

P. A. M. DIRAC :

" AGE IS, OF COURSE A FEWER CHILL
THAT EVERY PHYSICIST DOTH FEAR
HE'S BETTER DEAD THAN LIVING STILL
WHEN ONCE HAS PAST HIS THIRTIETH YEAR"

THE 21st CENTURY IS DIFFERENT

IT IS A KNOWLEDGE AND INFORMATION-BASED SOCIETY WHICH WILL PRODUCE NEW OPPORTUNITIES AND NEW CHALLENGES IN ALL DIMENSIONS OF OUR LIVES.

- CHANGE IS INEVITABLE
- COMPLETE COVERAGE IS IMPOSSIBLE
- OBSOLESCENCE IS UNAVOIDABLE

NEW TECHNOLOGIES, NEW DISCOVERIES, NEW MEDIA, NEW SOCIAL STRUCTURES AND NEW POSSIBILITIES FOR QUALITY OF LIFE MAKE **LIFE LONG LEARNING** ESSENTIAL SO THAT HUMANS CAN THINK, CREATE, LEARN, AND COLLABORATE "FOREVER."

THE DIVIDED LIFETIME, FIRST WITH LEARNING, THEN THE REST OF YOUR LIFE, APPLYING THIS KNOWLEDGE, NO LONGER WORKS.



REPORT OF THE EDUCATION COMMITTEE OF THE CHICAGO COMMERCIAL CLUB (2003)

CONCLUSIONS:

WITHOUT FUNDAMENTAL IMPROVEMENTS,
GENERATIONS OF CHICAGO'S CHILDREN WILL
PROCEED THROUGH A SCHOOL SYSTEM THAT
CONTINUES TO PRODUCE APPALLINGLY HIGH
LEVELS OF DROPOUTS AND STUDENTS WHO
FAIL TO MEET (THE LOW) STATE ACADEMIC
STANDARDS.

e.g. 36% OF 11TH GRADERS MEET STATE
READING STDS

26% MEET MATH STDS

CATER 40% HAVE DROPPED OUT

IF WE LOOK AT HIGH POVERTY SCHOOLS
THE NUMBERS ARE WORSE.

RECENT TRENDS ARE NOT PROMISING.

OUTSOURCERY

DEFINITION: WHITE COLLAR, BS IN ENGINEERING, COMPUTER SCIENCE JOBS ARE GOING TO INDIA, CHINA, BRAZIL.... PRODUCTIVITY VS JOB PROTECTION.

- IS THIS GOOD FOR THE U.S. ?
- IMPLICATIONS FOR SCIENCE EDUCATION
- FOREIGN STUDENTS WHO FILL OUR GRAD

- SCHOOLS ARE TAPERING OFF SHARPLY.
 - IMMIGRATION WHICH HAS CONTRIBUTED SO MUCH TO
 - OUR PROSPERITY VIA INNOVATION, IS DECREASING.
- WHAT WILL REPLACE INTERNET, CELL PHONES, TV, RADIO, GPS... IN 10-20 YEARS?

AND THERE IS THE DIGITAL DIVIDE

THE OBSOLESCENCE OF SCHOOLING IN, SAY, EE IS ABOUT 3 YEARS!

⇒ LEARNING MUST BE FOREVER

BUT

THE RHETORIC ASSOCIATED WITH EDUCATION
MUST BE ADMIRABLE:

1983 "WE ARE DROWNING IN A RISING TIDE
OF MEDIOCRITY... UNILATERAL EDUCATIONAL
DISARMAMENT...ETC" A NATION AT RISK

1989 FIFTY US GOVERNORS ASSEMBLED BY
GEORGE I COMMITTED THEMSELVES TO
ACHIEVING SIX GOALS, EACH BEGINNING

"BY THE YEAR 2000, EVERY CHILD WILL
ARRIVE AT SCHOOL READY TO LEARN."

"BY THE YEAR 2000, ...

"BY THE YEAR 2000, ...

