

Higher Education
in the New Century:
Themes, Challenges,
and Opportunities



A Social Transformation

The 20th Century

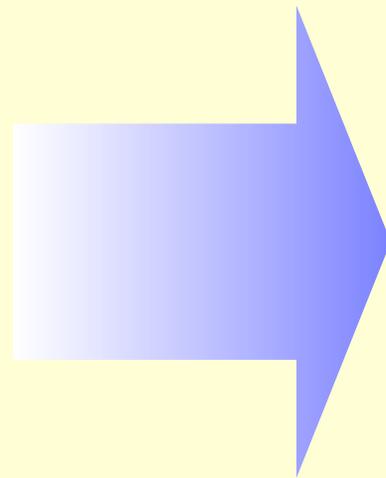
Transportation

Cars, planes, trains

Energy, materials

Nation-states

Public Policy



The 21st Century

Communications

Computers, networks

Knowledge, bits

Nationalism

Markets

The Age of Knowledge



Educated people and ideas

Prosperity

Security

Social well-being

**Educated people are the most valuable resource
for 21st societies and their institutions!!!**

The Forces of Change

The Age of Knowledge

The Knowledge Explosion
Globalization
The High Performance Workplace
Diversity
Accelerating Technological Change
Nonlinear Knowledge Transfer

Changing Societal Needs
Financial Imperatives
Technology Drivers
Market Forces

Forces of Change

A Changing World

The Knowledge
Explosion

Globalization

High Performance
Workplace

Diversity

Technological Change

Knowledge Transfer

Forces on the University

Economics

Societal Needs

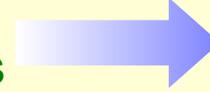
Technology

Markets

Evolution?

Revolution?

Extinction?



The Future of the University?

“Thirty years from now the big university campuses will be relics. Universities won’t survive. It is as large a change as when we first got the printed book.”

– *Peter Drucker*

“If you believe that an institution that has survived for a millennium cannot disappear in just a few decades, just ask yourself what has happened to the family farm.”

– *William Wulf*

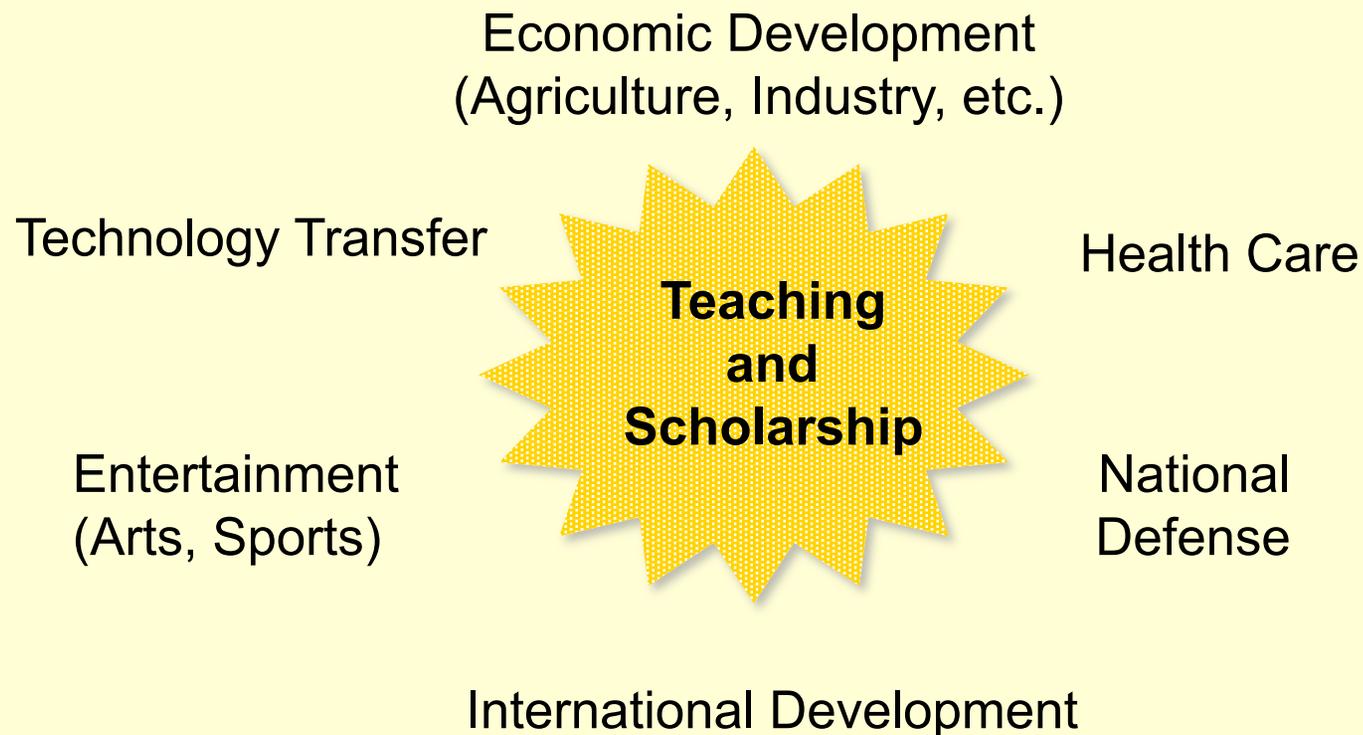
“I wonder at times if we are not like the dinosaurs, looking up at the sky at the approaching comet and wondering whether it has an implication for our future.”

– *Frank Rhodes*

Traditional Roles of the University: The Core



The Traditional Roles of the University: The Periphery

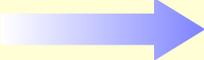
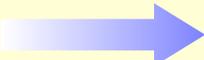
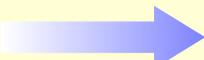


Case Study 1

Higher Education in the United States



The Evolution of U.S. Higher Education

1700s...Frontier America		Colonial Colleges
1800s...Industrial Society		Land-Grant Universities
1900s...Rise of Professions		Technical Colleges
1940s...WWII, the Cold War		Research Universities
1950s...Mass Education		University Systems
1990s...Market Forces		Cyber-U, Global U, For-profit U

The United States Higher Education “System”

AAU-Class Research Universities (60)

Research Universities (115)

Doctoral Universities (111)

Comprehensive Universities (529)

Baccalaureate Colleges (637)

Two-Year Colleges (1,471)

Total U.S. Colleges and Universities: 3,595

The Evolving U.S. Education System



Knowledge Infrastructure

(production, distribution, marketing, testing, credentialling)

Some Other Characteristics of the U.S. System of Higher Education

- 65% of high school graduates attend college
 - * (although only 50% of these will receive degrees)
- 15 million students enrolled in 3,595 colleges and universities
 - * (520,000 international students)
- 80% of students enrolled in “public” universities
- \$200 billion/year spent on U.S. higher education
 - * \$50 billion/y in federal student financial aid
 - * \$20 billion/y in federal research grants
 - * \$60 billion/y in state (regional) appropriations
 - * \$70 billion/y in tuition, gifts, business activities, etc.

The Role of Government in the U.S.

- The Federal Government:

- * No ministry, no national system, no controls...no policy
- * \$50 B/y of financial aid for students
- * \$15 B/y of research grants to faculty
- * NOTE: The federal government provides funds to people (students, faculty, patients), not universities.

- State Governments:

- * \$65 B/y to support operation of public universities
- * Great diversity in state governance, from rigidly controlled systems (New York, Ohio) to strategic master plans (California) to anarchy (Michigan)

The Role of Markets

The U.S. higher education enterprise is highly competitive!

- For students (particularly the best)
- For faculty (particularly the best)
- For public funds (research grants, state appropriations)
- For private funds (gifts, commercial)
- For winning athletics programs
- For everything and everybody...

