblr.



• Et al

They are enjoyable; but are they ultimately useful in our lives? Do I really care; if you just bought a cup of coffee?





#### Male: I already texted you that I am not in the mood! Female: If this is evolution, we are doomed!



## The WorldWideWeb

- Tim Berners-Lee, Oxford Mathematician, gets a two year consultancy in 1980 and later in 1984 a fellowship at CERN.
- CERN: The European Organization for Nuclear Research (French: Organisation européenne pour la recherche nucléaire).
- He is confronted with a problem that CERN has large numbers: Over 2,500 staff members, and hosts some 12,300 fellows, associates, apprentices as well as visiting scientists and engineers representing 608 universities and research facilities and 113 nationalities. A tower of Babel.
- It is a cauldron of ideas. They are all working multiple projects and preparing papers and notes in dozens of languages on dozens of different computers with different operating systems:
- How can they communicate and collaborate?
- He believes that if the left hand knew what the right hand was doing, even if the programs were different that there would be unexpected collaboration.
- In this instance he starts working alone part-time on a solution.
- Then leaves CERN for a commercial job but returns 2 year later and picks up on his collaboration scheme.





- With its different languages, both verbal and digital, CERN was a microcosm of the rest of the world.
- "I was looking for a system that would allow people to brainstorm and keep track of the institutional memory of projects"
- He wanted more than a data management system.
- He hit upon a simple maneuver that would allow him to make connections he wanted: <u>hypertext</u>.
- Now ubiquitous, <u>hypertext</u> is a word or phrase that is coded that when it is clicked; it sends the reader to an other document of piece of content.<sup>22</sup>

## **Origin of Hypertext**

Hypertext is text which contains links to other texts. The term was coined by Ted Nelson around 1965. Hypermedia is a term used for hypertext which is not constrained to be text: it can include graphics, video and sound.

Apparently Ted Nelson was the first to use this term too.





**Ted Nelson gives a presentation on Project** Xanadu, a theoretical hypertext model conceived in the 1960s whose first and incomplete implementation was first published in 1998

**Theodor Holm Nelson** is an American pioneer of information technology, philosopher, and sociologist. 23



- <u>Hypertext</u> was the core of his system. Anyone could link to documents on other computers, even those with different operating system, without asking permission.
- There was no central hub, no command hub; if you knew the address you could link to it.
- He adapted a protocol called a Remote Procedure Call. It allowed a program on one computer to call up a subroutine on an other computer.
- He prepare a set of principles for naming each document; Initially each had a <u>Universal Document Identifier</u>.
- He worked through the DARPA Internet Interface working group and UDI eventually became renamed the Uniform Resource Location (URL)

#### **Robert Cailliou and WorldWideWeb**



- At the end of 1989 Berners-Lee prepared a proposal for CERN management for funding to build out and implement his scheme.
- His request was down in the weeds and it baffled them. "Vague but exciting." Once again, a brilliant but self-effacing engineer needed a collaborator to turn a concept into reality: Robert Cailliou
- Robert Cailliou, a Belgian physicist at CERN had also been thinking about a similar system, but was nowhere as advanced. But, he was the project manager and salesman to Berners-Lee as Jobs was the manager and salesman to the visionary engineer, Wozniack.
- They joined forces and Cailliou worked the CERN management.
- They need a catchy new name, one that evoked breadth and universality within a scientific community
- They revised and streamlined the proposal:
  - WorldWideWeb: "Proposal for a Hypertext Project."
- Thus the Web was named

#### **Web Implementation**

- By the end of 1990 Berners-Lee created a suite of tools that allowed the network to come to life:
  - A <u>hypertext transfer protocol</u>: HTTP, that allowed hypertext to be exchanged on line.
  - A <u>Hypertext Mark Up Language</u>: HTML for creating pages.
  - A rudimentary browser to retrieve and display data.
  - Server software that could respond to requests from the network.

#### World Wide and Free

- Once the system was operational; the CERN, management wanted to patent it.
- Berners-Lee objected and successfully argued that for the system to spread and to be useful in the research world, it needed to be free. CERN acquiesced.
- The system was placed in the public domain and adopted Richard Stallman's General Public License.
- The result was one of the grandest free and opensource projects in history. This momentous project tip-toed into use on <u>August 6, 1991, 14:56, GMT-1</u>, when he responded to an Internet news group question: "... anyone know anything about hypertext retrieval research?"
- He responded from <u>timbl@info.cern.ch</u> the first public announcement of the Web.

#### Now Make It Universal



- To be universal the Web needed a browser.
- The CERN system only ran on NeXT computers of which there were only a few.
- Berners-Lee enlisted a CERN University intern, Nicola Pellow, to write the first all purpose browser for UNIX and Microsoft operating systems. It was rudimentary, but it worked.
- Then leaping on the collaboration he hoped the Web would spawn, he asked for improvements. He soon had six and other recommendations poured in.