1999 "RAISING THE ANALYTIC COMPETENCY OF ALL
OF OUR GRADUATING H.S. SENIORS IS
CRUCIAL TO THE FUTURE OF OUR NATION"

AND

"I BELIEVE WE NEED TO DO EVERYTHING
IN OUR POWER TO BOLSTER THE K-12
LEVEL OF SCIENCE, MATH, TECHNOLOGY
EDUCATION"

ALAN GREENSPAN IN
CONGRESSIONAL TESTIMONY

2000 AMERICANS ARE LIVING OFF THE ECONOMIC AND SECURITY BENEFITS OF THE LAST THREE GENERATIONS' INVESTMENT IN SCIENCE AND EDUCATION, BUT WE ARE NOW CONSUMING CAPITAL. OUR SYSTEM OF BASIC ... EDUCATION IS IN SERIOUS CRISIS, WHILE OTHER COUNTRIES ARE REDOUBLING THEIR EFFORTS. ...

U.S. COMMISSION ON NATIONAL SECURITY FOR THE 21ST CENTURY

2001 THE GLENN COMMISSION REPORT ON MATH & SCIENCE TEACHING SAYS IT ALL IN ITS TITLE:

"BEFORE IT IS TOO LATE"

2002 "LEAVE NO CHILD BEHIND" **NCLB**
PRES GEORGE W. BUSH



WHY MUST SCIENTISTS BE INVOLVED IN
EDUCATION?

AND

WHAT CAN THE SCIENTIFIC SPIRIT CONTRIBUTE
TO SCIENCE EDUCATION?

FOLLOWING THE GREAT ONES FROM GALILEO
TO EINSTEIN TO RICHARD FEYNMAN, WE
DISTILL THE QUALITIES THAT MAKE SCIENCE:

WHAT IS SCIENCE THINKING?

- BLEND OF CURIOSITY AND EGO
- HUMILITY IN RELATIONSHIP TO THE HERITAGE
- SKEPTICISM ABOUT THE UNIVERSAL VALIDITY OF WHAT HAS BEEN LEARNED
- A LIBERATING SENSE OF FREEDOM TO QUESTION AUTHORITY
- AN OPEN MINDEDNESS TOWARDS NEW IDEAS
- A CONFIDENCE IN RATIONALITY
- A FAITH IN THE ULTIMATE BEAUTY AND SIMPLICITY OF NATURE
- A RESPECT, NO, A REQUIREMENT FOR DIVERSITY IN MINDS AND CULTURES THAT HAVE MADE SCIENCE

SOMEHOW WE MUST TRY TO EMBED THESE
QUALITIES INTO ALL STUDENTS AS
WE TEACH SCIENCE.



WARs GET THE PRIORITY AND THE LIMITLESS BUDGET

THIS IS A WAR ON IGNORANCE

ITS OUTCOME MAY BE AS SIGNIFICANT
TO THE FUTURE OF THE NATION AS
ANY IN OUR HISTORY

"THE MEASURE OF A NATION'S SUCCESS
IN THE 21ST CENTURY WILL NOT BE
ON ITS MILITARY BUDGET BUT ON
HOW MUCH IT SPENDS ON EDUCATION"

A. EINSTEIN
OR SOMEBODY

Diana at diana@fnal.gov has sent you an article from The Onion, America's Finest News Source.

Diana included the following message:
from "The Onion" Pres. Bush finds error in physics calculation at Fermilab