In a sense, Michigan competes not only with UC-Berkeley, Harvard, and MIT, but also with Oxford and Cambridge, not to mention IBM and Microsoft!

Case Study 2

The University of Michigan



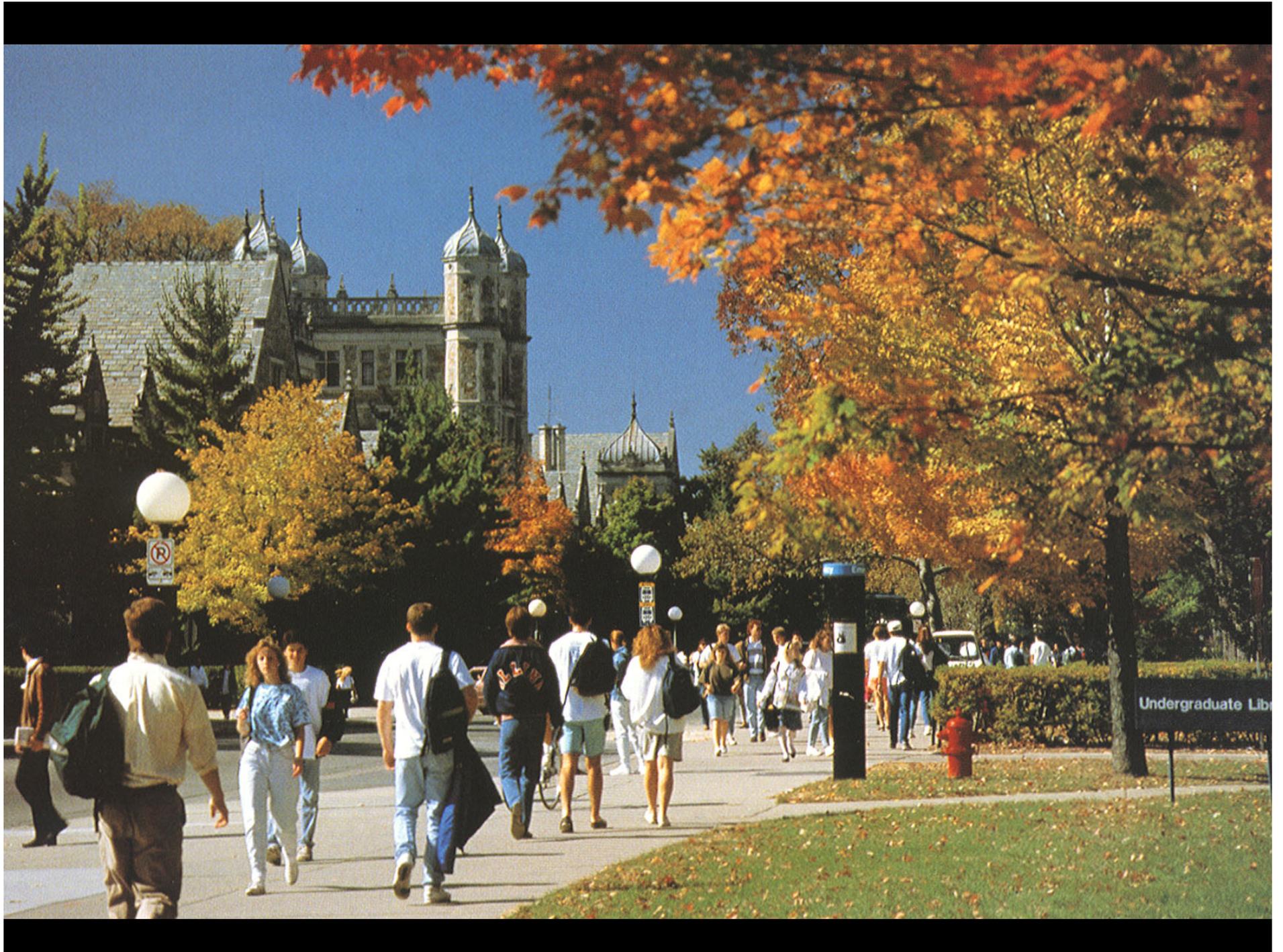


University of Michigan

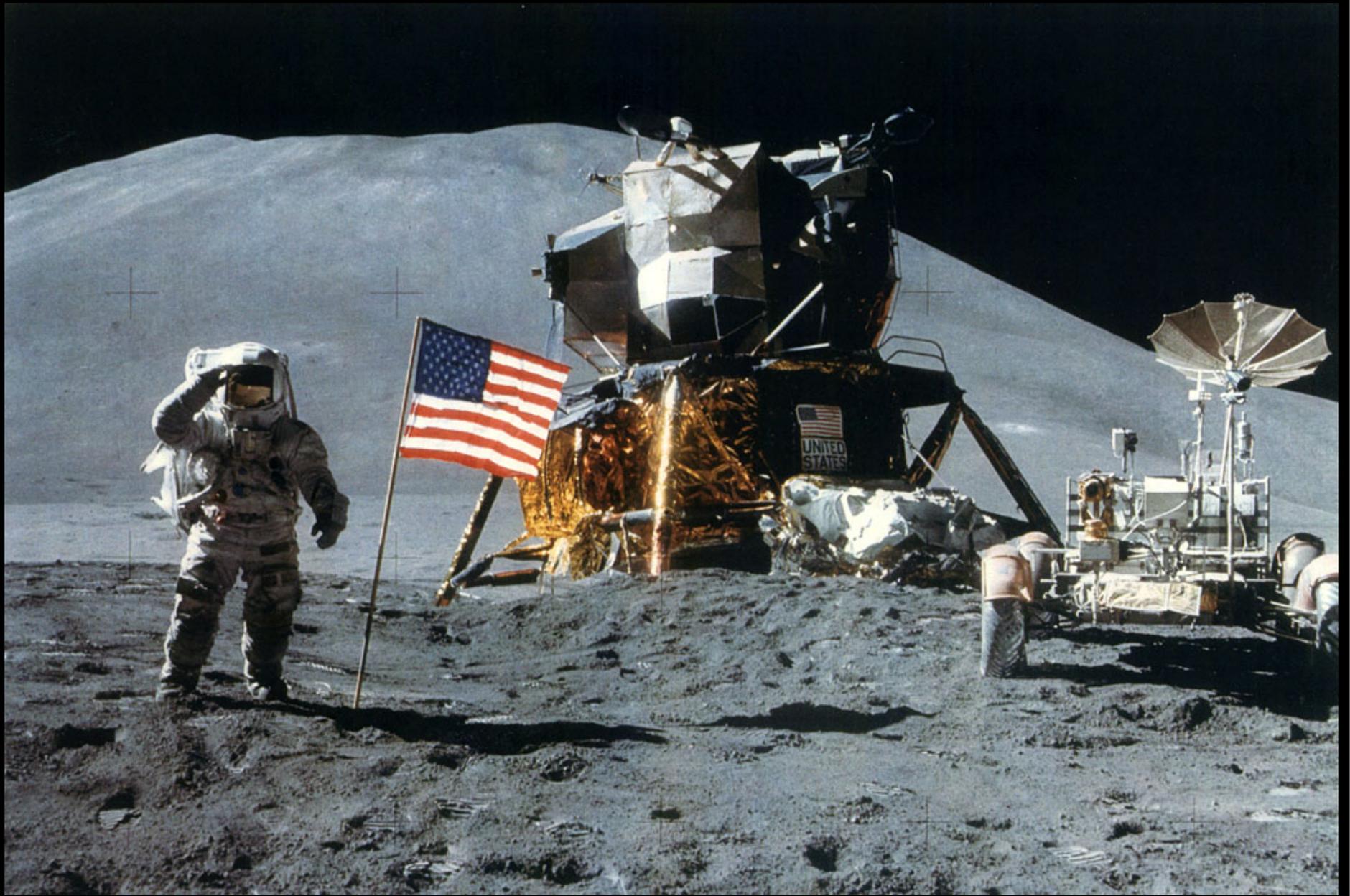
- First truly public university in United States (1817)
- Constitutional autonomy
- One of U.S.'s largest universities
 - * People: 50,000 students; 3,500 faculty, 25,000 staff
 - * Budget: \$3.4 billion/year; (\$3.9 billion endowment)
 - * Facilities: 3 million m² of facilities
 - * Campuses in Europe, Hong Kong, Korea, Brazil, cyberspace
- One of U.S.'s leading research universities (> \$600 million/year)
- Some other features:
 - * First university hospital (1 million patients a year, \$1.4 billion/year)
 - * Key role in developing and managing the Internet (now Internet2)

