

Centro de Física Aplicada y  
Tecnología Avanzada, UNAM Juriquilla



# Gestión del conocimiento: mitos y realidades

Víctor Manuel Castaño Meneses

2º. Foro sobre Innovación y Transferencia Tecnológica



CONACYT

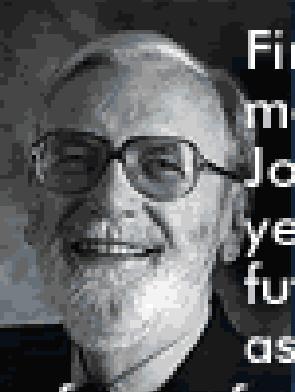
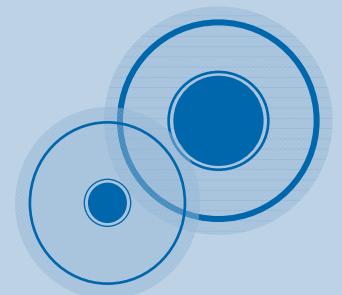


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# Globalización



# Joseph Coates



Find out more about Joe's 25+ years as a futurist and as founder of one of only a few organizations in the world exclusively dedicated to the study of the future...

**Joe**

## PREVIEW JOE'S CONTRIBUTIONS TO VOLUME 1 OF Tackling Tomorrow Today

### Futuristics: Looking Ahead

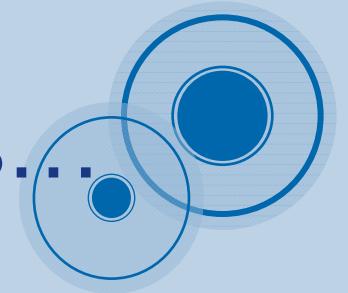


Fourteen original essays for high school students and educators introducing major perspectives, key questions and leading methods in the field of futuristics. Edited by Arthur B. Shostak, Ph.D.

View and download PDF versions of [82 Assumptions About the Next 25 Years: Refining Our View](#) and [Teens in Time](#) from our [Articles](#) section



# La fabrica del futuro es...

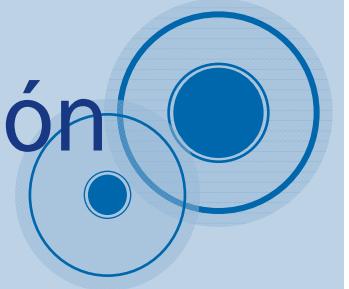


...un sistema de información altamente integrado que combine tecnologías avanzadas de producción con estrategias innovadoras, como producción “ligera”, justo a tiempo y gestión total de calidad.

Joseph Coates (2000)



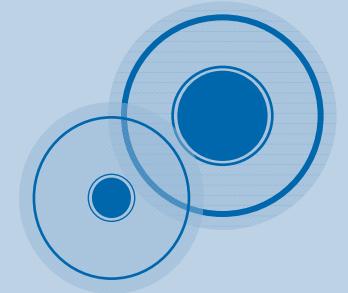
# Tendencias en la producción



- ❖ Computadoras y redes para todos los aspectos de manufactura y distribución
- ❖ Enfoque sistémico para lidiar con la complejidad
- ❖ Producción a la medida del cliente
- ❖ Reconocimiento del papel de factores no tecnológicos (estrategia y globalización, redes sociales)
- ❖ Desarrollos científicos y tecnológicos



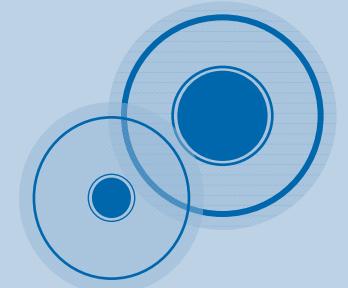
# Factores determinantes



- ❖ Globalización de negocios
- ❖ TICs
- ❖ Preocupación ambiental
- ❖ Respuesta a la medida del cliente
- ❖ Alianzas
- ❖ Empresa virtual
- ❖ Materiales nuevos (polímeros, cerámicos, biológicos)
- ❖ Nanotecnologías
- ❖ Logística
- ❖ Fábrica del futuro
- ❖ Empresa ágil
- ❖ Mercados de segunda mano
- ❖ Estandarización con diferenciación



# Evolución de la Economía



ERA  
INDUSTRIAL

TRABAJO

CAPITAL

TIERRA

ERA DEL  
CONOCIMIENTO

CONOCIMIENTO

ERA  
AGRÍCOLA



# Breve historia de la evolución



Billion Years Ago	
12	Big Bang (MEST)
11.5	Milky Way (Atoms)
8	Sun (Energy)
4.5	Earth (Molecules)
3.5	Bacteria (Cell)
2.5	Sponge (Body)
0.7	Clams (Nerves)
0.5	Trilobites (Brains)
0.2	Bees (Swarms)
0.100	Mammals
0.002	Humans, Tools & Clans Co-evolution



# Breve historia de la evolución

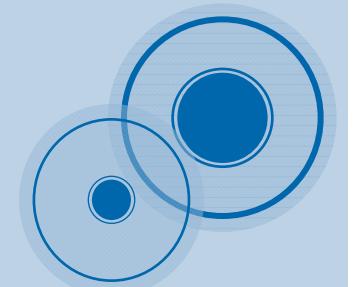
Generations Ago	
100,000	Speech
750	Agriculture
500	Writing
400	Libraries
40	Universities
24	Printing
16	Accurate Clocks
5	Telephone
4	Radio
3	Television
2	Computer
1	Internet/e-Mail
0	GPS, CD, WDM



# Breve historia de la tecnología

3 million years ago	collective rock throwing; early stone tools
1.5 million years ago	lever, wedge, inclined plane
500,000 years ago	control of fire
50,000 years ago	bow and arrow; fine tools
5,000 years ago	wheel and axle; sail
500 years ago	printing press with movable type; rifle
50 years ago	commercial digital computers
10 years ago	commercial internet

# información vs. conocimiento



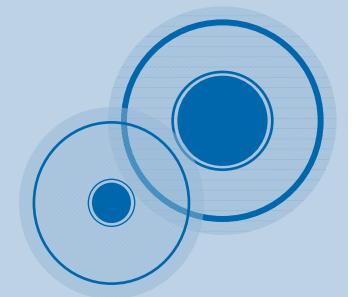
Esta definición otorga un valioso carácter operativo al conocimiento en tanto lo asume como dinámico. Desde esta perspectiva, el conocimiento es un "estado" que sólo se alcanza en tanto **es útil a las decisiones**, y que al dejar de serlo, vuelve a "degradarse" en información.