THERE'S SOME NEW JUICE in TOWN

Mobile/PDA | Books | Onion Merchandise & Subscriptions | National Distribution

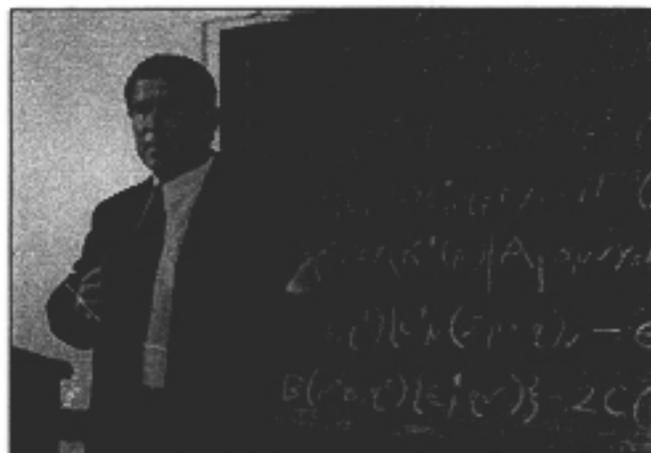
Media Kit | Employment | Copyright

the ONION 1 August 2001

Bush Finds Error In Fermilab Calculations

BATAVIA, IL--President Bush met with members of the Fermi National Accelerator Laboratory research team Monday to discuss a mathematical error he recently discovered in the famed laboratory's "Improved Determination Of Tau Lepton Paths From Inclusive Semileptonic B -Meson Decays" report.

"I'm somewhat out of my depth here," said Bush, a longtime Fermilab follower who describes himself as "something of an armchair physicist." "But it seems to me that, when reducing the perturbative uncertainty in the determination of V_{ub} from semileptonic Beta decays, one must calculate the rate of Beta events with a standard dilepton invariant mass at a subleading order in the hybrid expansion. The Fermilab folks' error, as I see it, was omitting that easily overlooked mathematical transformation and, therefore, acquiring incorrectly re-summed logarithmic corrections for the b -quark mass. Obviously, such a miscalculation will result in a precision of less than 25 percent in predicting the resulting path of the tau lepton once the value for any given decaying tau neutrino is determined."



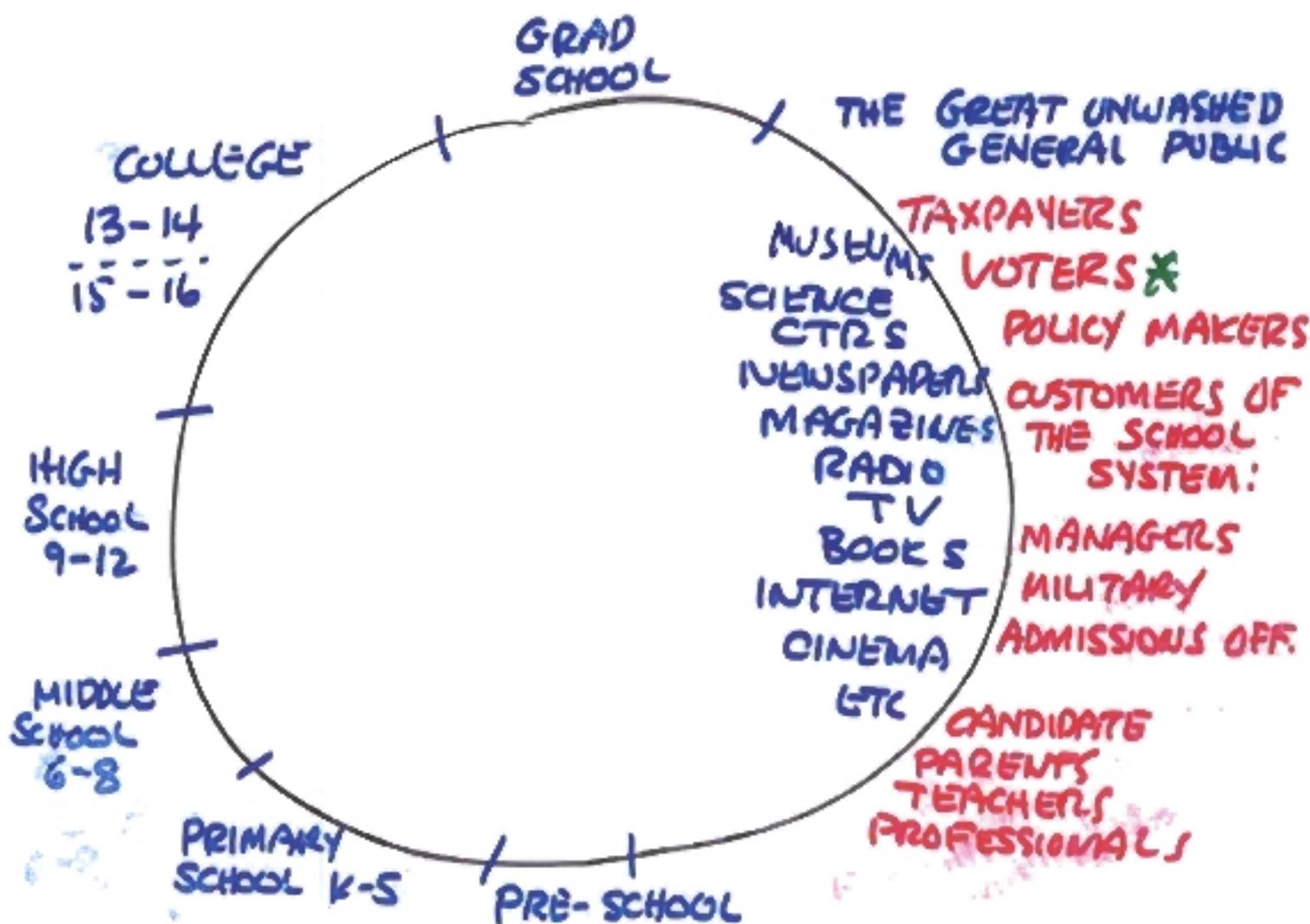
Above: Bush shows Fermilab scientists where they went wrong in their calculations.