UM Schools and Colleges

- Architecture
- Art and Design
- Business Administration
- Dentistry
- Education
- Engineering
- Graduate programs
- Information
- Kinesiology
- Law
- Humanities
- Medicine
- Music
- Natural Resources
- Nursing
- Pharmacy
- Public Health
- Public Policy
- Sciences
- Social Work









THIS FLAG CARRIED ABOARD APOLLO 15 DURING THE FIRST EXTENDED SCIENTIFIC EXPLORATION OF THE MOON. JULY 26 — AUGUST 7, 1971



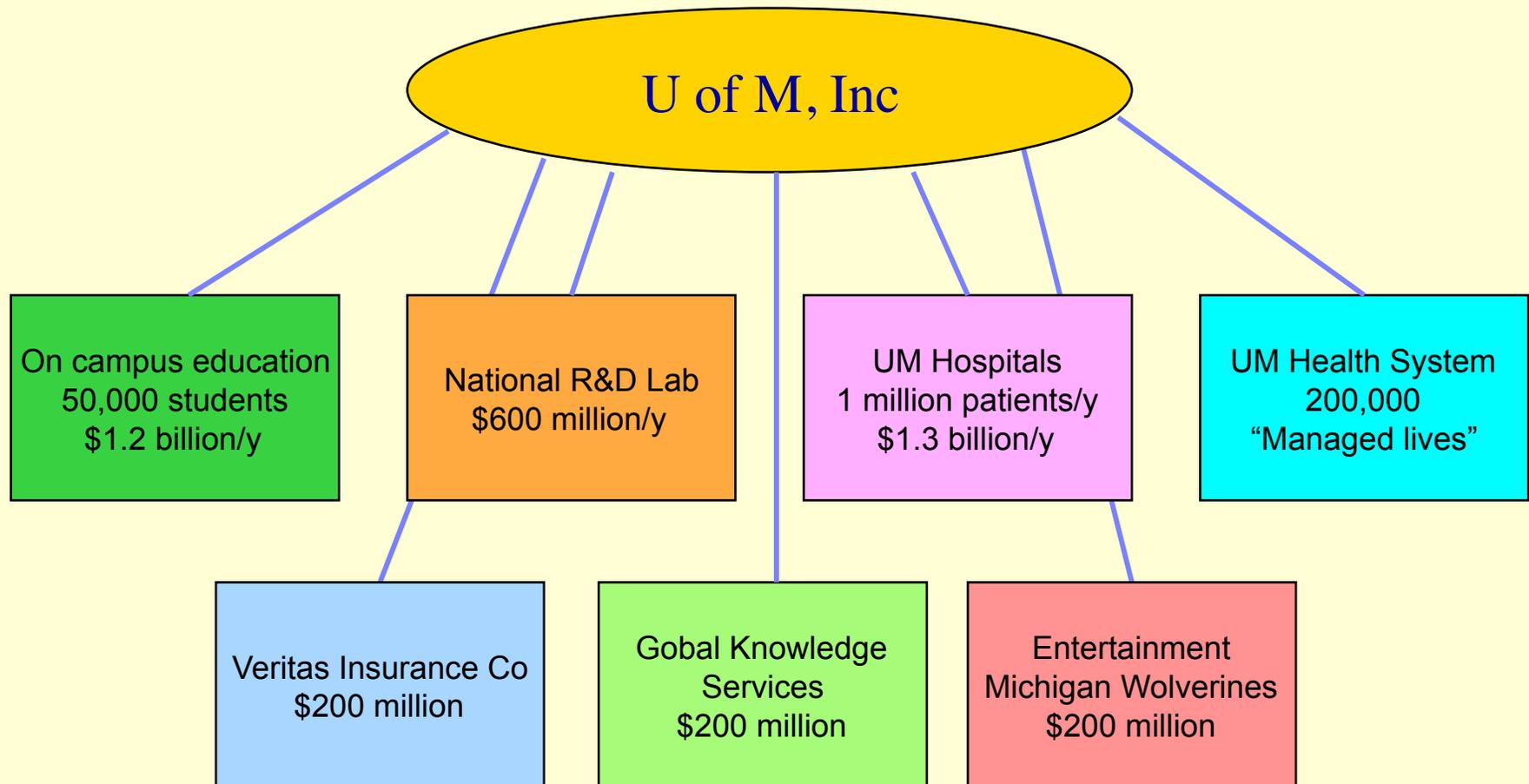








Another way to look at UM



The Forces of Change



Forces of Change

A Changing World

The Knowledge
Explosion

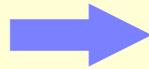
Globalization

High Performance
Workplace

Diversity

Technological Change

Knowledge Transfer



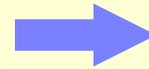
Forces on the University

Societal Needs

Economics

Technology

Markets



Brave New World?

Society of Learning?

Forces on the University

- Changing Societal Needs
- Financial Imperatives
- Technology
- Market forces

Changing Societal Needs

- Increasing population of “traditional” students
- The “plug and play” generation
- Education needs of adults in the high-performance workplace (lifelong learning)
- Passive student to **active** learner to **demanding** consumer
- “Just-in-case” to “just-in-time” to “just-for-you” learning
- Diversity (gender, race, nationality, socioeconomic,...)
- Global needs for higher education

Concern: There are many signs that the current paradigms are no longer adequate for meeting growing and changing societal needs.

Global Needs

Half of the world's population is under 20 years old.

Today, there are over 30 million people who are fully qualified to enter a university, but there is no place available. This number will grow to over 100 million during the next decade.

To meet the staggering global demand for advanced education, a major university would need to be created every week.

“In most of the world, higher education is mired in a crisis of access, cost, and flexibility. The dominant forms of higher education in developed nations—campus based, high cost, limited use of technology—seem ill-suited to addressing global education needs of the billions of young people who will require it in the decades ahead.”

Sir John Daniels

Financial Imperatives

- Increasing societal demand for university services (education, research, service)
- Increasing costs of educational activities
- Declining priority for public support
- Public resistance to increasing prices (tuition, fees)
- Inability to re-engineering cost structures

Concern: The current paradigms for conducting, distributing, and financing higher education may not be able to adapt to the demands and realities of our times

Technology

Since universities are knowledge-driven organizations, it is logical that they would be greatly affected by the rapid advances in information and communications technologies

We have already seen this in administration and research.

But the most profound impact could be on education, as technology removes the constraints of space, time, reality (and perhaps monopoly ...)

Concern: The current paradigm of the university may not be capable of responding to the opportunities or the challenges of the digital age.

Market Forces

Changing societal needs, economic realities, and rapidly evolving technology are creating powerful market forces in the higher education enterprise. The traditional monopolies of the university, sustained in the past by geography and certification, are breaking apart.