**"(El conocimiento) es una forma de alto valor de la información que está lista para ser aplicada a decisiones y acciones."**

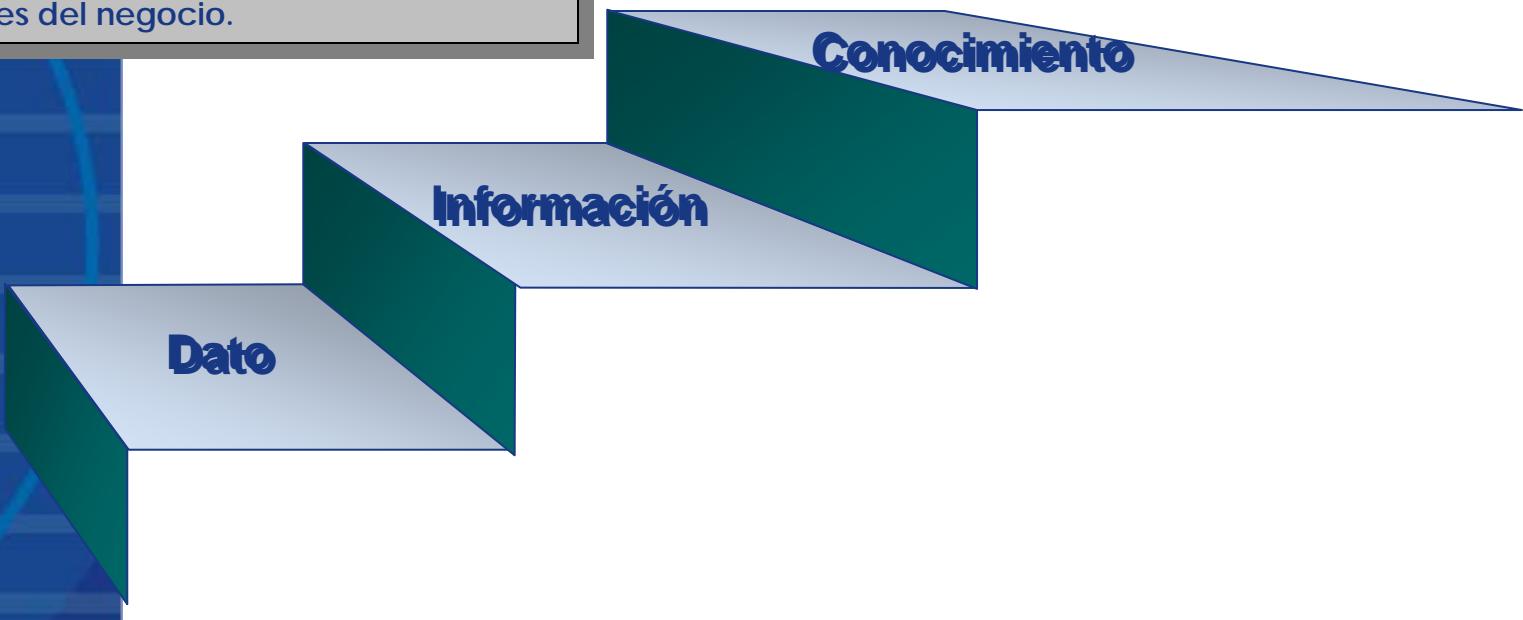
*Thomas H. Davenport / David W. De Long  
"Successful Knowledge Management Projects"*



# Evolución

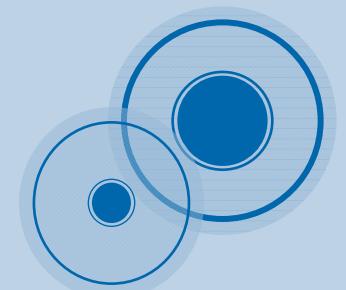


El Conocimiento puede ser visto como la evolución natural de los conceptos de Dato e Información. Muchas opiniones coinciden en que el Conocimiento irrumpió como concepto operativo porque hoy el problema no es obtener información, sino cómo, desde su superabundancia, "filtrar" aquella realmente útil a las decisiones del negocio.



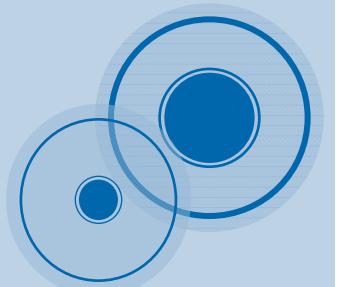


# Las “leyes” de la evolución del conocimiento



- v **Moore's Law - Miniaturization**
  - l Processing, Storage, ...
  - l Price/Performance 2X over 12-18 months
- v **Metcalf's Law - Interconnection**
  - l Economic value of a network increases as the square of the number of connections
- v **Gilder's Law - Quantization**
  - l Bandwidth increases 3X every 36 months
- v **Negroponte's Law - Digitization**
  - l Superiority of "bits over atoms"
  - l Profound impact felt in "Knowledge Economy" where ideas are ultimate raw material

# Las “leyes” de la evolución del conocimiento



## <sup>v</sup>Smith's Law - Simulation

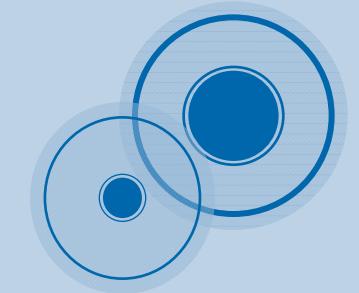
Alvy Ray Smith, Microsoft Research (to Howard Rheingold)

“Reality is 80 million polygons a second.”

