

**Neuroscience, Bio-system science,  
Third-Brain and  
Bio-Supercomputing**

**Dr. Steve Chen**

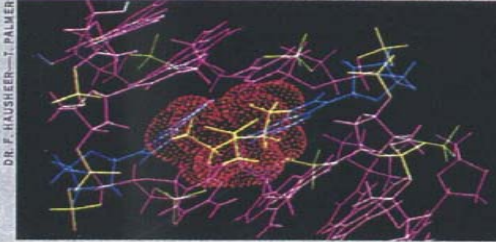
**U.S. National Academy of Engineering  
American Academy of Arts and Sciences**

**10-24-2006**

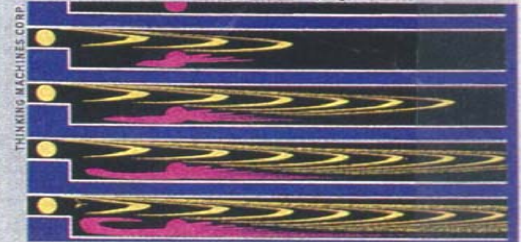
# 20<sup>th</sup> Century: US Leading HPC Development

New drug development for cancer treatment, oil exploration, weather forecast, wind tunnel simulation, jet plane design, and universe simulation.

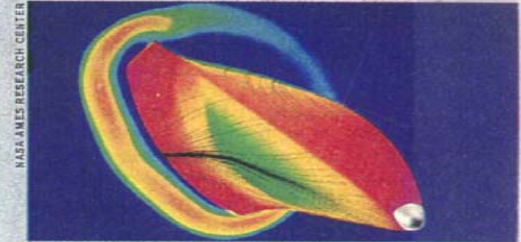
CANCER DRUG AT WORK



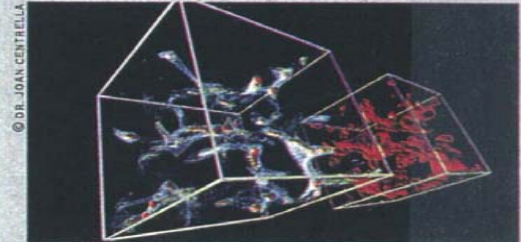
FLOWING LIQUIDS



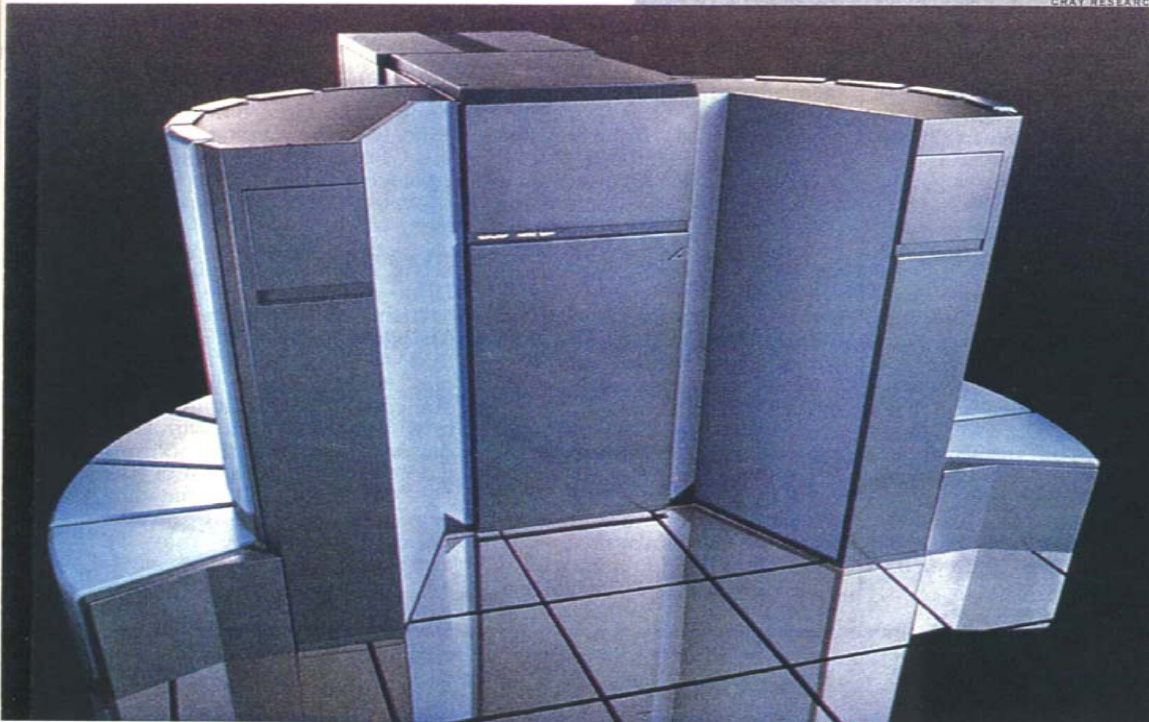
HYPERSONIC PLANE



EARLY UNIVERSE

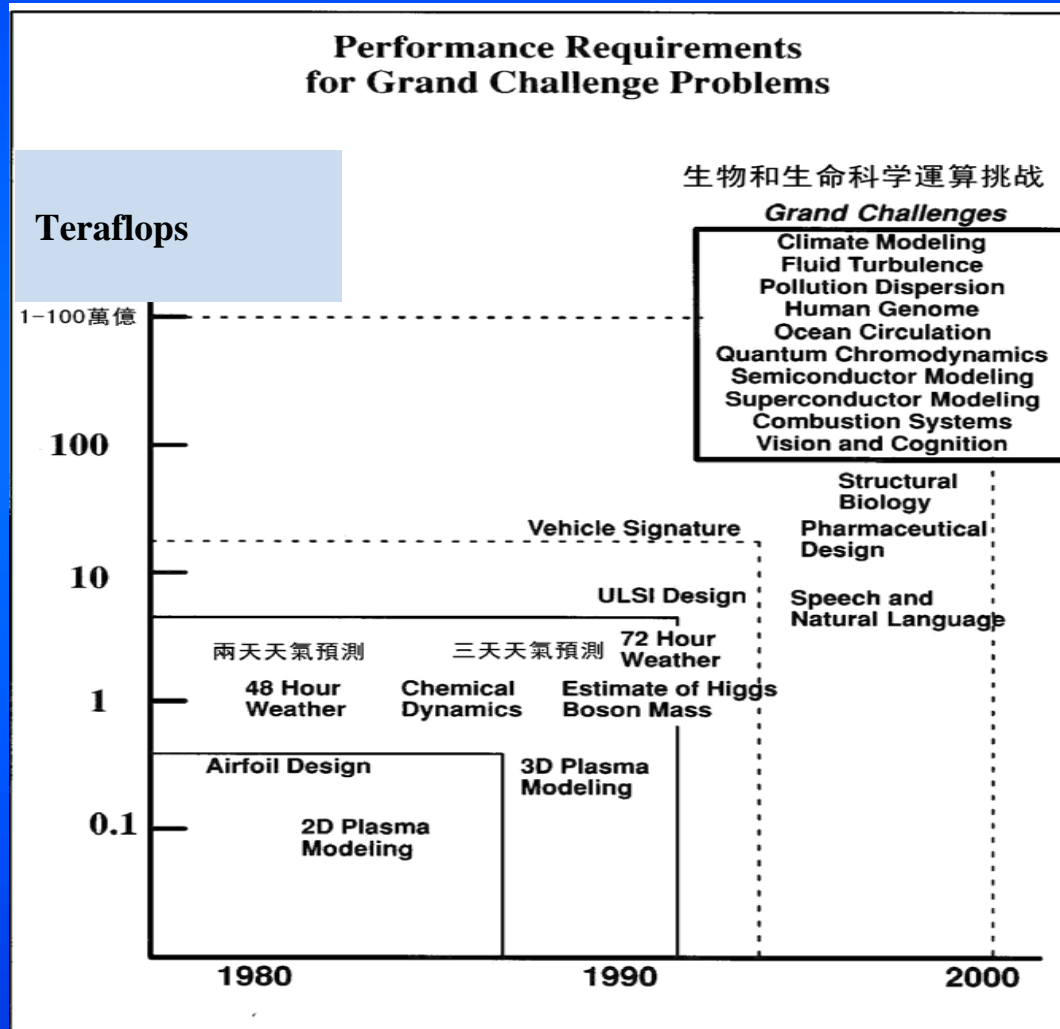


CRAY RESEARCH

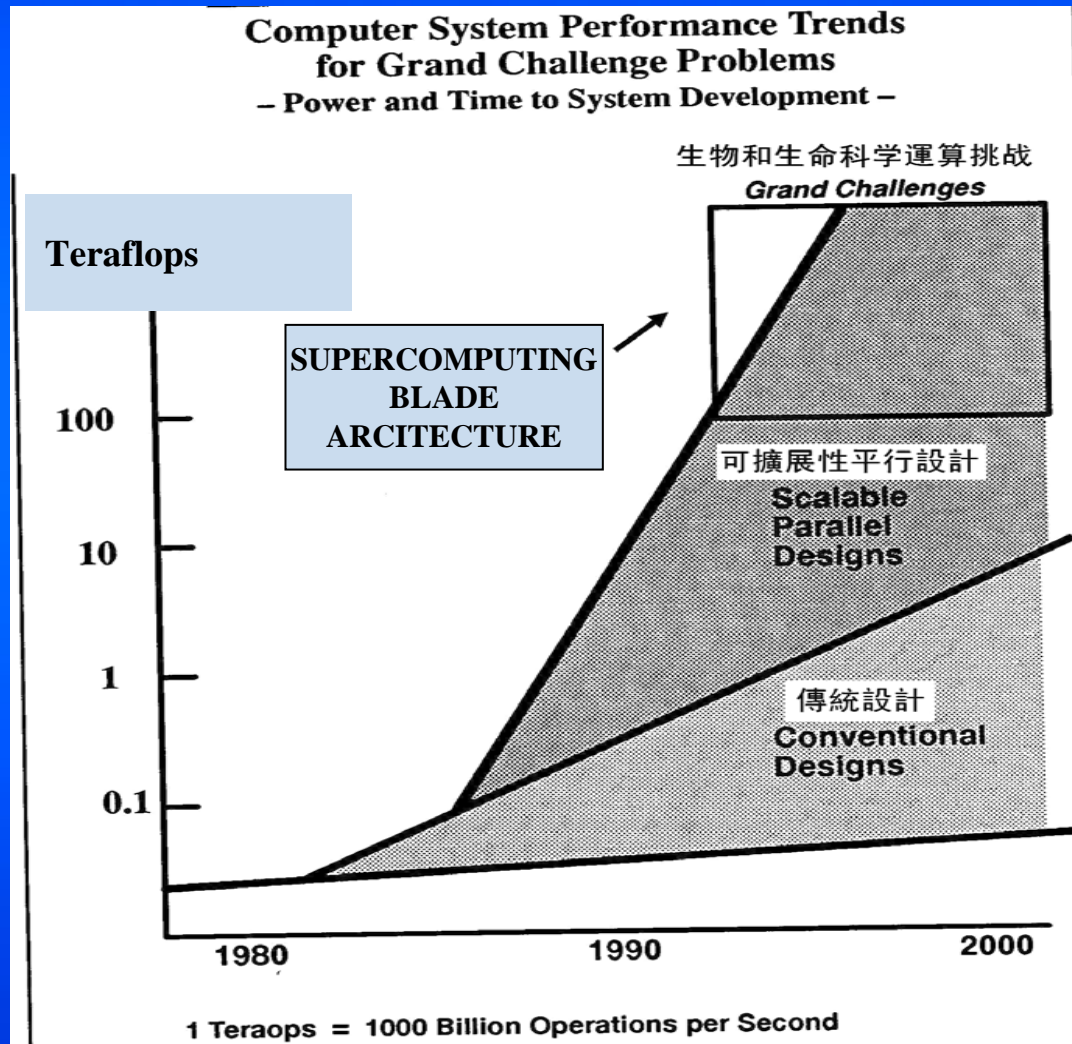


TIME, MARCH 28, 1988

# Continuous Growth of HPC Requirements



# System Architecture to Sustain HPC Growth



# HPC for Grand Challenges Problems

- **Automotive Development:** 100 Teraflops
- **Human Vision Simulation:** 100 Teraflops
- **Aerodynamic Analysis:** 1 Petaflops
- **Laser Optics:** 10 Petaflops
- **Molecular Dynamics in Biology:** 20 Petaflops
- **Aerodynamic Design:** 1 Exaflops
- **Computational Cosmology:** 10 Exaflops
- **Turbulence in Physics:** 100 Exaflops
- **Computational Chemistry:** 1 Zettaflops



# Biomedical and Life Science Research

- 2004, China-Made 1 Teraflops 128-blade Supercomputing System installed at Beijing Biomedical Research Institute