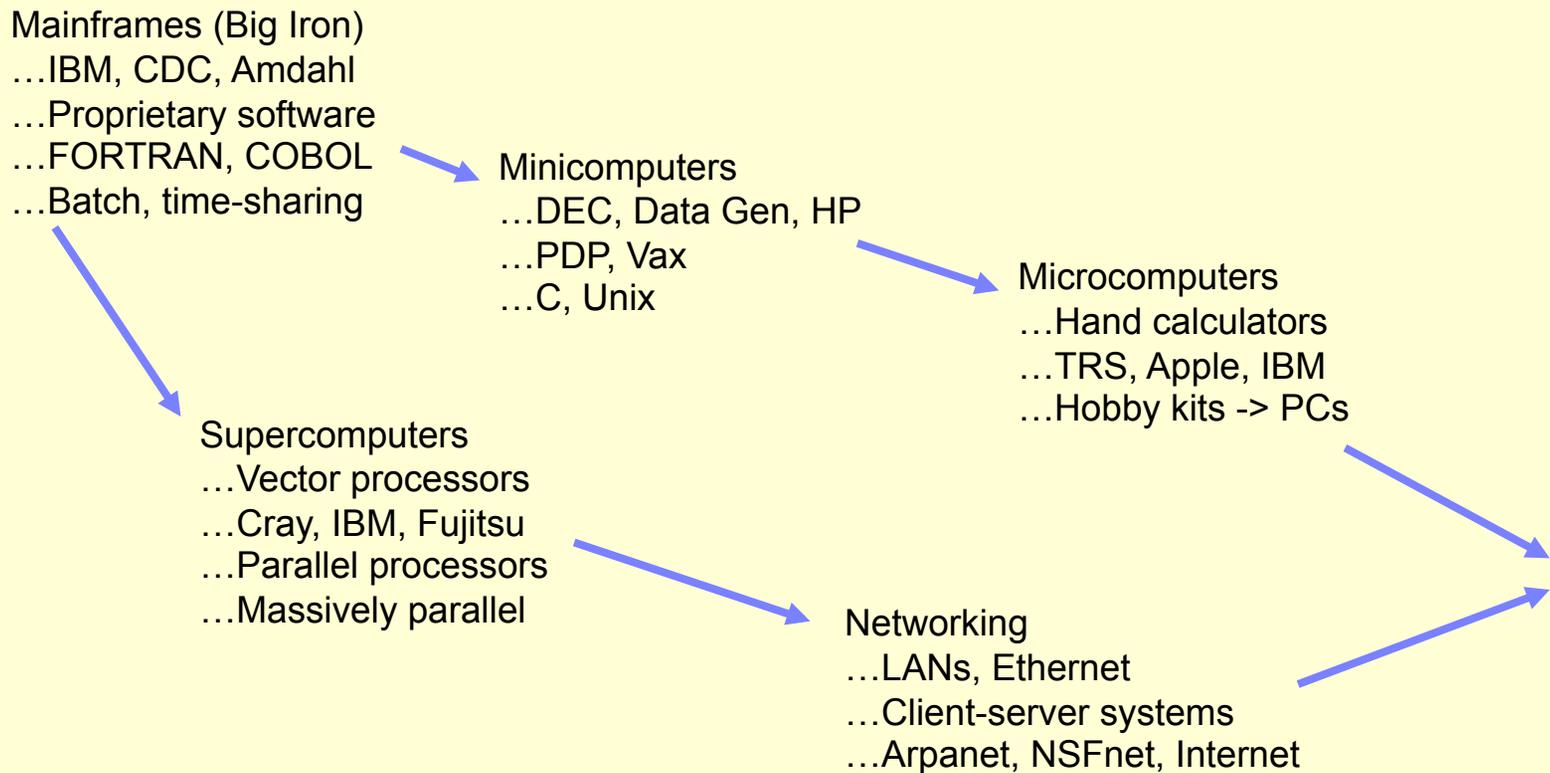
We may be seeing the early signs of a **restructuring** of the higher education enterprise into a global knowledge and learning industry.

Concern: The current faculty-centered, monopoly-sustained university paradigm is ill suited to the intensely competitive, technology-driven, global marketplace.