The Bush correction makes it possible for scientists to further study the tau lepton, a subatomic particle formed by the collision of a tau neutrino and an atomic nucleus.

Bush resisted criticizing the Fermilab scientists responsible for the error, saying it was "actually quite small" and that "anyone could have made the mistake."

"High-energy physics is a complex and demanding field, and even top scientists drop a decimal point or two every now and then," Bush said. "Also, I might hasten to add that what I pointed out was more a correction of method than of mathematics. Experimental results on the Tevatron accelerator would have exposed the error in

~ 10 YRS OF EXPERIENCE WITH EDUCATORS...



A PHYSICIST COPES WITH EDUCATION

THE EDUCATION CIRCUIT

* THE QUEST FOR SEAMLESSNESS *

Phases of Science (Math) Education

I CRIB, PRE-K, HEAD START, TO K-2

DEVELOPMENTAL PSYCHOLOGY, PLAY/LEARN, "FAN THE HOT EMBERS OF NATURAL CURIOSITY", HANDS-ON, INQUIRY, THE PROCESS OF SCIENCE, SCIS, FOSS, TMS... T.A.M.S.

II K-5

PROCESS → CONTENT, MATH AS PLAY AND GAMES, GRAPHS, PRE-ALGEBRA, THE SKY, MORE HANDS-ON, COMPUTERS, FIND CARMEN SANDIEGO! BEGIN INTRO TO ATOMS

III 6-8

MIDDLE SCHOOL, BEWARE OF RAGING HORMONES, DESCRIPTIVE NATURAL SCIENCE, ALGEBRA ONE, USE OF MATH, INTERMEDIATE PHYSICAL SCI, STORIES OF SCIENTISTS, SCIENCE IN SOCIETY, EARTH SCI, ENVIRONMENTAL SCIENCE, CONTINUE INTRO. TO ATOMS, SIMULATION, IMAGING...

IV 9-12

MY SUBJECT TODAY

V GRADES 13-14

THE GREAT COLLEGE CONSPIRACY ...

MAJOR PROBLEMS IN SCIENCE EDUCATION (AS SEEN BY A PASSIONATE NOVICE)

#1. The recruitment, training AND retention
OF TEACHERS "RTR"
* HOW TO TEACH *

→ * 2. THE SCIENCE CURRICULUM preK-16
* WHAT TO TEACH *

3. THE TEACHING MATERIALS AND TECHNOLOGY
- BOOKS - KITS - CALCULATORS - COMPUTERS - ETC
* HOW TO DELIVER TEACHING *

4. THE "SEAMS" i.e. DISCONNECTS
HOME → (K-5)
(K-5) → (6-8) - (6-8) → (9-12)
* THE EARLY YEARS (9-12) → (13 →)

5. THE ABSENCE OF CONTINUOUS PROFESSIONAL
DEVELOPMENT (upgrading the workforce)

6. STREAMLINING THE SYSTEM

STUDENTS
TEACHERS UNION

PRINCIPALS

SUPERINTENDANTS

LEGISLATORS

PARENTS

COMMUNITY GROUPS

TEXT BOOK PUBLISHERS

TEACHERS' COLLEGES

SCHOOL BOARDS ...