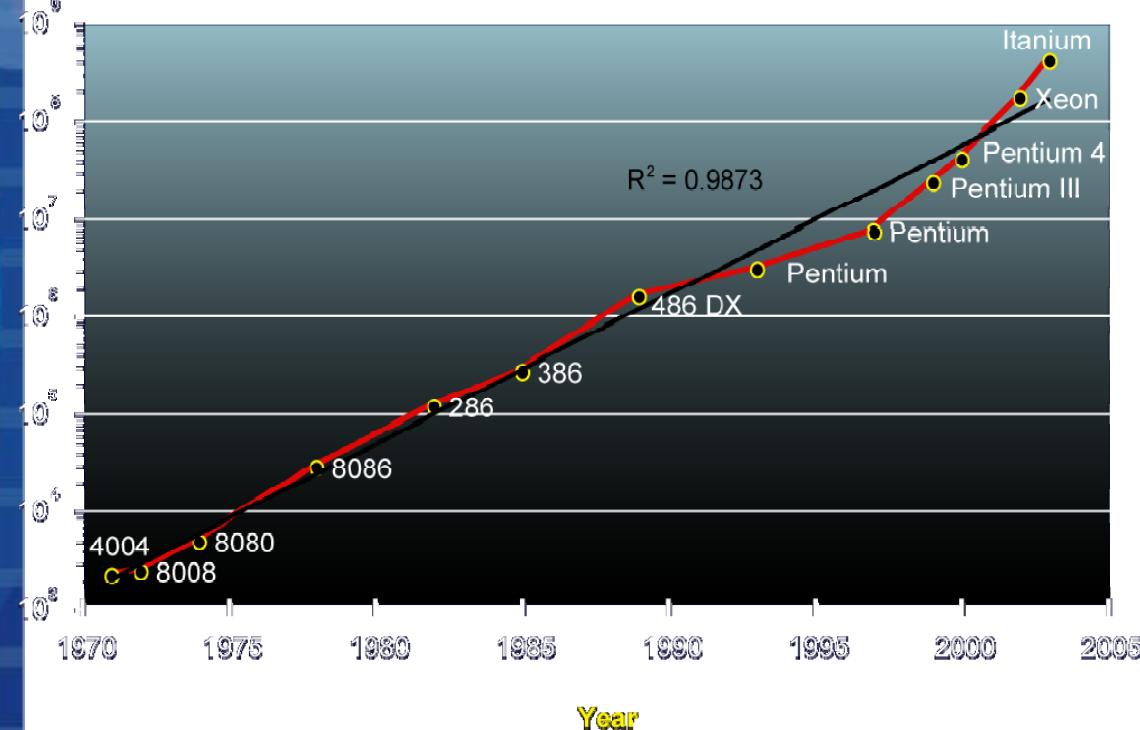
- ↳ A demand saturation threshold, like CPUs and productivity apps (which human-saturated in 1990's).
- ↳ No market saturation until we reach this point

$$\begin{aligned}
 h\nu &= \phi + E_{kmax} \\
 &\approx (mc^2)^2 \\
 h\nu \cdot W_0 &\approx \frac{hc}{\lambda} \cdot W_0 \\
 \Rightarrow A &\propto \lambda^{-1}
 \end{aligned}$$

## Transistors (Intel processors)



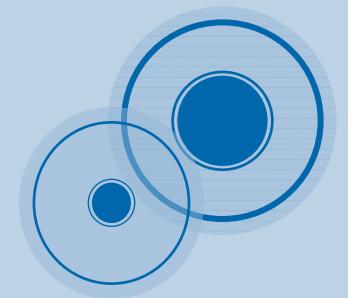
Transistors  
per chip



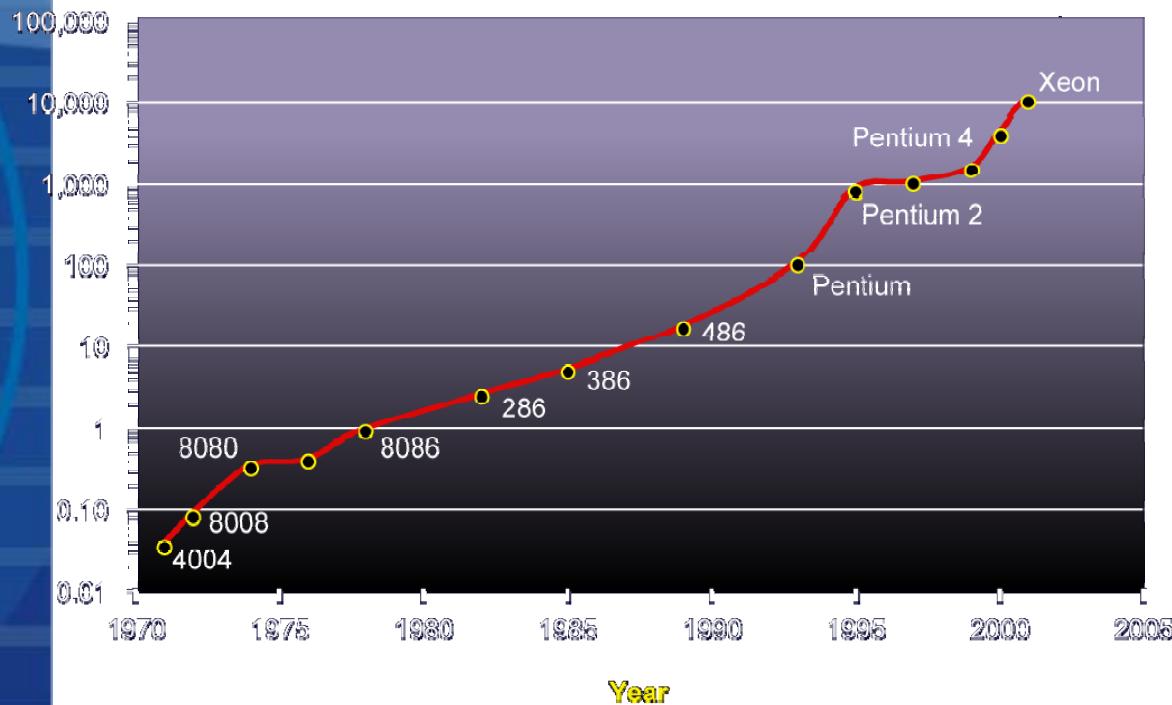
Source: Intel Research

Logarithmic Plot

$$\begin{aligned}
 h\nu &= \phi + E_{kmax} = \\
 &= (mc^2)^2 \\
 h\nu \cdot W_0 &\approx h\nu \cdot W_0 \\
 \Rightarrow A &= \lambda
 \end{aligned}$$