Information Technology and the Future of the University

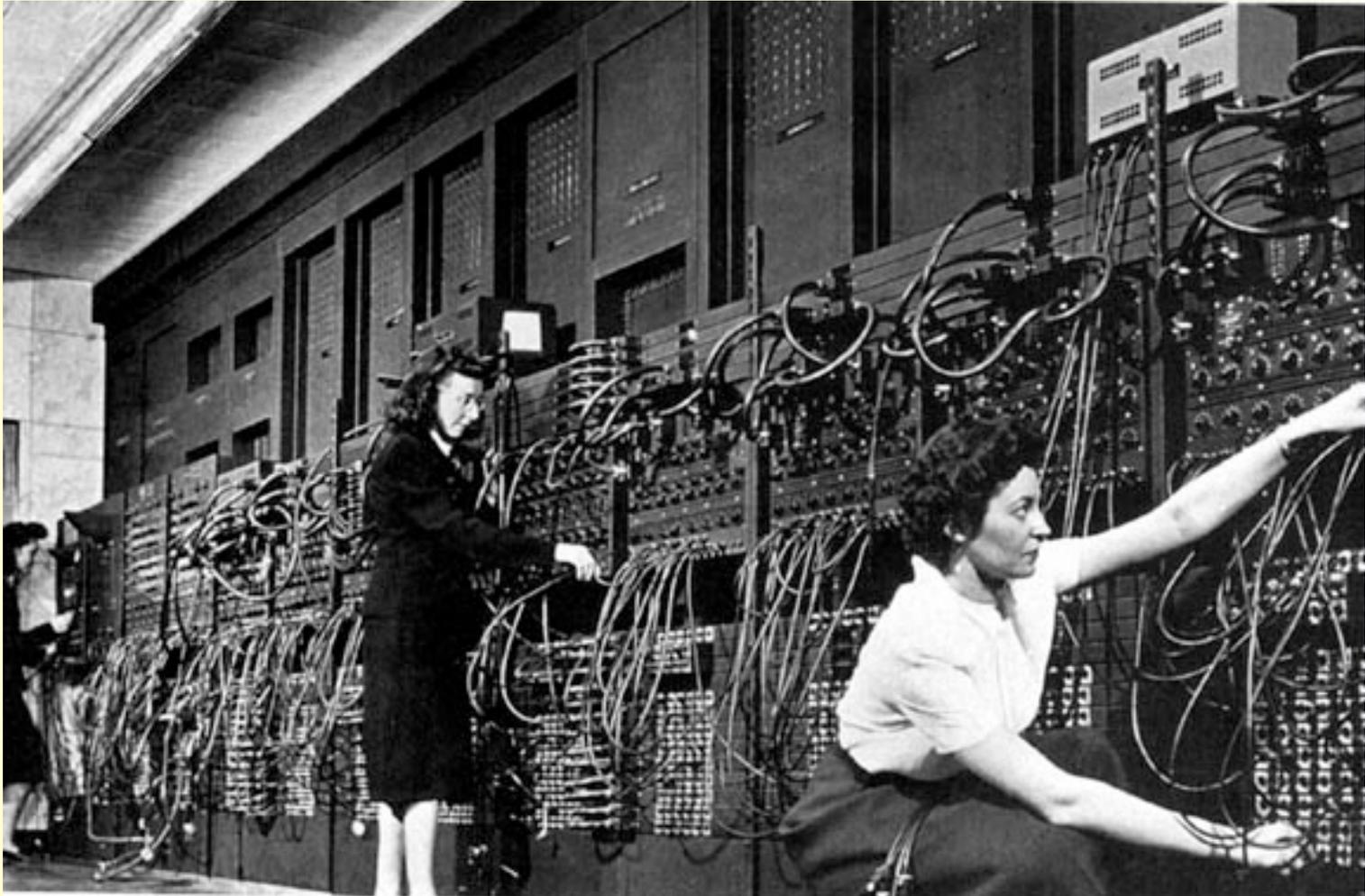


A Detour: The Evolution of Computers



Batch → Time-sharing → Personal → Collaborative

From Eniac





To ASCII "Q" ... and beyond



Japan Earth Simulator



PN-07-12/13

PN-08-08/09

PN-09-14/15

PN-21-14/15

PN-22-14/15

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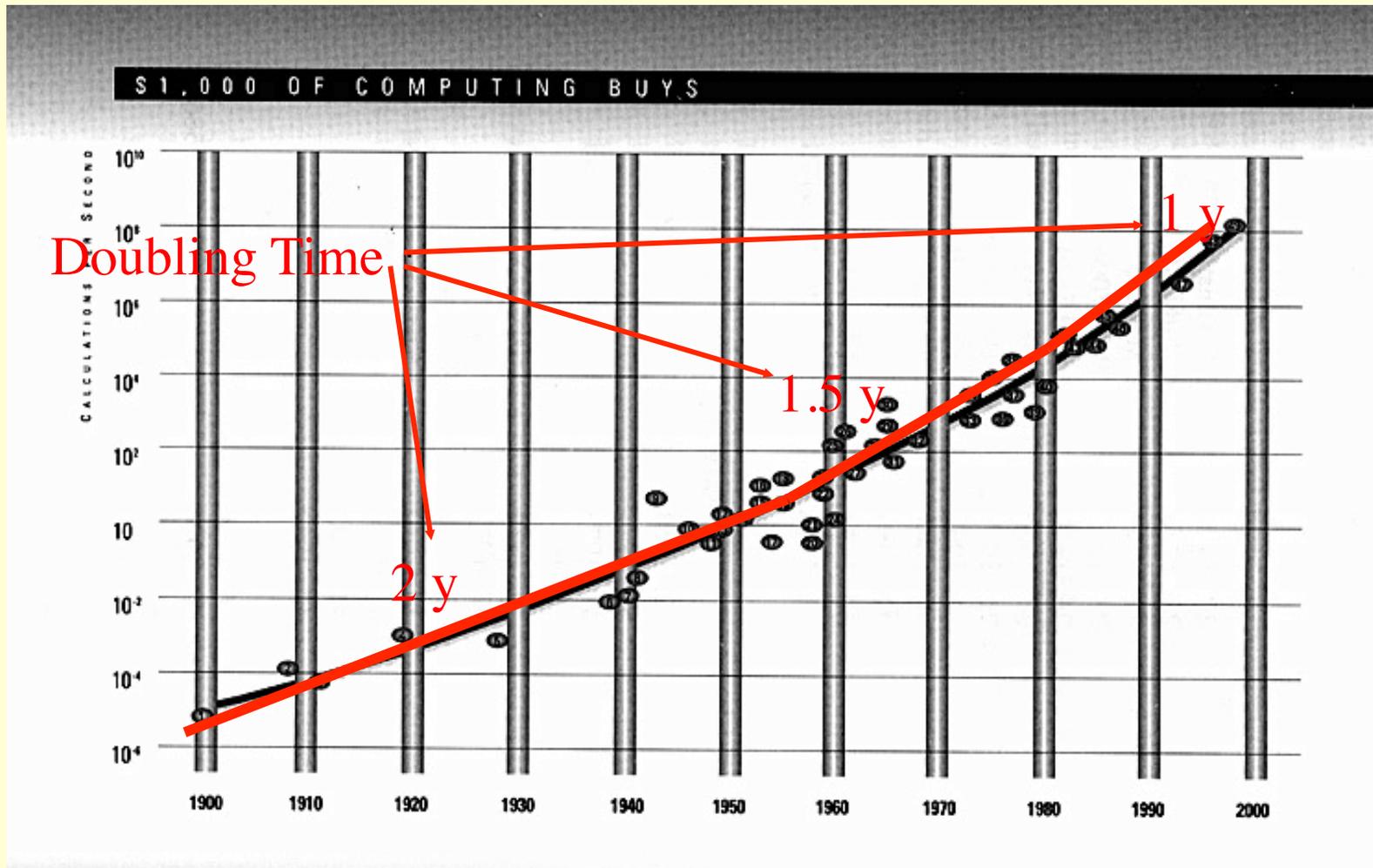
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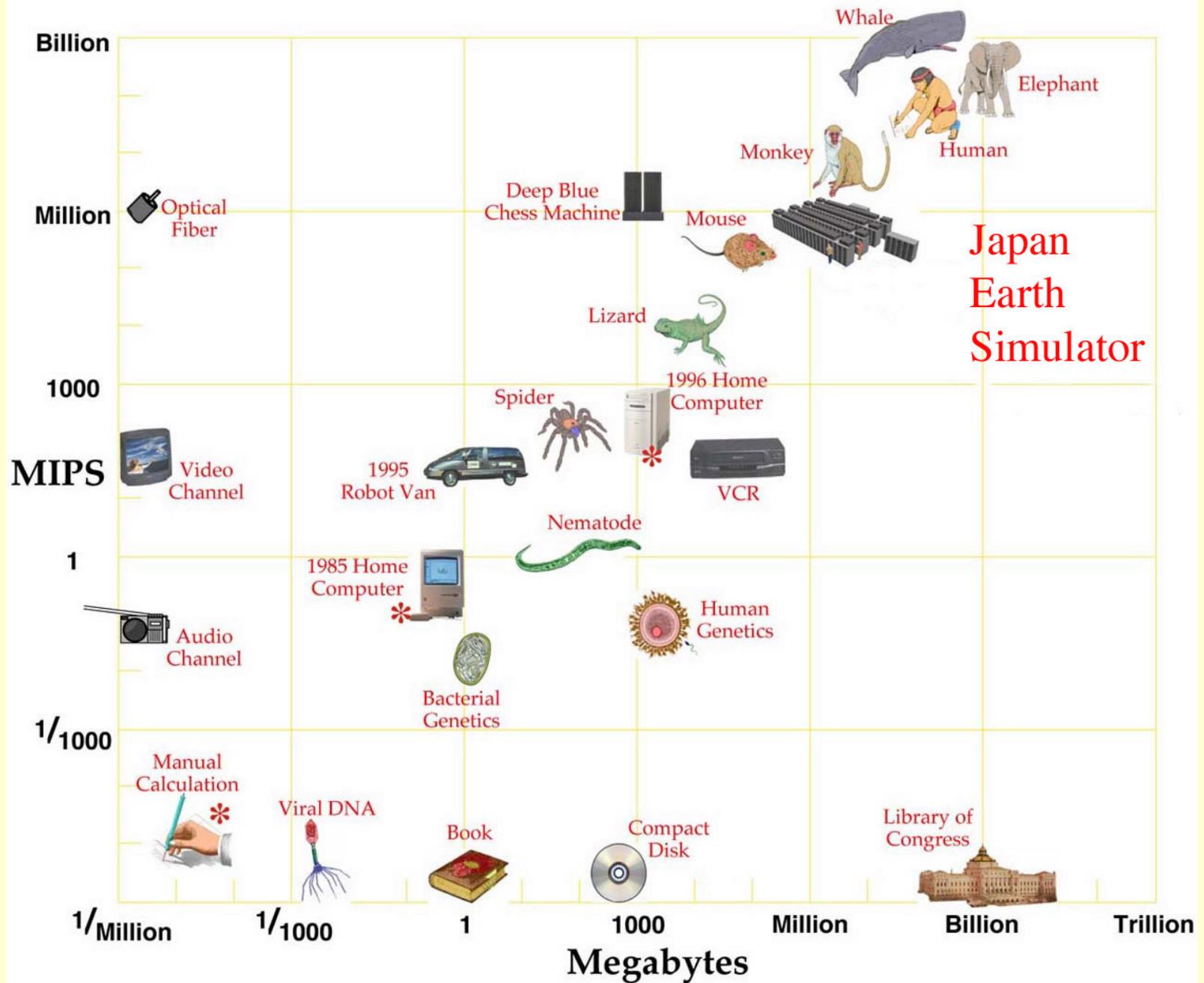
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The Evolution of Computing