TO REDUCE THE
RESISTANCE TO
CHANGE

* 7. PRINCIPALS



PHYSICISTS IN EDUCATION

JERRY AWE CALTECH (PASADENA)

LILLIAN McDERMOTT SEATTLE

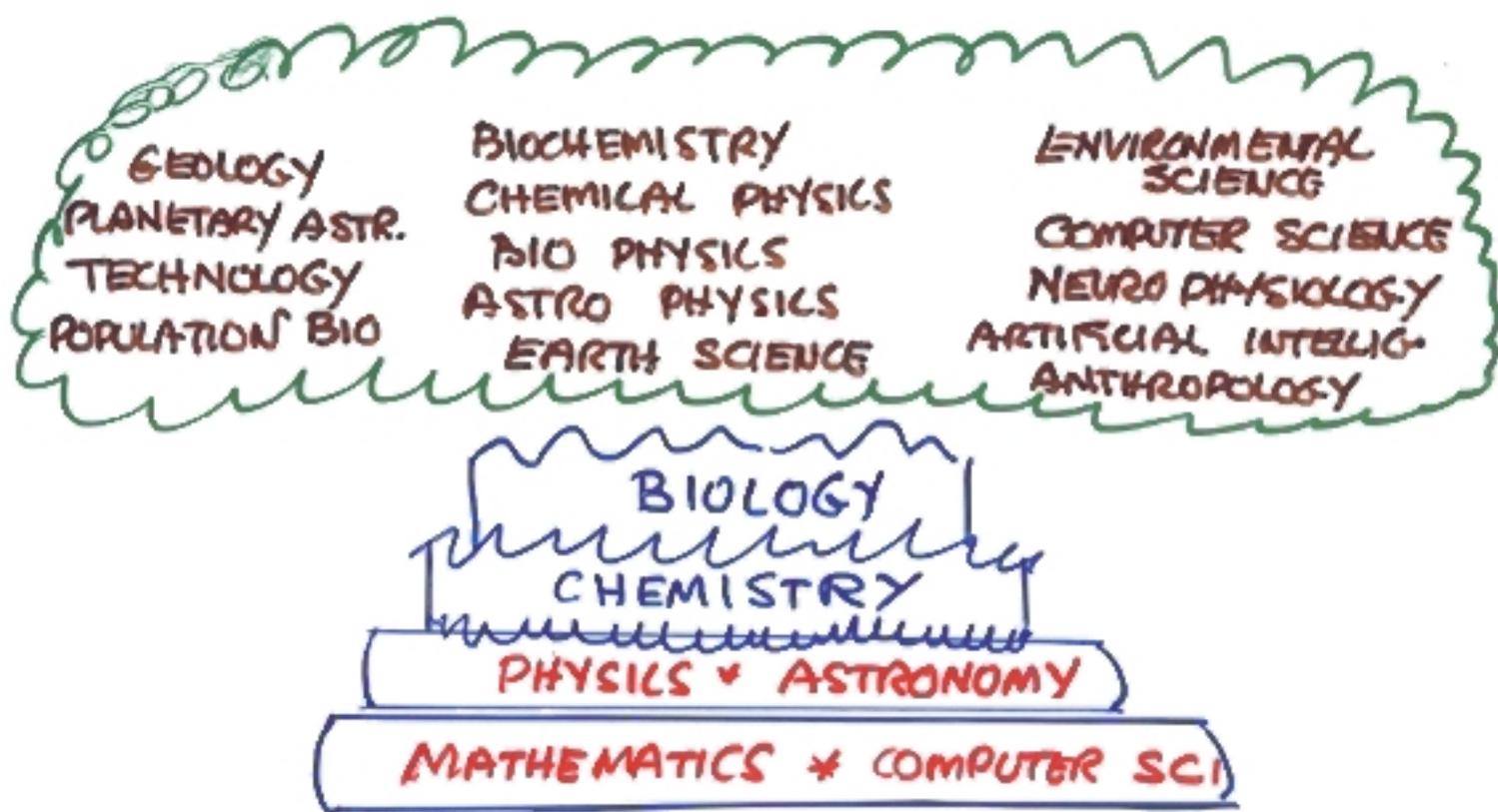
KEN WILSON OHIO

LNL CHICAGO

GLEN SEABORG
BERKELEY
ALRIGHT, A CHEMIST

THE CORE SCIENCES: PHYSICS, CHEMISTRY, BIO.

THE THREE DISCIPLINES EVOLVED NATURALLY, LARGELY INDEPENDENTLY BUT WITH EXCHANGE OF INSTRUMENTS, WITH OVERLAPPING ISSUES AND WITH PRINCIPLES THAT EACH DISCIPLINE HAD TO OBEY.



THERE IS A HIERARCHY IN SCIENCE

Howard Gardner

Disciplines are what separates us from barbarians. I don't think you can do interdisciplinary work until you have done disciplinary work.

COMMENT ON HIGH SCHOOL SCIENCE

THE EXISTENCE OF A HIERARCHY IN THE RELATIONSHIP OF THE SCIENCES IS, I BELIEVE, A PROFOUND COGNITIVE STATEMENT

PHYSICS AS THE FOUNATIONAL SCIENCE AND ITS UNIQUE ROLE IN IDEALIZATION DICTATES:

P-C-B

A YEAR OF PHYSICS GIVES STUDENTS A GOOD SENSE OF HOW SCIENCE WORKS ESPECIALLY WHEN WE INCLUDE STORIES

CHEMISTRY BROADENS THE STUDY OF MATTER AND ENERGY, DRAWING EXPLANATIONS FROM PHYSICS, AT THE SAME TIME DEEPENING THE STUDENT'S GRASP OF CONCEPTS. MORE STORIES