## Processor Performance (MIPS)



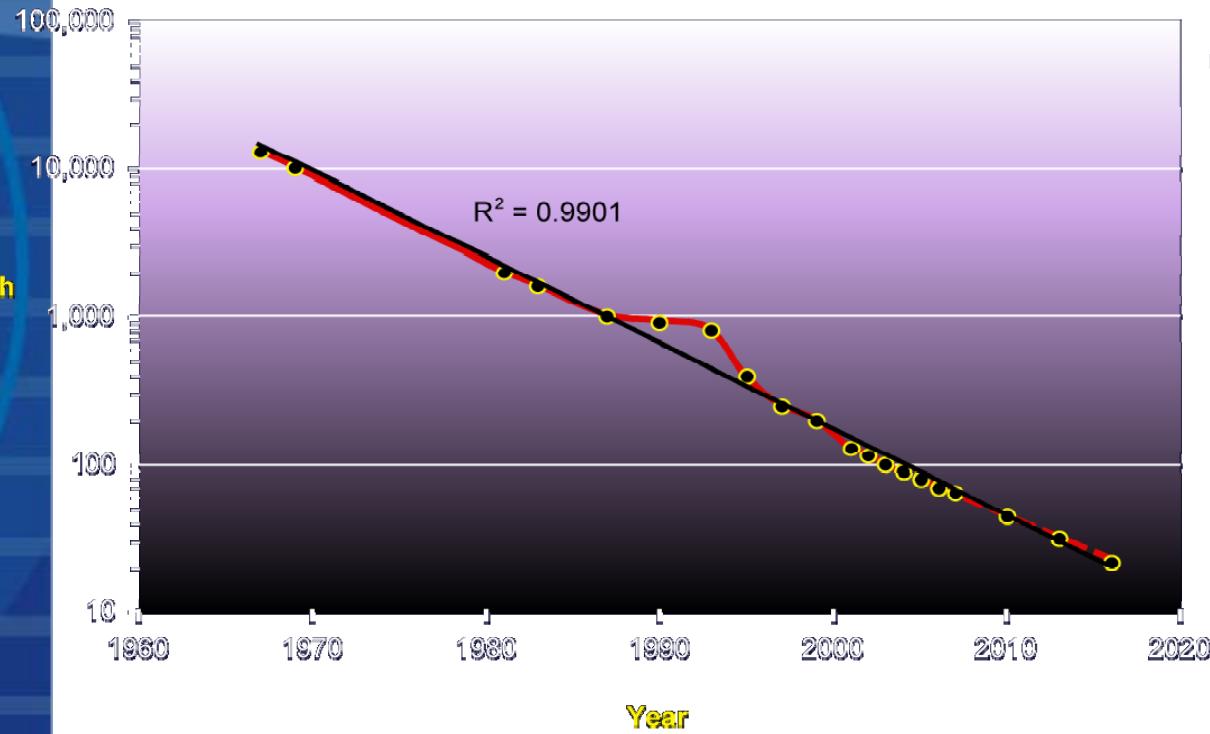
MIPS

Source: Intel

Doubling time: 1.8 years

$$\begin{aligned}
 h_f &= \phi + E_{kmax} = \\
 &= (mc^2)^2 \\
 &= h\nu \cdot W_0 \approx \frac{hc}{\lambda} \cdot W_0 \\
 \Rightarrow A &\propto \lambda^{-1}
 \end{aligned}$$

## Dynamic RAM Memory "Half Pitch" Feature Size



Logarithmic Plot

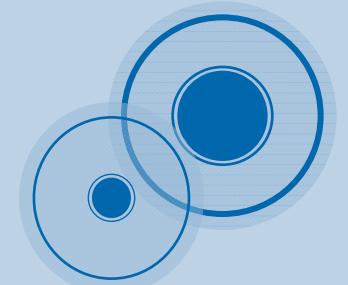
Source: Intel, SEMATECH ITRS Roadmap

Halving time: 6.4 years

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## Leyes de este tipo, como la de Moore se aplican también en la ciencia y la tecnología



Moore's Law describes a long-term trend in the history of computing hardware, in which the number of transistors that can be placed inexpensively on an integrated circuit has doubled approximately every two years

Rather than being a naturally-occurring "law" that cannot be controlled, however, Moore's Law is effectively a business practice in which the advancement of transistor counts occurs at a fixed rate.

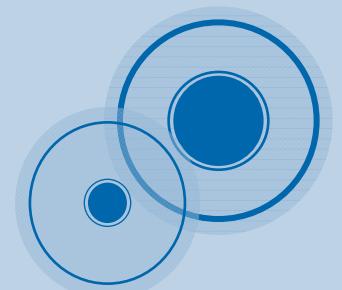
The capabilities of many digital electronic devices are strongly linked to Moore's law: processing speed, memory capacity, sensors and even the number and size of pixels in digital cameras.

All of these are improving at (roughly) exponential rates as well. This has dramatically increased the usefulness of digital electronics in nearly every segment of the world economy.

Moore's law precisely describes a driving force of technological and social change in the late 20th and early 21st centuries. The trend has continued for more than half a century and is not expected to stop until 2015 or later. The law is named for Intel co-founder Gordon E. Moore, who introduced the concept in a 1965 paper. It has since been used in the semiconductor industry to guide long term planning and to set targets for research and development.

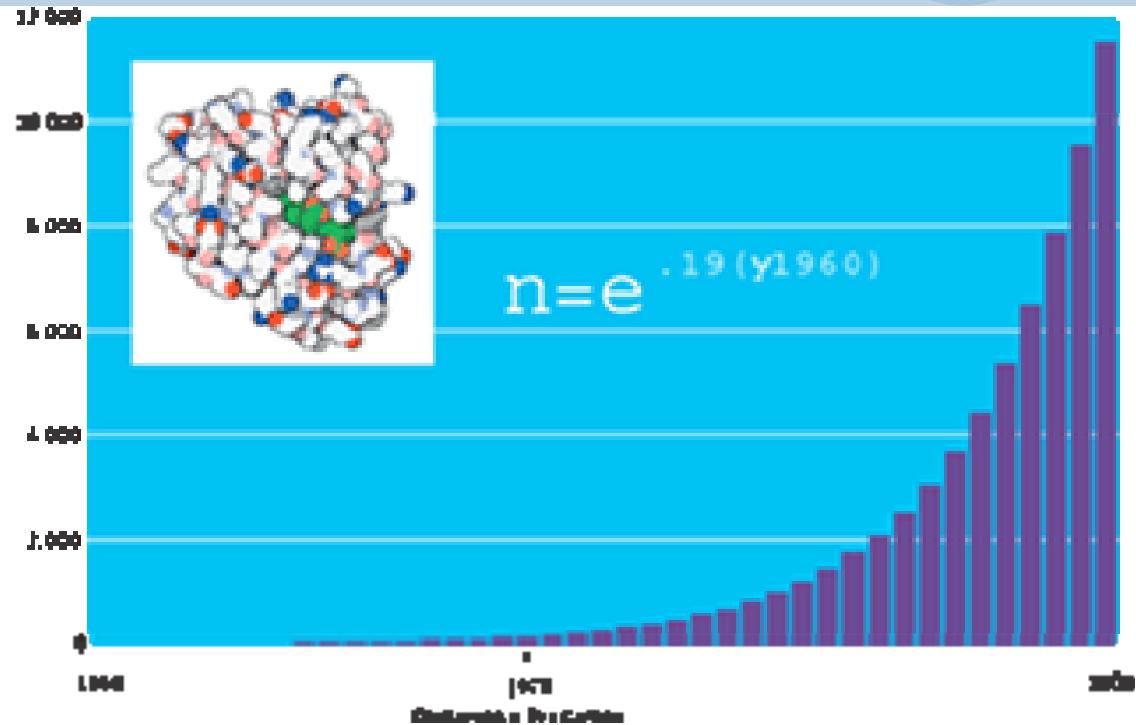


Leyes de este tipo, como la de Moore se aplican también en la ciencia y la tecnología



Richard Dickerson  
1978, Cal Tech:

Protein crystal  
structure solutions  
grow according to  
 $n = \exp(0.19y - 1960)$



Dickerson's law predicted **14,201** solved crystal structures by 2002. The actual number (in online Protein Data Bank (PDB)) was **14,250**. Just 49 more.