All Things, Great and Small



ASCI Purple (2004):

100 TeraFlops

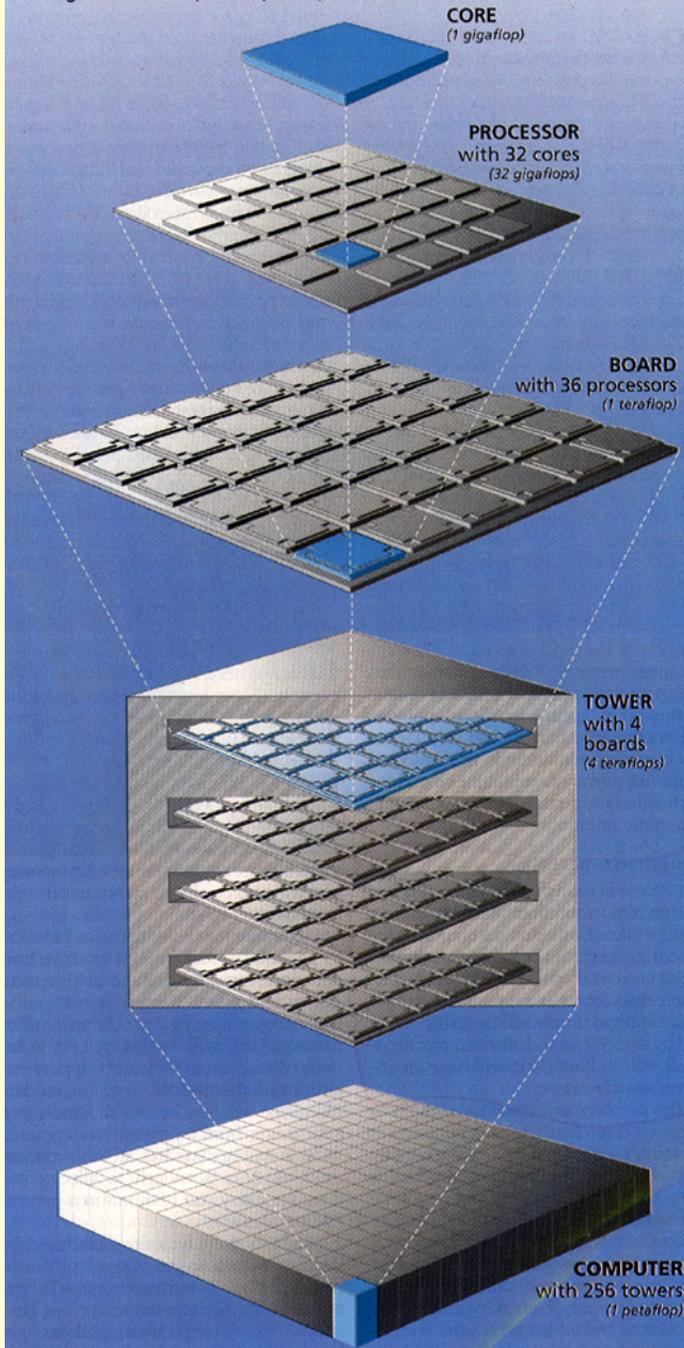
IBM Blue Gene L (2004):

360 TeraFlops

IBM Blue Gene P (2006):

“Several” PetaFlops

Blue Gene
Building blocks for a petaflop computer



Some Extrapolation of the PC

	<u>2000</u>	<u>2010</u>	<u>2020</u>
Speed	10^9	10^{12}	10^{15}
RAM	10^8	10^{11}	10^{14}
Disk	10^9	10^{12}	10^{15}
LAN	10^8	10^{12}	10^{15}
Wireless	10^6	10^9	10^{12}

Some Examples

- **Speed**

- * MHz to GHz to THz to Peta Hz

- **Memory**

- * MB (RAM) to GB (CD,DVD) to TB (holographic)

- **Bandwidth**

- * Kb/s (modem) to Mb/s (Ethernet) to Gb/s
- * Internet2 (Project Abilene): 10 Gb/s

- **Networks**

- * Copper to fiber to wireless to photonics
- * “Fiber to the forehead...”

Computer-Mediated Human Interaction

- **1-D (words)**
 - * Text, e-mail, chatrooms, telephony
- **2-D (images)**
 - * Graphics, video, WWW, multimedia
- **3-D (environments)**
 - * Virtual reality, distributed virtual environments
 - * Immersive simulations, avatars
 - * Virtual communities and organizations
- **And beyond...**
 - * Telepresence
 - * Neural implants

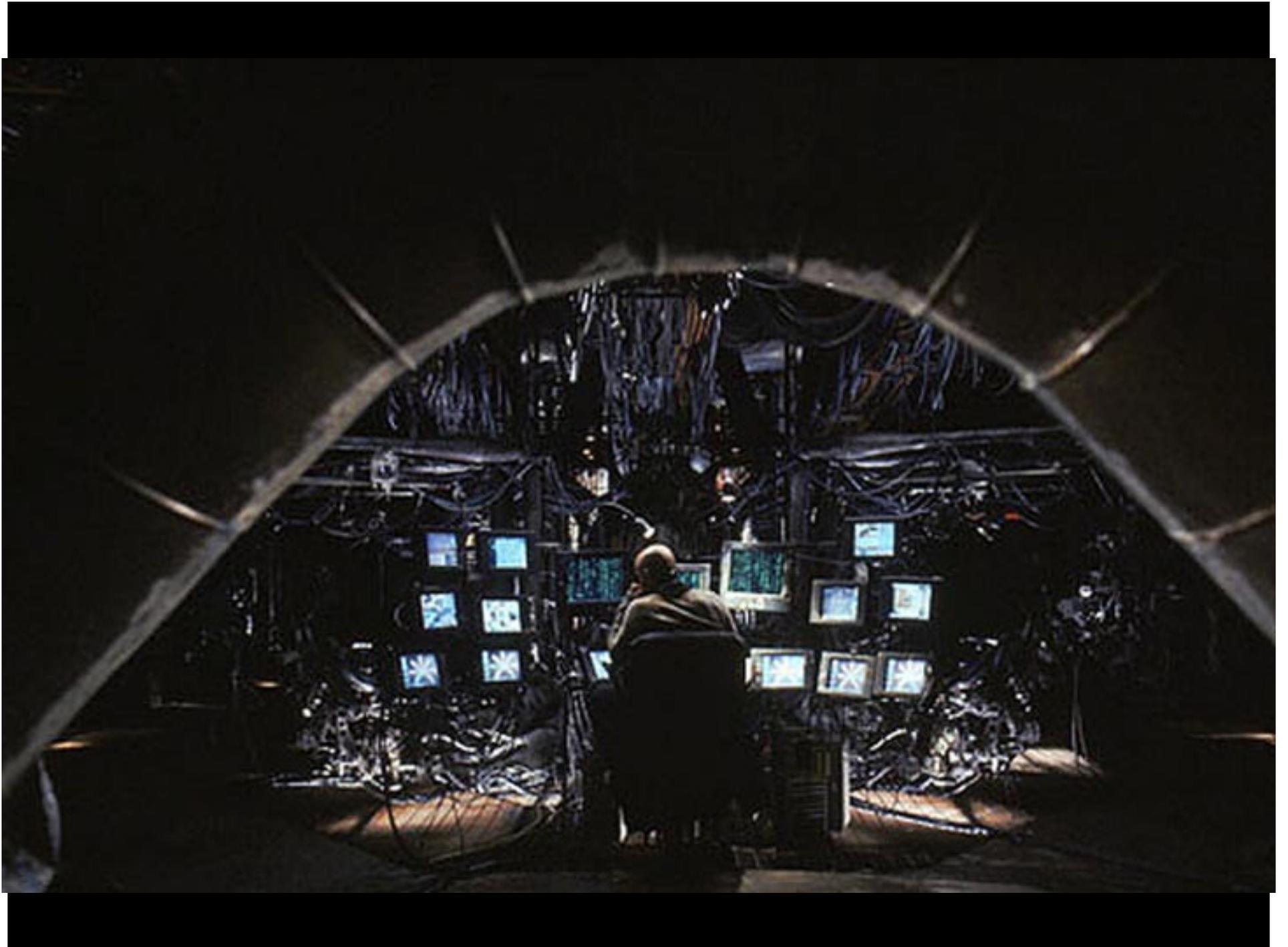
Evolution of the Net

- Already beyond human comprehension
- Incorporates ideas and mediates interactions among millions of people
- 200 million today; more than 1 billion in 2005
- Internet2, Project Abilene