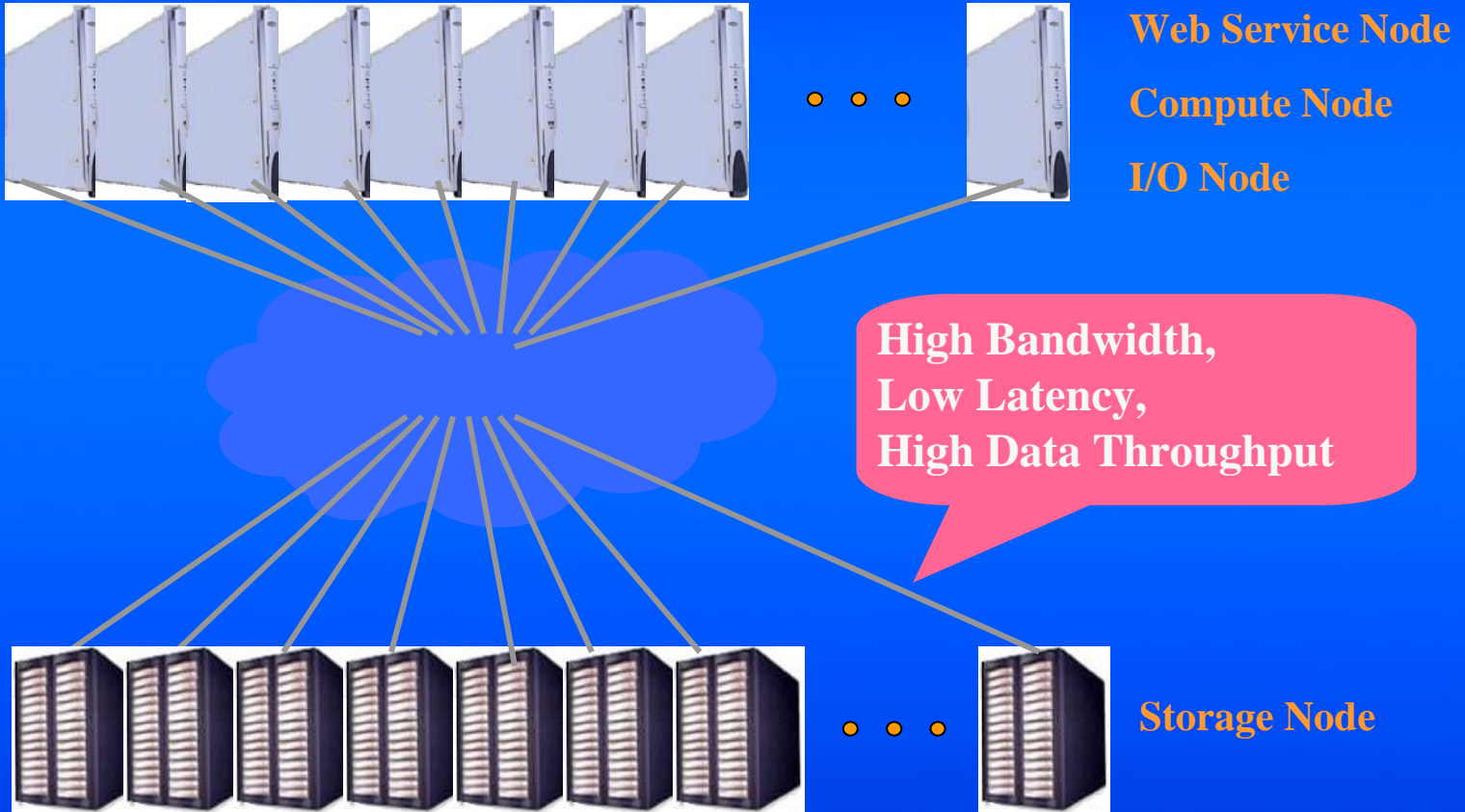


# Highly Parallel & Massive Data Processing and Data Mining



# Supercomputing Blade System Architecture

## Point-to-Point High Speed Interconnect





# Collaborative R/D and App. Platform

## Integral Utility Grid Supercomputing Grid

Applications: Distributed, Parallel and Collaborative Computing