BIOLOGY PROVIDES A MORE COGNITIVE CHALLENGE, BUILDING ON THE CHEMISTRY AND PHYSICS THAT UNDERGIRD BIOLOGICAL ORDER

THE HOOK

TODAY, IN 99% OF ALL U.S. HIGH SCHOOLS, STUDENTS TAKE THE SEQUENCE



BIOLOGY* - CHEMISTRY - PHYSICS

TAUGHT USUALLY AS SEPARATE, INDEPENDANT SUBJECTS, HAVING VERY LITTLE TO DO WITH ONE ANOTHER.

THIS SEQUENCE WAS STARTED IN 1893 BY A "COMMITTEE OF TEN" WHICH SET OUT TO STANDARDIZE H.S. SCIENCE CURRICULA.

OK IN 1893, NOT IN 1930. AND WE NOW KNOW THAT THE NEW BIOLOGY (AFTER THE DISCOVERY OF DNA STRUCTURE & FUNCTION) IS MOLECULAR-BASED. AND

* MOLECULES ARE MADE OF ATOMS...

"NINTH GRADE BIOLOGY HAS MORE NEW WORDS THAN 9TH & 10TH GRADE FRENCH.

"ARISE"

American Renaissance
in Science Education

M. BARDEEN ET AL

ORGANIZED IN CHICAGO
(FERMILAB - 30 MI WEST)
IN 1995 BY TEACHERS,
SUPERVISORS, SCIENTISTS
WITH WASHINGTON D.C.
MOVERS & SHAKERS

- ① STEP ONE REVERSE THE SEQUENCE
IN WHICH THE DISCIPLINES ARE TAUGHT
- ② STEP TWO PRESERVE THE INTEGRITY OF
THE DISCIPLINES BUT LOWER THE BOUNDARIES
AND STRESS THE CONNECTIONS
- ③ STEP THREE SACRIFICE SOME CONTENT
TO THE PROCESS OF SCIENCE. HOW IT WORKS.
- ④ STEP FOUR INSIST ON CONTINUOUS,
COLLEGIAL PROFESSIONAL DEVELOPMENT