#### Web Expansion

- By the end of 1991 there were six European experimental versions at other research centers.
- In December, the leap over the Atlantic, Dr. Paul Kunz from Stanford was at CERN.
- Kunz reluctantly agree to a briefing by Berners-Lee. He thought that it would be an other boring talk down in the weeds on info management.
- His eyes were opened as Berners-Lee pulled info from some IBM computer someplace else.
- Kunz brought the software back with him and hppt://slacvm.slas.stanford.edu became the first Web server in the US.
- 1993 Web hits orbital velocity: January 50 Web servers in the world, by October 500.

#### Marc Andreesen/Eric Bina and

- The word was spreading.
- In the US the U of Minn. had package called Gopher.
- Then at the University of Ill., from the National Center for Supercomputing Applications<sup>\*</sup>, an easy to install and graphics rich browser: Mosaic. It was built in two month binge by Marc Andreesen and Eric Bina.
- They had witnessed a CERN version and knew that it could be improved. Just as Berners-Lee anticipated.
- On Jan 23,1993 with little fanfare, marca @ncsa.uiuc.edu announced Mosaic on the www-talk Internet newsgroup.
  - "By the power vested in me by nobody in particular," alpha/beta version 0.5 of NCSA's Motif based networked information system and World Wide Web browser X Mosaic is hereby released."
  - \* Funded by the Gore Act

#### But Berners-Lee's Dream Was Dampened



- Once again a collaborating team: Marc Andreesen, a product driven visionary/Eric Bina a methodical programmer.
- Two days after the release, Berners-Lee posted, "Brilliant, each new version is sexier."
- Andreesen, had a canny entrepreneurial instinct to respond to users inputs and turned out release after release incorporating user feedback.
- He had the lore of wizz-bang and money
- Berners-Lee became disappointed, Mosaic was enabling rich media for publishing eye-catching pages; he felt that the focus should be on tools to facilitate serious collaboration.
- A year later, 1994, Andreessen joins with an other entrepreneur, Jim Clark, to launch Netscape Navigator, a commercial version of Mosaic.

#### The Web Business Model

- Berners-Lee visited Tim Nelson, who 25 years earlier described a system for his Xanadu that would have a scheme for two way collaboration with a micro payments for content providers.
- The payments scheme was not established.
   Isaacson was working for *Time, Inc.* and set up their online versions.
- Time, Inc. intended to charge a subscription, but advertisers flocked to pay for banner ads and the services and content were free and the public was conditioned to have free access burdened with ads.

#### **Attempts-Initial Success**

- The first site cataloging attempts were hand assembled lists: Hall's • "Links from the Underground," Paul Phillip's "Useless Pages," Tim Berners-Lee's "WWW Virtual Library," NCSA's "What's New," Tim O' Reilly's" Global Network Navigator."
- Along with these, two Stanford graduate students Jerry Yang and • David Filo, created "Jerry and David's Guide to the Web." They did everything they could to avoid finishing their dissertations.
- When Mosaic was release they began to assemble by hand a growing list organized by categories, each with dozens of sub-categories.
- By the end of 1994 they renamed their guide **Yahoo**. Sites kept increasing they could not keep up.
- But tools were becoming available to do the search and listings. The • tools used link hopping robots or **bots** darting around the Web picking URLs and data about sites, these would be in placed a database accessible by a query server.

#### **Initial Search Tools**

- WWW Wanderer built by Mathew Grey at MIT
- WebCrawler built by Brian Pinkerton at U of wash
- AltaVista built by Louis Monier at DEC
- Lycos built by Michael Mauldin at Carnegie Mellon
- OpenText built by a team at the U of Waterloo in Canada
- Excite built by a team at Stanford.

### Yahoo's Model Could not Keep Up

- Yahoo licensed a crawler and continued to builds their lists by hand.
- If a query matched their list, fine, if not then the crawler was sent out.
- Yahoo had assembled a team. The team's hand selecting lists made for better news selection but not general search.
- Eventually they were overtaken by an automated search engine built by two other Stanford grad students.



# Google is actually a misspelling of Googol which connotes the large number 10<sup>100</sup>; that is, the digit 1 followed by 100 zeroes.

#### Larry Page, Sergey Brin and Search

- Larry Page and Sergey Brin's parents were academics. The Pages taught computer science and Math at U of Mich, and Mr. Brin taught computer science at the U of Moscow, Mrs. Brin was a mathematician at the State oil and Gas Institute.
- The Brins became refusnicks, lost their jobs, eked out an existence for a few years, but eventually made it to Maryland, where he taught at U of Maryland and she worked at NASA Goddard.
- Both boys were schooled in math and science from their earliest years. Sergey had a Commodore 64 in Jr. High.
- Page went to U of Mich and Brin went to U of Maryland. They both applied to grad school at MIT and Stanford. MIT rejected th n Stanford accepted then.
- They met on campus, they had similar interest, they became the best of friend, they collaborated and we have
- Let the story continue .....





Larry and Sergey



- Brin studied Data Mining
- Page studied Human Computer Interaction and Symbiosis. It was the field that was pioneered by Licklider and Englebart. This was considered soft science-Turing Machine-ish.
- Larry and Sergey had complimentary personalities.
   Page was not a social animal. Brin could be charmingly brash.
- They were office mates and the best of friends.
- Both Larry and Sergey were searching for dissertation topics. Eventually Page settled on a project to assess the relative importance of different sites on the Web.