Macroscopically, the curve has been quite consistent.



## Ley de Icaza-Castaño sobre publicaciones en nanotecnología

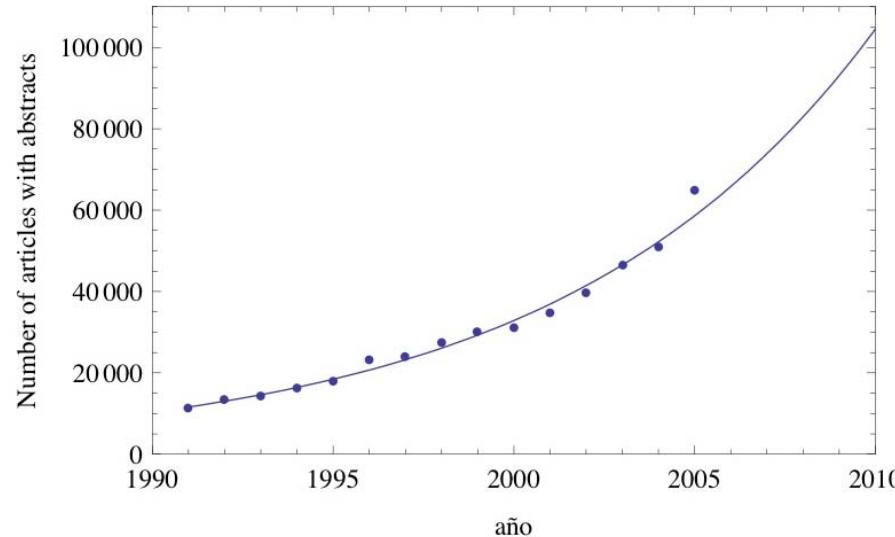
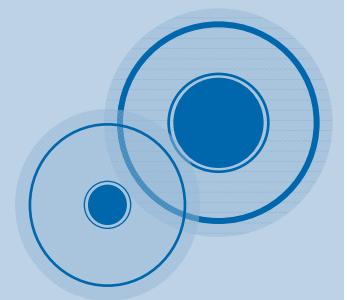


Figura 1: Nanotechnology is booming! In the fundamental nanotechnology research literature as represented by the Science Citation Index/Social Science Citation Index (SCI/SSCI) (SCI 2006), nanotechnology publications grew from 11,265 records (classified as Articles or Reviews) in 1991 to 64,737 records in 2005.

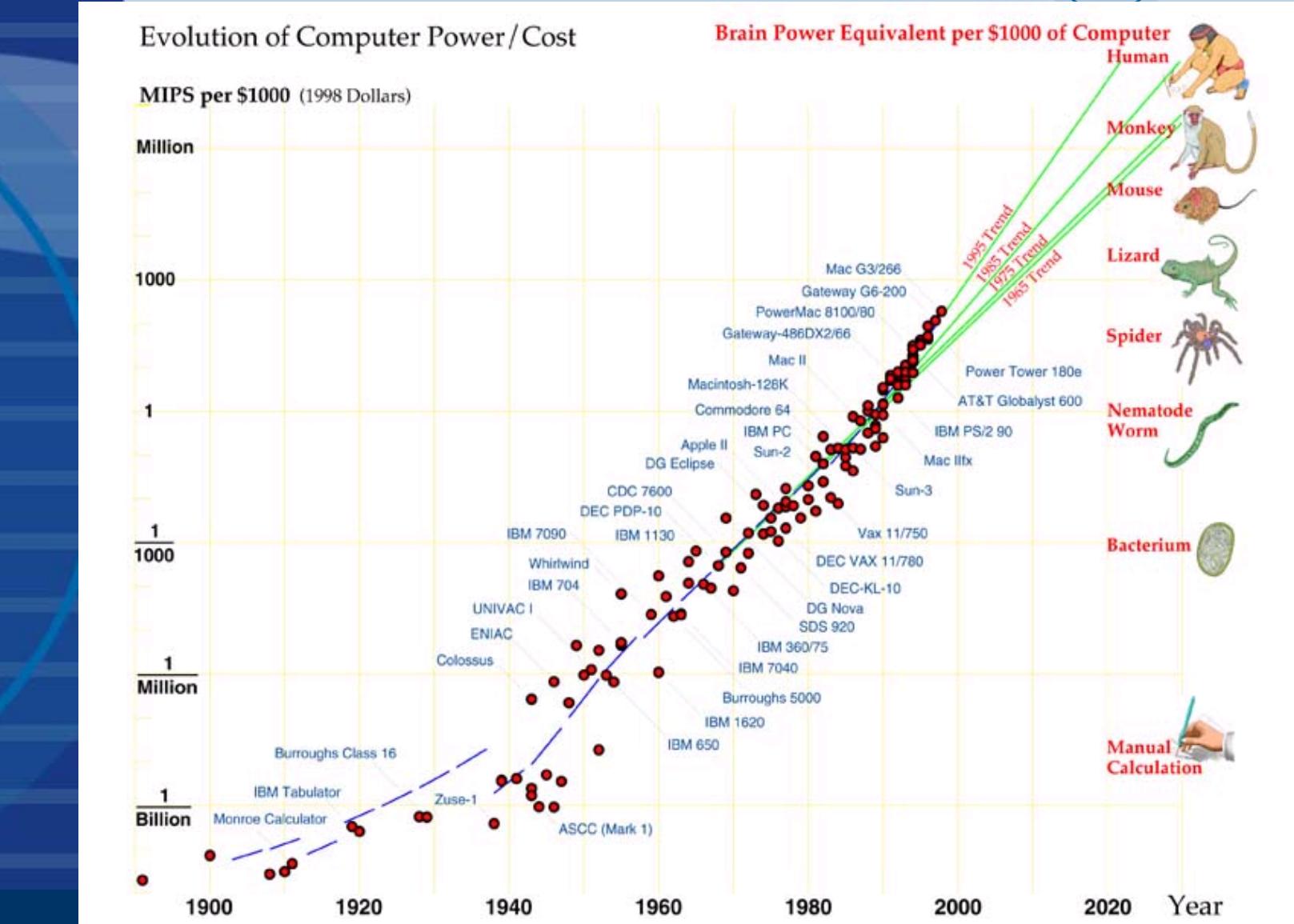
Figura tomada de: Technical structure of the global nanoscience and nanotechnology literature. Ronald N. Kostoff, Raymond G. Koytcheff & Clifford G. Y. Lau J Nanopart Res 9,701, 2007.