SO

- 9TH GRADE - MOSTLY PHYSICS AND
ASTRONOMY: CONCEPTUAL
- 10TH GRADE - MOSTLY CHEMISTRY
BUILDING ON 9TH GRADE
- 11TH GRADE - MOSTLY BIOLOGY, USING
THE PHYSICS & CHEMISTRY
AND ELECTIVES!

American Renaissance in Science Education

* 23



The Three-Year Science Requirement for High School's
Workshop in Naperville, Illinois • September 22-24, 1995

FIRST OF THREE WORKSHOPS

NAPERVILLE	'95
CHICAGO	'98
SAN DIEGO	'02

21 108

If we can produce one success by concentrating on the most egregious failure of curriculum, then "we" can build on this success, extending the reform downward to pre-K and upwards to college.

THIS IS OBVIOUSLY THE B-C-P sequence!

- HOWEVER the plan (ARISE) is not merely to rearrange the disciplines to P-C-B.
- Conceptual physics in ninth grade must start with macroscopic phenomena that surrounds the student, it must be, by its laboratory work, inquiry based, rich in process but also a prerequisite for chemistry. Or, chemistry as an important example of the application of physics (Shh!)
- Ideally, when the chemical phenomena require more sophisticated physics, it can be added by the chemistry teacher or team taught. The connecting ideas and principles must be stressed. BUT CONCEPTUAL PHYSICS is thereby ENRICHED.
- The same issues apply to the chemistry-biology and physics-biology interface.

THE IMPLICATIONS? PROFESSIONAL DEVELOPMENT.

IMPLICATIONS OF REVERSED SEQUENCE

- PHYSICS, CHEM, BIO, MATH TEACHERS MUST MEET TOGETHER, AT LEAST 4-5 HOURS PER WEEK TO LEARN, COORDINATE, PLAN AND STRATEGIZE.
- BUT HOW CAN THEY NOT INCLUDE THE HISTORY, ART, LITERATURE, ... TEACHERS? **PERHAPS THIS IS THE WAY TO CLOSE THE TWO CULTURES GAP.**
- THE GOAL FOR ALL STUDENTS IS SCIENCE AS A WAY OF THINKING, DESIGNED TO GENERATE COMFORT WITH NEW IDEAS, BEHAVIORS, SITUATIONS SO CHARACTERISTIC OF OUR TIMES.
- NUMEROUS PEDAGOGIC EXCURSIONS TO REAL WORLD PROBLEMS THAT INVOLVE INTER- AND TRANS-DISCIPLINARY APPROACHES
- NEW EDUCATION TECHNOLOGY (eg TINKER) MAKE VISUALIZATION EASY AND THE APPROACH TO ABSTRACTION POSSIBLE IN MUCH EARLIER GRADES.
- WIDE ADOPTION OF INVERSE ORDER MUST HAVE WAVES THAT GO DOWN TO K-8 AND UP TO GRADES 13-16 NO. 13-100

WHY PHYSICS FIRST?

THE KEY TO MODERN SCIENCE IS THE ATOM
"EVERYTHING IS MADE OF ATOMS"

(RICHARD FEYNMAN'S LEGACY OF THE MODERN WORLD)

ATOMS DETERMINE THE PROPERTIES OF GASES AND LIQUIDS

ATOMIC ARRAYS

- MAKE CRYSTALS
- MAKE SOLIDS WHICH CONDUCT ELECTRICITY
- MAKE INSULATORS
- MAKE SEMICONDUCTORS
- MAKE SUPERCONDUCTORS

ATOMS COMBINE TO MAKE MOLECULES OF H_2O
 $NaCl$

ATOMS EXCHANGE PLACES TO MAKE CHEMICAL REACTIONS

ATOMS DEFINE THE CHEMIST'S FLAG

H								He
Li	Be	B	C	N	O	F	Ne	
Na	Mg	Al	Si	P	S	Cl	Ar	

LARGE MOLECULES ARE COMPLEX → BIOLOGY
MOLECULAR BIOLOGY HAS TO DO WITH GENES, CELLS, DNA, ...