Some Other Possibilities



- **Ubiquitous computing?**
 - * Computers disappear (just as electricity)
 - * Calm technology, bodynets
- **Agents and avatars?**
 - * Fusing together physical space and cyberspace
 - * Plugging the nervous system into the Net
- **Emergent behavior?**
 - * ... Self organization
 - * ... Learning capacity
 - * ... Consciousness (HAL 9000)



IT and the University

Missions: teaching, research, service?

Alternative: Creating, preserving, integrating, transferring, and applying knowledge.

The University: A “knowledge server”, providing knowledge services in whatever form is needed by society.

Note: The fundamental knowledge roles of the university have not changed over time, but their realizations certainly have.

Research

- Simulating reality
- Collaboratories: the virtual laboratory
- Changing nature of research
 - * Disciplinary to interdisciplinary
 - * Individual to team
 - * “Small think” to “big think”
- Analysis to creativity
 - * Tools: materials, lifeforms, intelligences

Libraries

- Books to bytes (atoms to bits)
- Acquiring knowledge to navigating knowledge
- What is a book?
 - * A portal to the knowledge of the world.

Teaching to Learning

- Pedagogy
 - * From lecture hall to environment for interactive, collaborative learning
 - * From teacher to designer and coach
- Classroom
 - * From handicraft to commodity
 - * From solitary students to learning communities
 - * From campuses to virtual, distributed environments
- Open learning
 - * From teacher-centered to learner-centered
- **Passive Student to Active Learner to Demanding Consumer**
 - * Unleashing the power of the marketplace



















The Plug and Play Generation

- Raised in a media-rich environment
 - * Sesame Street, MTV, Playstation, Nintendo
 - * Home computers, Internet, virtual reality
- Learn through participation and experimentation
- Learn through collaboration and interaction
- Multiprocessing, multimedia literacy, bricolage

A Study by
the National Academy of Sciences

The Impact of Information Technology on the Future of the Research University



Information Technology and the Future of the Research University

Premise:

Rapidly evolving information technology poses great challenges and opportunities to higher education in general and the research university in particular.

Yet many of the key issues do not yet seem to be recognized or understood by either the leaders or stakeholders of the university.

ITFRU Task Force

- James Duderstadt (Chair), President Emeritus, University of Michigan
- Daniel Atkins, Professor of Information and Computer Science, University of Michigan
- John Seely Brown, Chief Scientist, Xerox PARC
- Marye Anne Fox, Chancellor, North Carolina State University
- Ralph Gomory, President, Alfred P. Sloan Foundation
- Nils Hasselmo, President, Association of American Universities
- Paul Horn, Senior Vice President for Research, IBM
- Shirley Ann Jackson, President, Rensselaer Polytechnic Institute
- Frank Rhodes, President Emeritus, Cornell University
- Marshall Smith, Professor of Education, Stanford; Program Officer, Hewlett Foundation
- Lee Sproull, Professor of Business Administration, NYU
- Doug Van Houweling, President and CEO, UCAIC/Internet2
- Robert Weisbuch, President, Woodrow Wilson National Fellowship Foundation
- William Wulf, President, National Academy of Engineering
- Joe B. Wyatt, Chancellor Emeritus, Vanderbilt University
- Raymond E. Fornes (Study staff), Professor of Physics, North Carolina State University

Objectives

- To identify those information technologies likely to evolve in the near term (a decade or less).
- To examine the possible implications of these technologies for the research university: its activities; its organization, management, and financing and the impact on the broader higher education enterprise.
- To determine what role, if any, there is for the federal government and other stakeholders in the development of policies, programs, and investments to protect the valuable role and contributions of the research university during this period of change.

Early Conclusions

- The extraordinary evolutionary pace of information technology is likely to continue for the next several decades.
- The impact of information technology on the university will likely be profound, rapid, and discontinuous—affecting all of its activities (teaching, research, service), organization (academic structure, faculty culture, financing and management), and the broader higher education enterprise.

Conclusions (continued)

- Yet, for at least the near term, the university will continue to exist in essentially its present form, although meeting the challenge of emerging competitors in the marketplace will demand significant changes in how we teach, how we conduct scholarship, and how our institutions are financed.
- Although we feel confident that information technology will continue its rapid evolution for the foreseeable future, it is far more difficult to predict the impact of this technology on human behavior and upon social institutions such as the university.

Conclusions (continued)

- In summary, for the near term (meaning a decade or less), we anticipate that information technology will drive comprehensible if rapid, profound, and discontinuous change in the university. **It is a disruptive technology.**
- For the longer term (two decades and beyond), the future is less clear. The implications of a million-fold or billion-fold increase in the power of information technology are difficult to even imagine, much less predict for our world and even more so for our institutions.

Another Perspective ...

The impact of information technology will be even more radical than the harnessing of steam and electricity in the 19th century. Rather it will be more akin to the discovery of fire by early ancestors, since it will prepare the way for a revolutionary leap into a new age that will profoundly transform human culture.

–Jacques Attali, *Millennium*

The Restructuring of the Higher Education Enterprise



The Restructuring of the
Higher Education ~~Enterprise~~
Industry

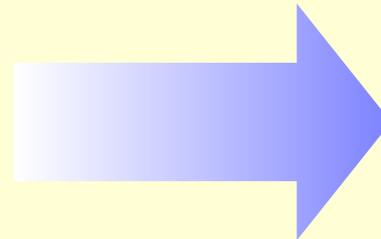


Market Forces

Changing Social Needs

Financial Imperatives

Evolving Technology



**Powerful
Market
Forces**

The Role of Markets

- For students (particularly the best)
- For faculty (particularly the best)
- For public funds (research grants, operating appropriations)
- For private funds (gifts, commercial revenue)
- For everything and everybody

A Restructured Industry?

There are signs that higher education may be in the early stages of a major restructuring like other economic sectors such as energy, banking, and transportation that underwent restructuring following deregulation.