El trazo continuo de esta gráfica corresponde a:

$$N(x) = e^{-221 + 0.1157 t}, \quad (1)$$

donde  $t$  es la expresión decimal del tiempo en años.

$$\begin{aligned}
 h_f &= \phi + E_{kmax} = \\
 &= (mc^2)^2 \\
 h\nu &\approx hc \\
 \rightarrow A &\approx \lambda W_0
 \end{aligned}$$



# La evolución CONTINUA de la tecnología

Technological or Sociotechnological Innovation Location	Date (A.D.),
Alchemy (pre-science) develops a wide following	410, Europe
Constantinople University	425, Turkey
Powers and Roots (Aryabhata)	476, India
Heavy plow; horse shoes; practical horse harness	500, Europe
Wooden coffins (Alemanni)	507, Germany
Draw looms (silk weaving)	550, Egypt
Decimal reckoning	595, India
Canterbury Monastery/University	598, England
Book printing	600, China
Suan-Ching (Science Encyclopedia)	619, China
Originum Etymologiarum Libri XX (Sci. Encyc.)	622, Spain
First surgical procedures	650, India
Water wheel for milling (Medieval energy source)	700, Europe
Stirrup arrives in Europe from China	710, Europe
Early Chemistry (Abu Masa Dshaffar)	720, Mid-East

<b>Medicine, Astronomy, Math, Optics, Chemistry</b>	<b>750, Arab Spain</b>
<b>Hanlin Academy</b>	<b>750, China</b>
<b>Pictorial Book Printing</b>	<b>765, Japan</b>
<b>Iron and smithing become common; felling ax</b>	<b>770, Europe</b>
<b>Chemistry (Jabir)</b>	<b>782, Mid-East</b>
<b>Mayan Acropoli (peak)</b>	<b>800, Mexico</b>
<b>Algebra (Muhammed al Chwarazmi)</b>	<b>810, Persia</b>



<b>Ptolemaic Astronomy; Soap becomes common</b>	<b>828, Europe</b>
<b>Rotary grindstone to sharpen iron</b>	<b>834, Europe</b>
<b>Paper money</b>	<b>845, China</b>
<b>Salerno University</b>	<b>850, Italy</b>
<b>Iron becomes common; Trebuchets</b>	<b>850, Europe</b>
<b>Astrolabe (navigation)</b>	<b>850, Mid-East</b>
<b>Angkor Thom (city)</b>	<b>860, Cambodia</b>
<b>New Mathematics and Science (Jahiz, Al-Kindi)</b>	<b>870, Mid-East</b>
<b>Viking shipbuilding</b>	<b>900, Europe</b>
<b>Paper arrives in Arab world</b>	<b>900, Egypt</b>

<b>Salerno Medical School</b>	<b>900, Italy</b>
<b>Linens and woolens</b>	<b>942, Flanders</b>
<b>First European bridges</b>	<b>963, England</b>
<b>Arithmetical notation brought to Europe by Arabs</b>	<b>975, Europe</b>
<b>1,000 volume encyclopedia</b>	<b>978, China</b>
<b>First Mayan and Tiuanaco Civilizations</b>	<b>1000,</b>
<b>Cent./S.America</b>	
<b>Horizontal loom</b>	<b>1000, Europe</b>



<b>Astrolabe arrives in Europe</b>	<b>1050, Europe</b>
<b>Greek medicine arrives in Europe (Constantine)</b>	<b>1070, Europe</b>
<b>Water-driven mechanical clock</b>	<b>1090, China</b>
<b>Antidotarium (2650 medical prescriptions)</b>	<b>1098, Italy</b>
<b>Bologna University</b>	<b>1119, Italy</b>
<b>Mariner's compass</b>	<b>1125, Europe</b>
<b>Town charters granted (protecting commerce)</b>	<b>1132, France</b>
<b>Al-Idrisi's "Geography"</b>	<b>1154, Italy</b>
<b>Oxford University</b>	<b>1167, England</b>
<b>Vertical sail windmills</b>	<b>1180, Europe</b>

Glass mirrors		1180, England
Second Mayan Civilization		1190, Cent. America
Cambridge University		1200, England
Arabic numerals in Europe (Leonardo Fibonacci)		1202, England
Tiled roofs		1212, England
Cotton manufacture	1	225, Spain
Coal mining		1233, England
Roger Bacon, our first scientist (Opus; Communia)		1250, England

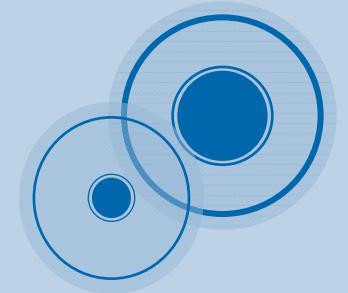


Goose quill writing pen	1250, Italy
The inquisition begins using instruments of torture	1252, Spain
Tradesman guilds engage in street fighting over turf	1267, England
Toll roads	1269, England
Human dissection	1275, England
Wood block printing; spectacles	1290, Italy
Standardization of distance measures (yard, acre)	1305, England
Use of gunpowder for firearms (Berthold Schwarz)	1313, Germany
Sawmill; wheelbarrow; cannon (large and hand)	1325, Europe

Pisa and Grenoble Universities; Queens College	1330, Europe
First scientific weather forecasts (William Merlee)	1337, England
Mechanical clock reaches Europe	1354, France
Blast furnaces; cast iron explodes across Europe	1360, Europe
Steel crossbow first used in war	1370, Europe
Vienna, Hiedelberg, and Cologne Universities	1380, Europe
Incorporation of the Fishmonger's Company	1384, England