#### Problem: Berners-Lee Designed a WWW That Only Looked in One Direction

- You could look at a web page and see all the links going out but you could not see the number and quality of the links pointing in.
- So Page set about to develop a huge database of links to follow them in reverse to see which sites were linking to which page.
- He had a classic midnight idea; spent the next day writing and describing what had to be accomplished and possibly how.
  - Mapping the Web is not simple. Even in Jan 1996, there were 100,000 web sites with 10 million documents and close to a billion links between them and growing exponentially each year.

#### **Start of a Solution: A Web Crawler**

- In July 1996 Page built a Web Crawler, named Back Rub, that started on his page and just went out as far as it could. He collected 24 million URLs and 100 million links and believed that he only covered 15 % of the Web. He was running out of memory and bandwidth.
- He realizes that he is not ranking the sites by "Importance." This is where Brin comes in. They realize that if their Back Rub could rank the importance of the sites [by who establishes them, who interrogates them and how often] they could grade the site.
- Example: Looking for data on Prostate Cancer The Johns Hopkins site appears and is often interrogated by medical oncologists and NIH queries. This earns a high ranking, and placed first on the list of Prostate Cancer hits.
- Google is born here!

#### Back Rub becomes Page Rank

- The mathematics were very extensive but were solvable.
- They continue to refine and test their system.
- They continued to add computing power and also studied:

   [1] How the users could use the system.
   [2] How far down the list of sites did a users go before stopping, presumably finding what they wanted?
   [3] How was the data presented?
- By 1998 their database contained maps of > 518 M hyperlinks out of approximately 3B on the Web.
- They wanted to turn their dissertation into a business and were reluctant to publish much. But, their advisors needed something to cover the University's investments.
- So, they presented a 20 page paper in 1998 in Australia. *The Anatomy of a Large-Scale Hypertextual Web Search Engine*.

#### Stanford University's Commercial Model Technological Entrepreneurship Was Expected

- There are hundreds of Research Universities in the US. They have an academic model: Research, publish, teach.
- Stanford from its founding had/has a commercial model. Great research. OK! ... But what will you do with it? How will these great ideas and breakthroughs be used to better civilization. What are the product and services and where are the companies that will implement them?
- Stanford established SRI in the 1940s, a company where ideas were commercialized and a environment where grad students could work and earn \$\$.
- The University helped get patents and legal assistance to establish companies.
- Page and Brin were surrounded by this ethos.

#### Their Paper Was Only a Thinly Veiled Presentation - This Was a Commercial Product

- The presentation concluded. "Google is designed to be a scalable search engine. The primary goal is to provide high quality search results."
- Google was consistent with Stanford's commercial credo. "The best way to provide an idea is to build it; not write about it.

- Stanford President John Hennessy

 So they attempted to license their concept and preliminary computer/software/database suite.

#### They found A Surprising Lack of Interest *In Search*

- They were turned down by Yahoo, Excite and AltaVista.
   "Search is not that Important!"
- So assisted by Stanford they thought about starting their own company. In August 1999, one of their professors arranged a meeting with a prominent venture capitalist, Andy Bechtolsheim.
- A phone call was followed with a meeting with him early the next morning.
- As a VC he reviews and rejects investment ideas by the dozens. "Most are PowerPoint vaporware!"
- Case and Brin brought a working model that Bechtolsheim used. He entered specific queries that produced better results than AltaVista!
- "This is the best idea that I have heard in years."

#### I'm In! Bechtolsheim Writes a Check for \$100,000

- They discuss what they have been doing to sell the product. They were asking a \$1 Million for licensing rights. Bechtolsheim tells them that they were pricing their enterprise too low. Go form your own company.
- He recommend that they consider clearly placed ads in the retrieved lists. Cash Flow!
- He writes a \$100,000 check to Google Inc.
  - "But we don't have a checking account."
  - "So, go open one."
- The check spurred them to incorporate.
- They splurge by going to Burger King for breakfast.

#### **Google World Headquarters**

- With further well place demonstrations and Bechtolsheim's reputation more investments poured in, including \$\$ from both of Silicon Valley's two key investment rivals.
- They rented a house with a two car garage in Menlo Park CA, and wrote on a white board mounted over the door "Google World Headquarters."
- Their approach melded both human and machine intelligence.
- The Google search algorithms relied on billions of <u>human</u> judgements!

#### "As We May Think" – Google Sixty Years in Coming. Isaacson, Page 465

- Bush's 1945 challenge: "The summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent maze to the momentary important item is the same as a that used in square-rigged ships."
- "Brin and Page made the same point in their paper. Their words were less elegant but they succeeded in fulfilling Bush's dream of a human-machine collaboration to deal with information overload.
- Goggle became the culmination of a 60 year process to create a world in which humans, computers, and networks were intimately linked."

#### The Dream of Human-Machine Collaboration by the Individual



#### DILBERT SCOTT ADAMS



No discussion of software development and the Software Department would be complete without a Dilbert reference

Google

#### "Google makes everyone a GENIUS" Eleanor Cassion, First Lady, in David Baldacci's The Target