Collaboration OS

Collaborative Middleware

Network OS

Intelligent IP Networking

Engine OS

Single System Management

System OS

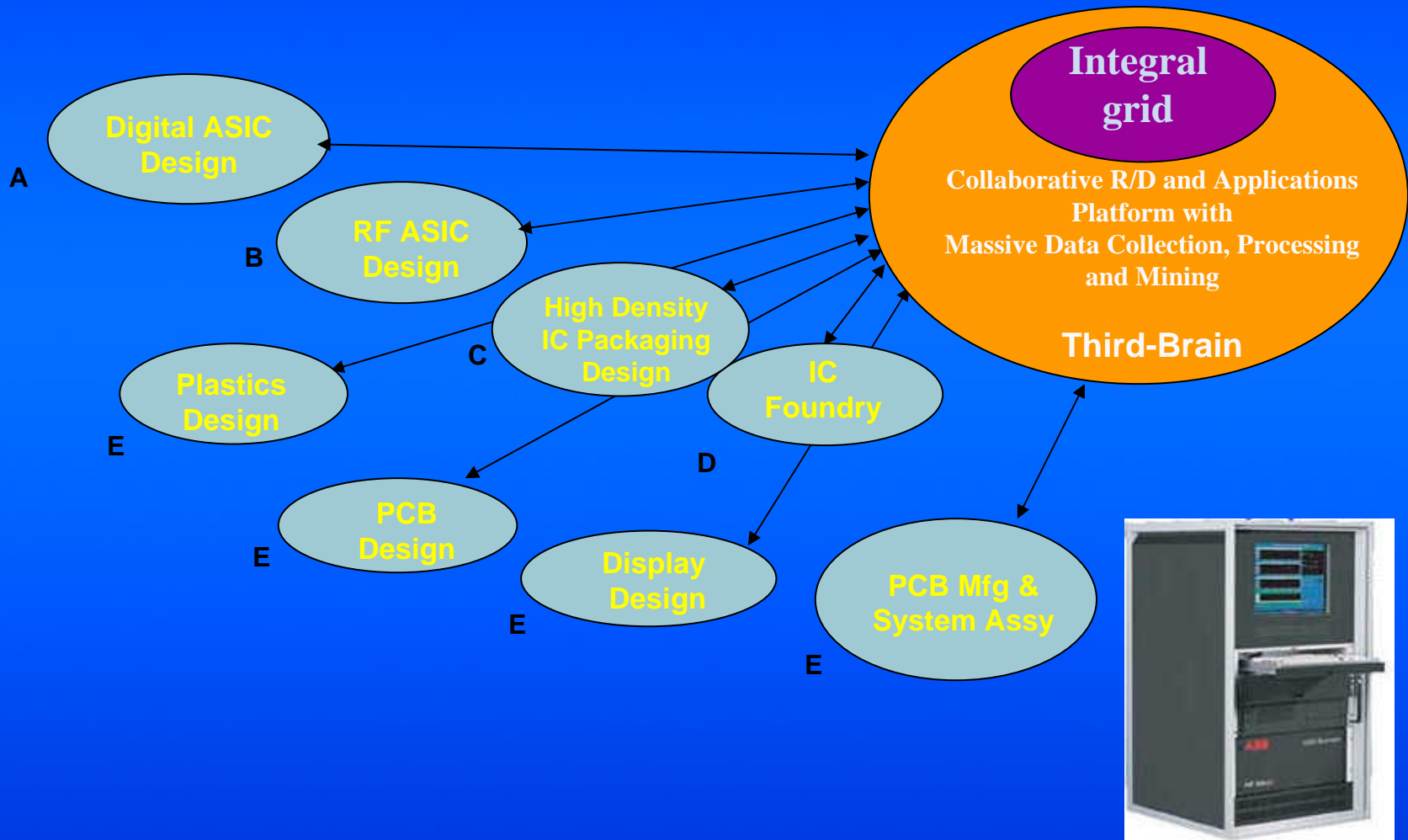
Linux or Windows

Hardware

Supercomputing Blade System



# Integral Utility Supercomputing Grid (Multi-level and Physical Distributed)



Last Frontiers:  