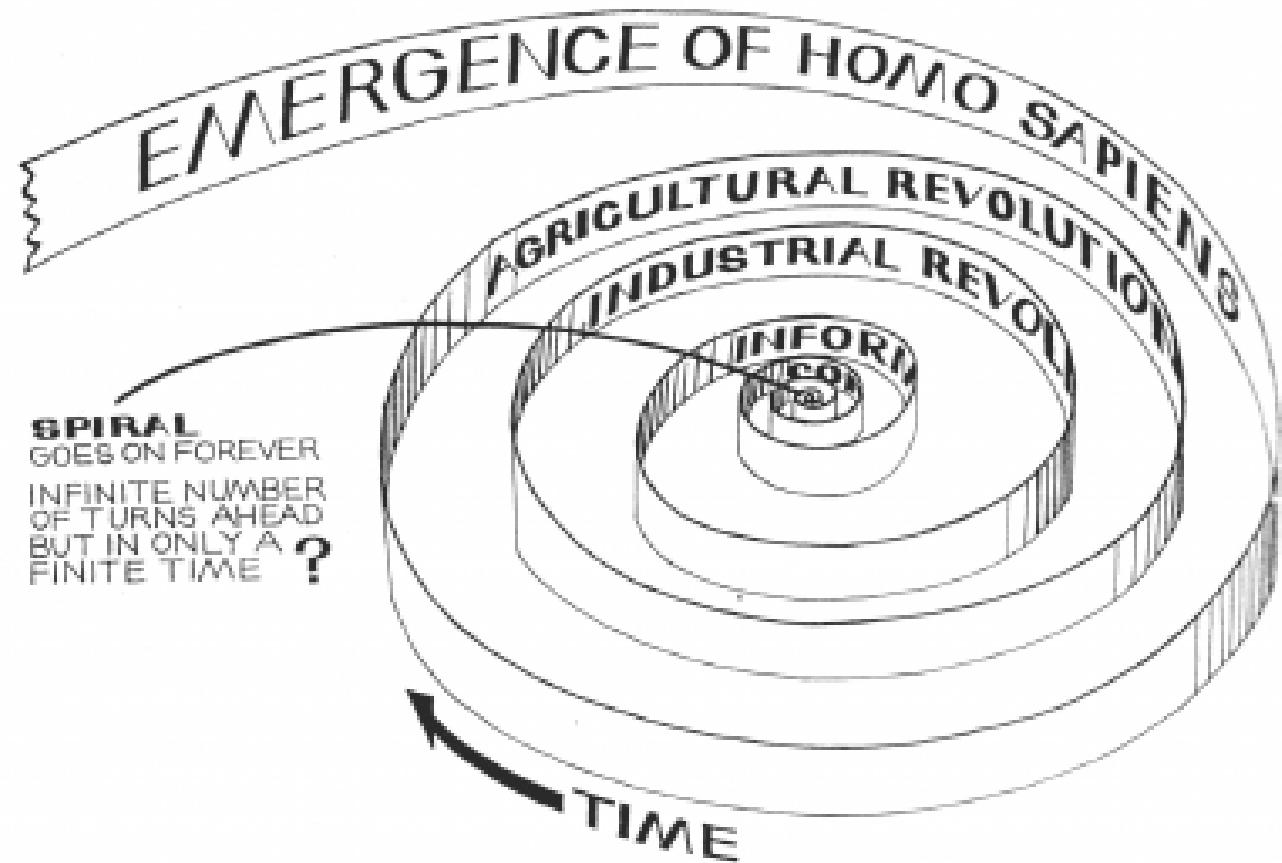
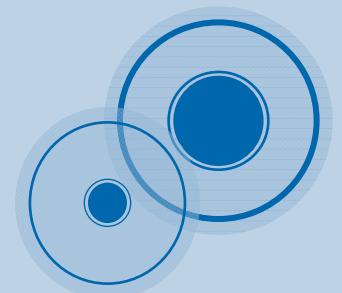


Johann Gutenberg, inventor of mass printing, born 1396, Germany



- Lesson: Tech innovation appears to be a **developmental** process, independent of Wars, Enlightenments, Reformations, Inquisitions, Crusades, Subjugations, and other aspects of our cyclic **evolutionary** ideological, cultural, and economic history.
- Tech advances are something we consistently choose, even unconsciously, regardless of who is in power, because they have strong "non-zero sum" effects on human aspirations.

$$\begin{aligned}
 hf &= \phi + E_{kmax} = \\
 &= (mc^2)^2 \\
 h\nu \cdot W_0 &\approx \frac{hc}{\lambda} \cdot W_0 \\
 \rightarrow A &= \frac{\lambda}{c} \cdot W_0
 \end{aligned}$$





# Henry Brooks Adams (1838 –1918)

- In 1910, Adams printed and distributed to university libraries and history professors the small volume *A Letter to American Teachers of History* proposing a "theory of history" based on the second law of thermodynamics and the principle of entropy. This, essentially, states that all energy dissipates, order becomes disorder, and the earth will eventually become uninhabitable. In short, he applied the physics of dynamical systems of Rudolf Clausius, Hermann von Helmholtz, and William Thomson to the modeling of human history. In his manuscript *The Rule of Phase Applied to History*, Adams attempted to use Maxwell's demon as an historical metaphor. Adams interpreted history as a process moving towards "equilibrium," but he saw militaristic nations (he felt Germany pre-eminent in this class) as tending to reverse this process, a "Maxwell's Demon of history." Adams made many attempts to respond to the criticism of his formulation from his scientific colleagues, but the work remained incomplete at Adams' death in 1918. It was only published posthumously.



"Our Power Is Always Running Ahead of Our Mind": Henry Adams's Phases of History

KEITH R. BURICH

WHEN Henry Adams composed "The Rule of Phase Applied to History" in 1909, he intended it as a good-natured but pointed jab at his fellow historians for naively assuming that the future is determined by the past. The message, unfortunately, was lost. Leaving "The Rule of Phase" unpublished, Adams abandoned it to pursue the more dramatic and frightening consequences predicted by the second law of thermodynamics which he set forth in "A Letter to American Teachers of History" in 1910. Sandwiched between *The Education of Henry Adams*, which Adams had privately printed in 1907, and the "Letter," "The Rule of Phase Applied to History" has never been the subject of serious scholarly analysis. Instead, it has been casually regarded as another, if more obtuse, version of Adams's obsessive search for the universal, immutable laws that govern men and molecules alike and, of course, presage the inevitable and irreversible degradation of the universe, including mankind. A close examination of the phase rule itself, the physical principle upon which the essay was predicated, suggests on the contrary that Adams was not attempting to demonstrate that history is a continuous, deterministic process, whether of infinite upward progression or ultimate degradation. A careful analysis of the first draft of "The Rule of Phase," which has generally been ignored by Adams's biographers, supports the contention.<sup>1</sup> Although