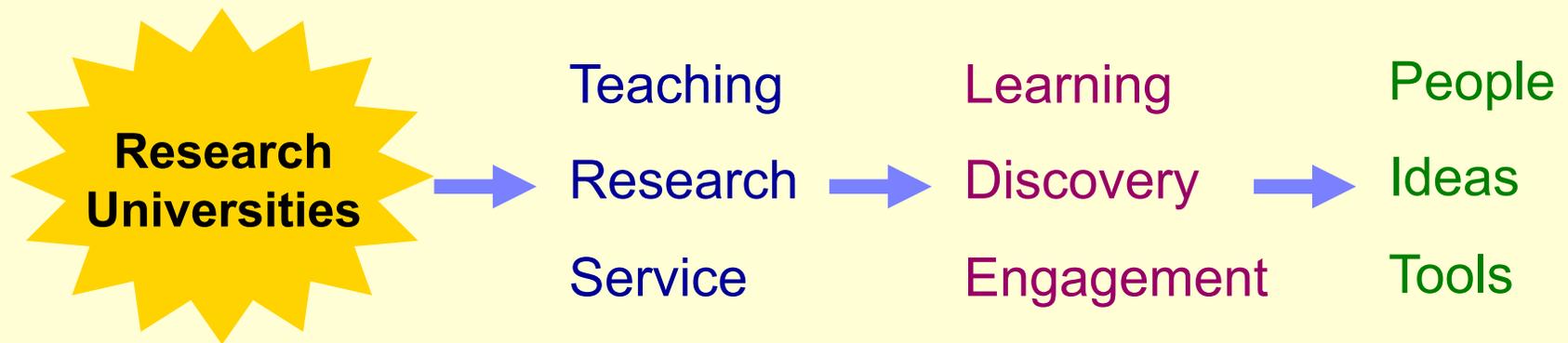
The restructuring of the higher education enterprise is being driven by changing social needs, financial pressures, rapidly evolving technology, and most significantly, emerging market forces. These are also driving a convergence of education with other knowledge-intensive industries such as information technology, telecommunications, information services, and entertainment into what might be regarded as:

A Global Knowledge and Learning Industry

A Quote from a Venture Capital Prospectus

“As a result, we believe education represents the most fertile new market for investors in many years. It has a combination of large size (approximately the same size as health care), disgruntled users, lower utilization of technology, and the highest strategic importance of any activity in which this country engages Finally, existing managements are sleepy after years of monopoly.”

Contributions of the Research University



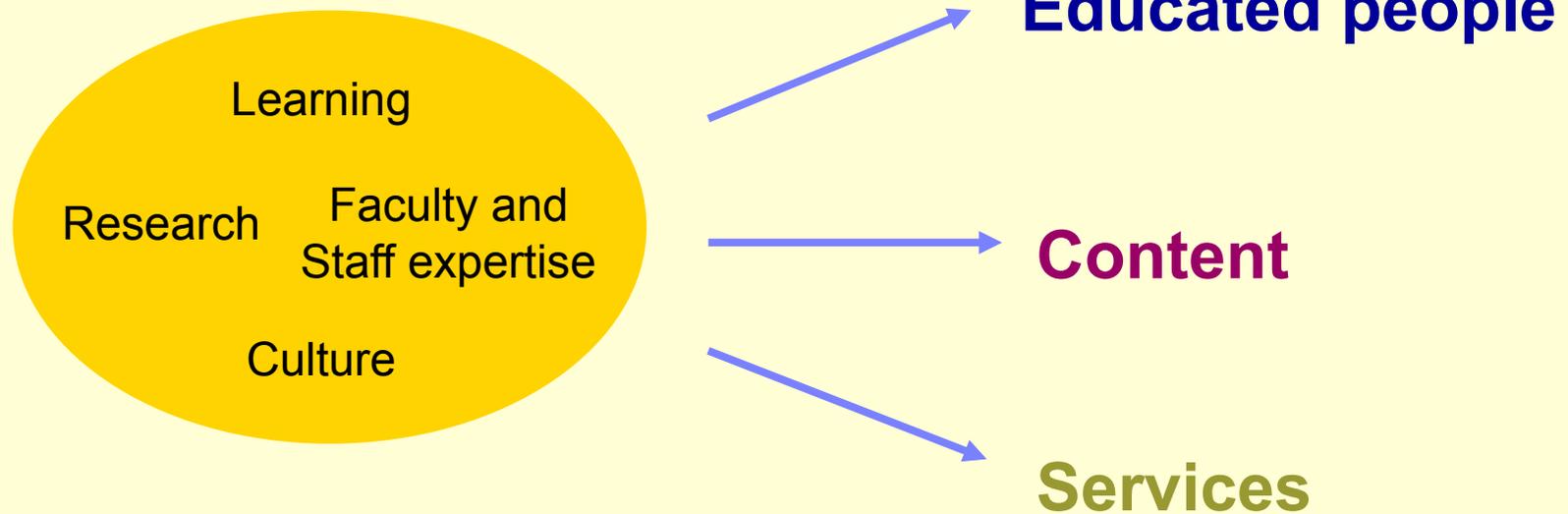
Scenario 1

The Brave, New World of Commercial Higher Education

The Knowledge Industry

Hardware	→	Boxes, PCs, PDAs	→	IBM, HP, Sun, Lucent, Nokia, Ericsson
Networks	→	Backbones, LANs, Wireless	→	AT&T, MCI, Telcoms Microsoft, IBM, Sun
Software	→	OS, Middleware, Applications	→	Accenture, EDS, IBM, Unisys
Solutions	→	Systems, Integrators	→	Time-Warner, Disney, “dot.coms”, AAU?
Content	→	Data, Knowledge, Entertainment, Learning?	→	

The Core Competencies of the University



A Possible Future for the U.S. Higher Education Enterprise

- \$300 billion (\$3 trillion globally)
- 30 million students
- 200,000 faculty “facilitators”
- 50,000 faculty “content providers”
- 1,000 faculty “celebrity stars”

Supported by a commercial industry handling the production and packaging of learning ware, the distribution and delivery of educational services to learners, and the assessment and certification of learning outcomes.

(compared to 800,000 current faculty serving a \$180 billion enterprise with 15 million students ...)

Possibilities

- Unbundling
- A commodity marketplace
- Mergers, acquisitions, hostile takeovers
- New learning lifeforms
- An intellectual wasteland???

Scenario 2

A Society of Learning

A Society of Learning

Since knowledge has become not only the wealth of nations but the key to one's personal prosperity and quality of life, it has become the responsibility of democratic societies to provide their citizens with the education and training they need, throughout their lives, whenever, wherever, and however they desire it, at high quality and at an affordable cost.

Key Characteristics of Education in a Society of Learning

- Learner-centered
- Affordable
- Lifelong learning
- A seamless web
- Interactive and collaborative
- Asynchronous and ubiquitous
- Diverse
- Intelligent and adaptive

A Key Policy Question

How do we balance the roles of market forces and public purpose in determining the future of higher education. Can we control market forces through public policy and public investment so that the most valuable traditions and values of the university are preserved?

Or will the competitive and commercial pressures of the marketplace sweep over our institutions, leaving behind a higher education enterprise characterized by mediocrity?

Which of the two scenarios will be our future?

Some Remaining Questions



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1. How do we respond to the diverse educational and intellectual needs of knowledge-driven societies? (For example, as human capital becomes more important than physical or financial capital.)

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Some Remaining Questions

1. How do we respond to the diverse educational and intellectual needs of knowledge-driven societies? (For example, as human capital becomes more important than physical or financial capital.)
2. Is higher education a public or a private good?
3. How do we balance the roles of public purpose versus market forces in determining the future of our universities? (Can public investment counter competitive and commercial market pressures?)
4. What should be the role of the research university within a changing higher education enterprise? Should we lead change? Or should we protect key values and traditions (e.g., academic freedom, social critic)?

And, perhaps the most important question of all...

Are we facing a period of evolution, revolution, or possible extinction of the university as we know it today?

One of civilization's most enduring institutions

For a thousand years the university has benefited our civilization as a learning community where both the young and experienced could acquire not only knowledge and skills, but as well the values and discipline of the educated mind.

It has defended and propagated our cultural and intellectual heritage, while challenging our norms and beliefs.

It has produced the leaders of our governments, commerce, and professions.

It has both created and applied new knowledge to serve our society.

And it has done so while preserving those values and principles so essential to academic learning: the freedom of inquiry, an openness to new ideas, a commitment to rigorous study, and a love of learning.

The Continuity of Change

Clearly higher education will flourish in the decades ahead. In a knowledge intensive society, the need for advanced education and knowledge will become ever more pressing, both for individuals and societies more broadly.

Yet it is also likely that the university as we know it today—rather the current constellation of diverse institutions comprising the higher education enterprise—will change in profound ways to serve a changing world.

Just as it has done, so many times in the past.