Inside the Brain

- Light
- Telescope
- Microscope
- TV/Film



- Broadcast
- Microphone
- Telephone
- Cell Phone

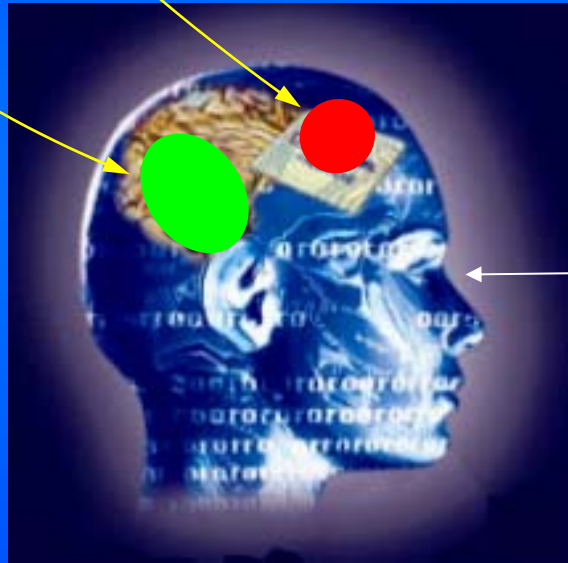
Mechanic Engine

- Cars
- Airplane
- Motor
- Crane

# Human Brain Learning

Learning  
Management

Memory  
Storage

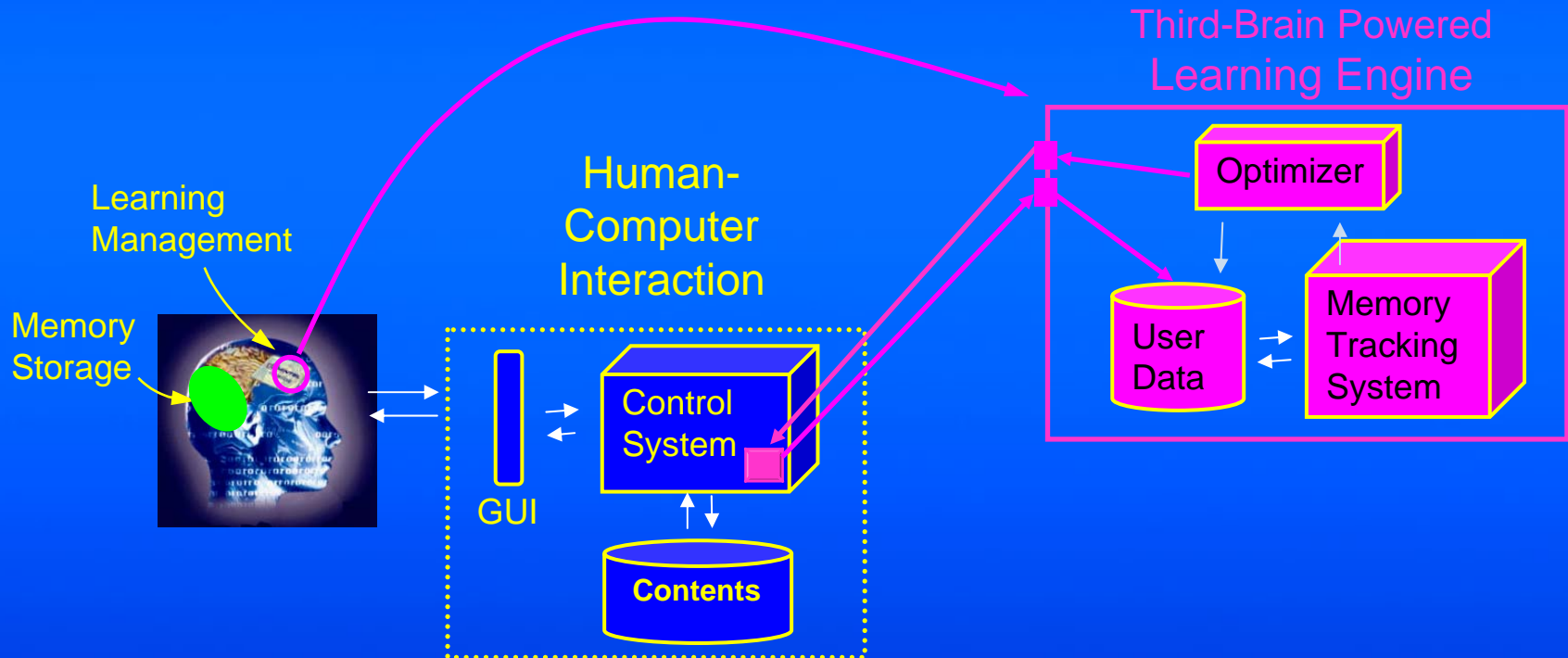