<sup>1</sup>Henry Adams, "The Rule of Phase Applied to History," in *The Degradation of the Democratic Dogma* (New York: Macmillan Co., 1920), pp. 267–311. All references to "The Rule of Phase Applied to History," henceforth to appear in the text, will be to the draft typescript in the Henry Adams Papers, Massachusetts Historical

$$hf = \phi + E_{max} =$$

$$(mc^2)^2$$

$$= h\nu \cdot W_0 \approx hc \cdot W_0$$

$$\rightarrow A + \lambda$$



# Henry Adams, 1909: The First Singularity Theorist

Henry Adams  
*The Rule of Phase Applied to History*  
 1909

"A Law of Squares"



Accelerating.org



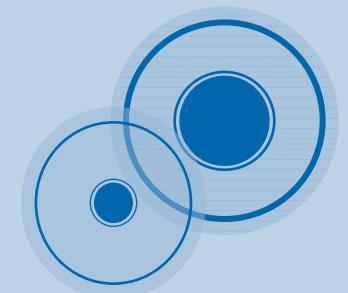
The final Ethereal Phase would last only about four years, and thereafter "bring Thought to the limit of its possibilities."

Wild speculation or computational reality?

Still too early to tell, at present.



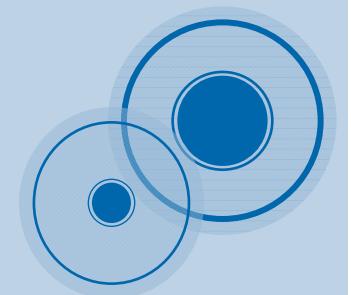
# Ambientalismo: las 3 Rs



- ❖ Reciclamiento: del reuso a la rehabilitación de materiales
- ❖ Recuperación: reintroducción de componentes usados en el proceso
- ❖ Remanufactura: reacondicionamiento de productos.
  - Responsabilidad del productor en cuanto a la disposición de desechos o productos fuera de su ciclo de vida



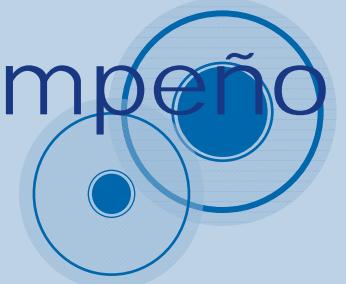
# Retos sociales inmensos



- ❖ La crisis de empleo
- ❖ La brecha tecnológica y la asimetría de la información
- ❖ Deterioro de términos de intercambio
- ❖ Países en desarrollo con muy escasa cobertura de necesidades básicas
- ❖ Pobre formación de capacidades
- ❖ Seguridad pública y seguridad social



# Competitividad y desempeño social



- ❖ Dependen de la preparación de gente.
- ❖ Capacidad de investigación e innovación.
- ❖ Acceder, guardar, procesar y usar información.
- ❖ Empleos de alta remuneración
- ❖ Búsqueda de la sustentabilidad: utilizar racionalmente recursos para las generaciones de hoy y mañana.



# Sociedad del conocimiento

**Cambio en el modelo de producción y uso del conocimiento (Gibbons, 1994).**

- ❖ Transdisciplinario e interinstitucional.
- ❖ Contexto de aplicación.
- ❖ Nueva contabilidad social (rendición de cuentas).
- ❖ Nuevo sistema de control de calidad.
- ❖ Sistema socialmente distribuído.

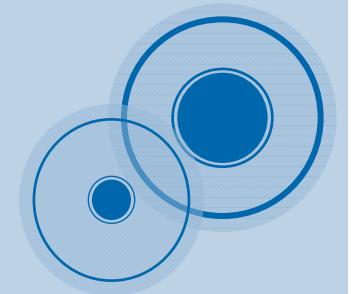


## Modo 2. Nuevo proceso de producción de conocimiento

Atributo	Modo 1	Modo 2
Participación	Disciplinaria	Transdisciplinaria <ul style="list-style-type: none"><li>□ Marco evolutivo para solución de problemas</li><li>□ Componentes teóricos y empíricos</li><li>□ Dinámico</li></ul>
Comunicación	Canales institucionales Revistas científicas y conferencias	Redes complejas
Organización	Alrededor de disciplinas y líderes científicos	Heterogénea Sistema socialmente distribuido Múltiples lugares de generación de conocimiento Interconexión de los sitios Determinada por el contexto socioeconómico
Evaluación	Por la comunidad científica Juicio de pares	En el contexto de la aplicación
Control de calidad	Indicadores científicos tradicionales Juicio de pares	Interés intelectual Efectividad económica Aceptación social Competitividad Rendición de cuentas a la sociedad



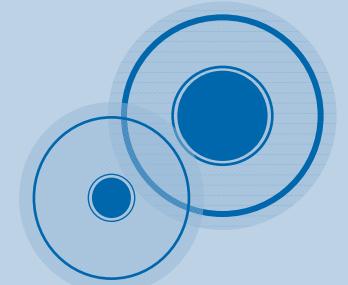
# Consecuencias



- ❖ **Expansión y diversificación de fuentes de conocimiento**
- ❖ **Demanda por conocimiento especializado**
- ❖ **Necesidad de respuesta rápida**
- ❖ **Permeabilidad al contexto**
- ❖ **Formación y participación en redes**
- ❖ **Avance hacia sistemas de innovación**



# Los centros de I&D y la innovación abierta



- **La interdependencia en cuanto a conocimiento crea nuevos retos directivos**
- Los riesgos y dificultades de las transacciones de conocimiento
- El establecimiento de relaciones interorganizacionales diversas para adquirir conocimiento y habilidades
- En América Latina, la cooperación entre empresas y centros apenas está en estado incipiente
- Falta experiencia institucional, orientación a la solución de problemas de usuarios y traducción adecuada de conocimiento en activos intelectuales

## Renovación

Cuando el conocimiento se reutiliza, se genera conocimiento nuevo

### Reutilizar y renovar

Reutiliza conocimiento existente

Renueva conocimiento obsoleto a través de mejora continua

## Aprendizaje

### Crear y capturar

Crea y genera nuevo conocimiento

Captura de conocimiento interno y externo

Almacena conocimiento

### medición

- Mapa de conocimientos
- Fuentes de aprendizaje
- Indicadores de capital intelectual

### Asimilar y aplicar

Las personas necesitan acceder al conocimiento, interpretarlo y asimilarlo para luego aplicarlo

## Inteligencia

Transformación de conocimiento tácito en explícito

### Distribuir y compartir

Hacer el conocimiento accesible

Distribuir, difundir y transmitir

## Distribución