# Learning with Third-Brain

Like engine liberated human from heavy physical work, **Third-Brain** will liberate human from heavy mental tasks.

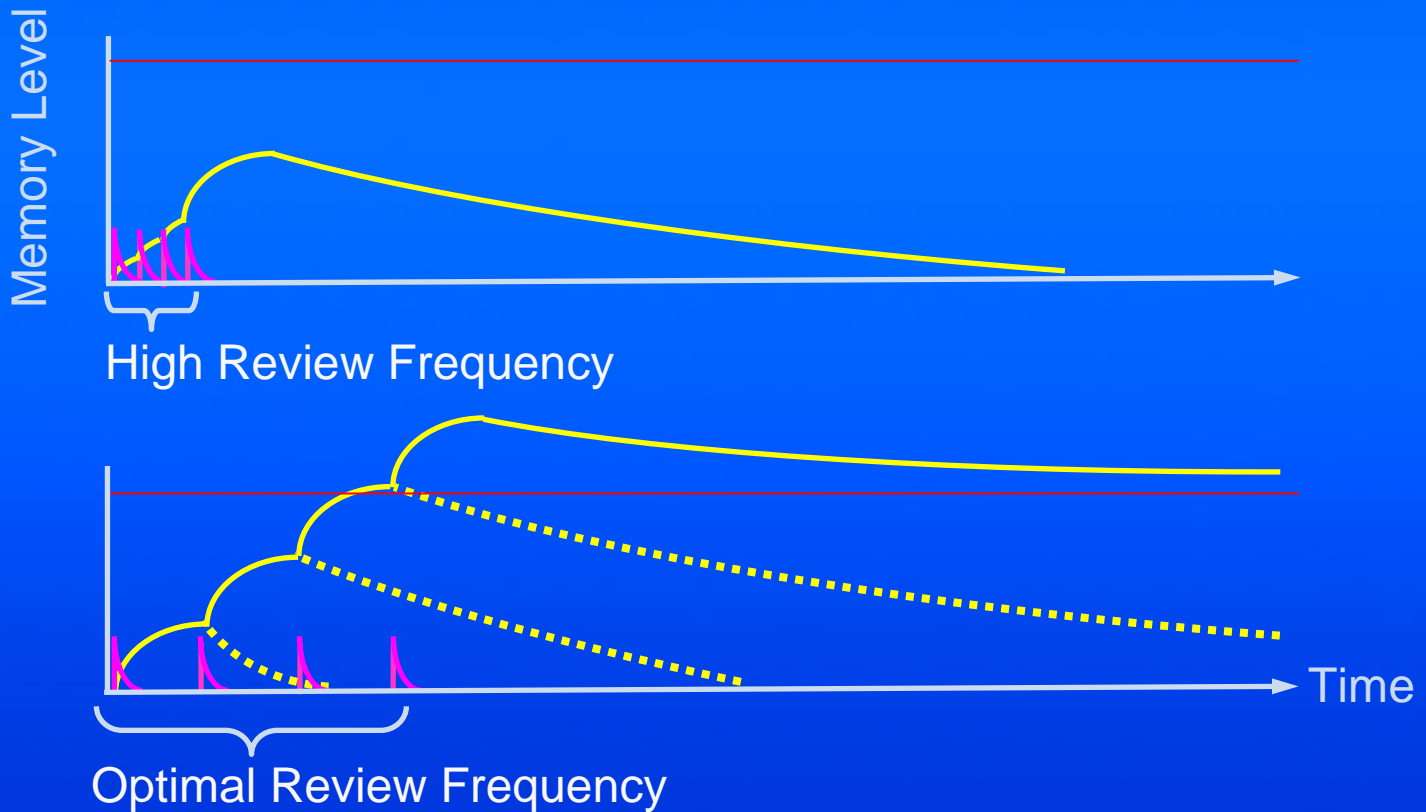
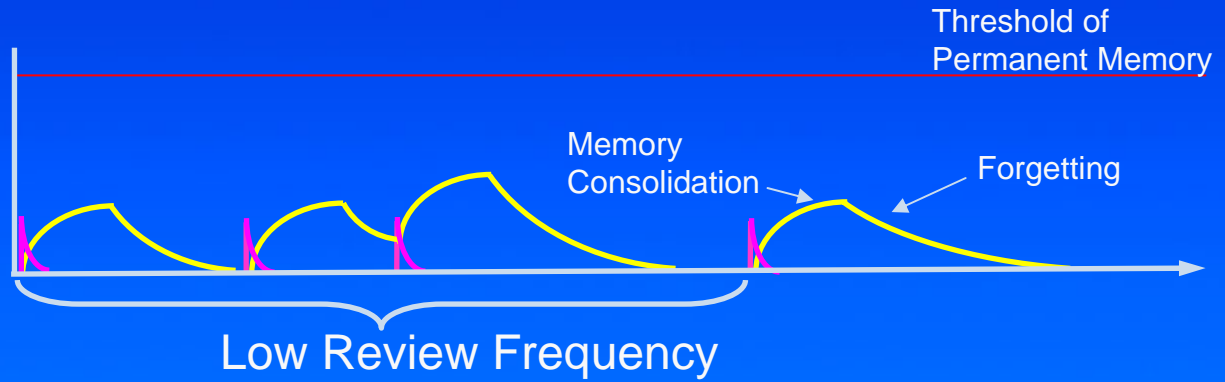
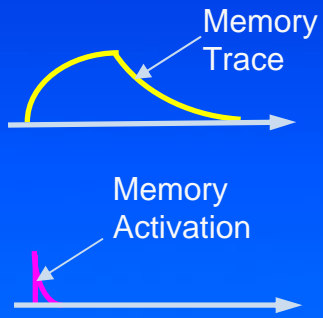
Advantage of **Third-Brain** over human brain:

- Accurate history data
- Accurate memory tracking
- Massive data optimization

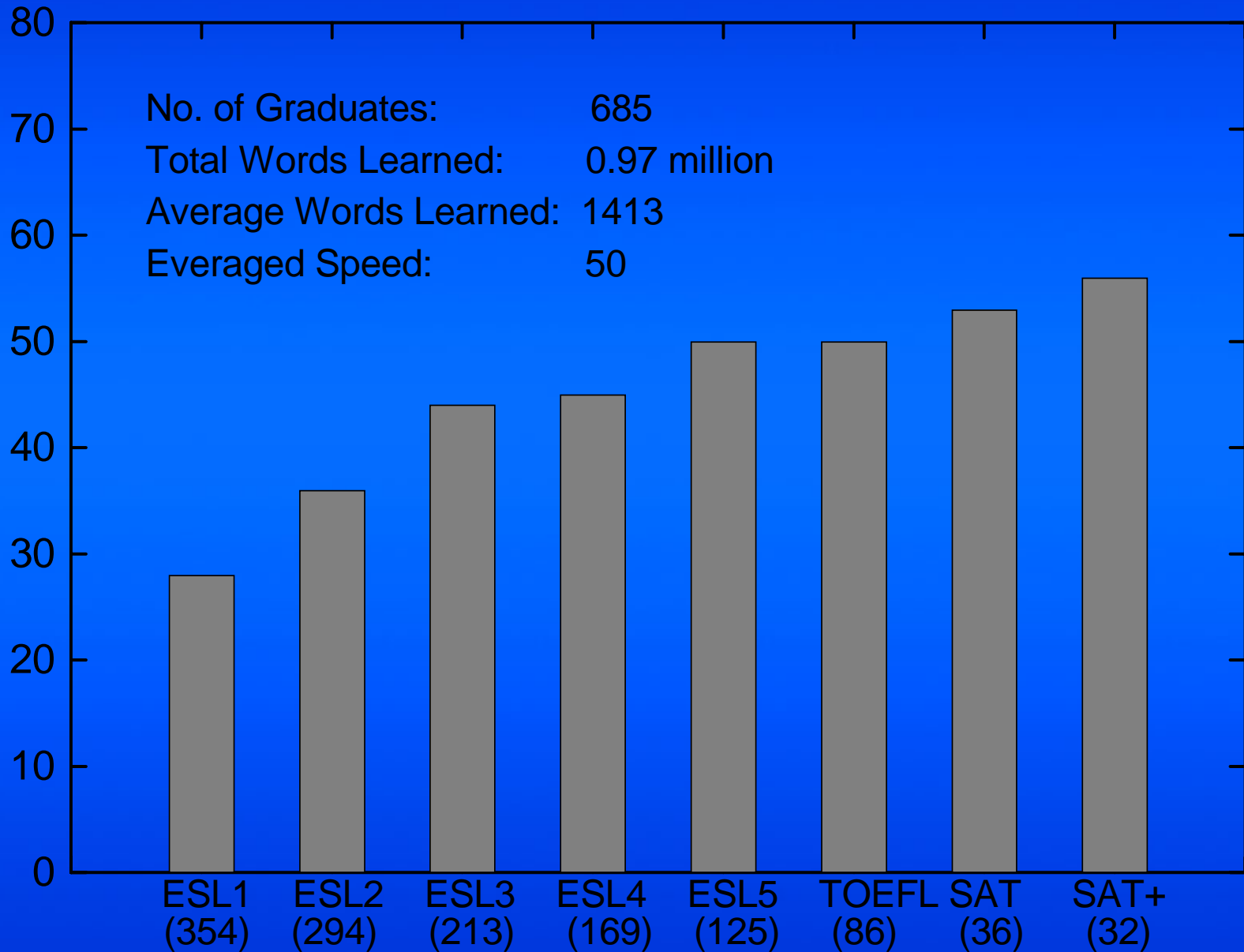




# Optimized Memory Accumulation



# Results of USA Students in 2003



# **Beyond Petaflops**

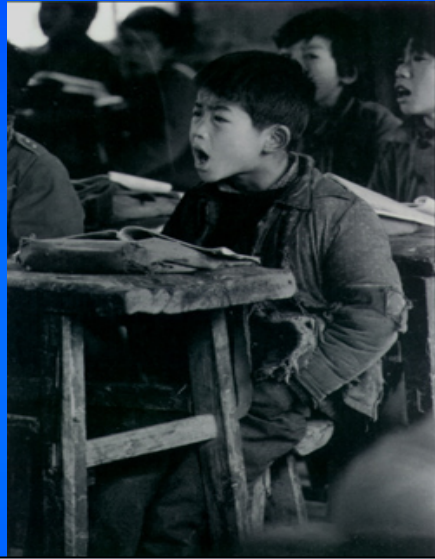
**Combining Neuroscience, Bio-System Science  
and Supercomputing Science  
to Accelerate  
Brain Research,  
Brain Development, Brain Protection and  
Third-Brain Creation**

# **Third-Brain powered Integral Utility Supercomputing Grid**

**Not only assist scientists  
and engineers to perform concentrated and intensive  
simulation in studying the mystery of human brain  
at gene, molecular or system level, and  
establish accurate physical model with  
massive data collection, mining and analysis,**

**it also provides scientists and engineers a common platform to  
collaborate on project requirements, management,  
monitoring, analysis, decision, exchange, interaction,  
to enhance effectiveness, reduce errors  
and minimize time and space limitations**

# Demand on Pervasive Low-Cost High-Quality Healthcare and Education at the Bottom of Human Society Pyramid





# Learning Injury I -- Suicide

Pressure of learning is the No. 1 killer!!!





# Learning Injury -- Crimes



青少年教育

# Life with Third-Brain



More enjoyable and peaceful!!!

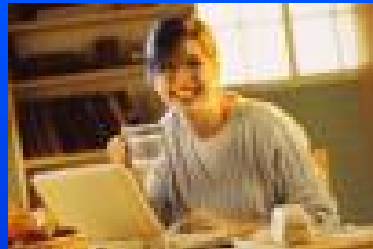
Spend less time and money and learn more

Expand learning and healthcare capacities

Enhance mental health and reduce learning injury

Human can further explore the world to achieve higher capacity

Eliminate the barriers created by differences in languages and cultures



# **Third-Brain Powered Integral Utility Supercomputing Grid**

**Artificial Intelligence  
Neuro-Bio System Modeling  
Human-Machine Interaction  
Third-Brain Bio-Supercomputing  
Early Disease Detection and Treatment  
Personalized Medicine and Learning Engine  
Alternative Medical Procedure and Drug Discovery  
National Healthcare and Education Information Grid**

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**Worldwide Scientists Can Work Together  
in  
Brain Research,  
Brain Protection,  
Brain Development,  
Third-Brain Creation  
to  
Build a Healthy, Intelligent,  
Happy and Harmonic Human Society**

**Third-Brain Research Institute**

**Dr. Steve Chen, Dr. Basba Yu, Dr. Wayne Yang, Dr. YC Lee,  
Dr. EnRico Melson, Dr. Shaunhu Wang**