CONCEPTUAL PHYSICS

- ALL TOO MANY TEACHERS ASSUME THAT ABILITY TO SOLVE PROBLEMS TESTS GRASP OF CONCEPTS.
- EVEN THOUGH ALGEBRA USE IS MINIMIZED, THE IMPORTANCE OF MATHEMATICS IN PHYSICS, CHEM & BIOLOGY MUST BE EULOGIZED, USE EXAMPLES:
$$X = VT$$
- AND THE ABSTRACT NATURE OF MATH (CONTRAST!) EXPLAINED
- CONCEPTS E.G. MOMENTUM, FORCE, ACCELERATION, TEMPERATURE, ETC MUST BE UNDERSTOOD AS INVENTIONS OF SCIENTISTS FOR THEIR USE.

CONSERVATION LAWS ARE THE NATURAL BRIDGE TO OTHER DISCIPLINES \rightarrow SYMMETRY

Emmy Noether



Welcome to EmmyNoether.com

a website devoted to:

Teaching Symmetry in the Introductory Physics Curriculum

Authors:

Prof. Christopher T. Hill,
Theoretical Physics Department,
Fermi National Accelerator Laboratory,
MS. 106, P.O. Box 500, Batavia, Illinois, 60510, USA



email: hill@fnal.gov

Prof. Leon M. Lederman,
Illinois Math and Science Academy
Resident Scholar
1500 W. Sullivan Rd.
Aurora, Ill. 60506-1000

HERE IS A TEST OF CONCEPTUAL IDEAS. WHICH WORD DOES NOT FIT?

COAL
OIL
BROOM
SUN
ENERGY
WOOD
COFFEE
BANANA
CELL PHONE

OTHER CONCEPTS INVENTED BY PHYSICISTS:

MOMENTUM, TEMPERATURE, ENTROPY,
PRESSURE, ANGULAR MOMENTUM, ...
FORCE, ACCELERATION, MAGNETIC &
ELECTRIC FIELDS, ...

IT IS THE SKILLFUL USE OF SUCH CONCEPTS THAT LEADS TO AN UNDERSTANDING OF MOTION, OF PENDULUM CLOCKS, THE TRAJECTORY OF PROJECTILES, PLANETS AND MOONS ... AND, IMPORTANTLY THE STRUCTURE AND BEHAVIOR OF ATOMS

WAIT! THERE'S MORE

IN DESIGNING THE 21ST CENTURY HS. SCIENCE CURRICULUM, WE MUST ASK:

WHAT DO WE WANT THEM (ALL OF THEM) TO REMEMBER IN 10 YEARS? They will have forgotten $F=ma$ and $E=mc^2$ IN THIS H.S. SCIENCE FOR ALL STUDENTS, EACH DISCIPLINE MUST SACRIFICE, SAY 20% OF CONTENT TO TEACHING THE PROCESS OF SCIENCE.

- HOW DOES IT WORK?
- HOW MESSY IS THE PROCESS OF DISCOVERY
- THE NEED FOR OPEN MINDEDNESS, SKEPTICISM, SOME SENSE OF HISTORY, SCIENCE AS A HUMANISTIC ACTIVITY STORY TELLING
- THE SOCIAL AND ECONOMIC RESULTS
- SCIENCE AS THE ONLY UNIVERSAL CULTURE, THE SAME EVERYWHERE
- SCIENCE AS A WAY OF THINKING AND KNOWING
- SCIENCE AND VALUES ... ETHICS, MORALITY AND THE BRIDGE TO THE HUMANITIES

SUMMARY OF KEY ELEMENTS TO A 21ST CENTURY APPROACH TO SCIENCE LITERACY

- THERE MUST BE A CORE SEQUENCE CONSISTING OF THE THREE DISCIPLINES IN THE ORDER OF P-C-B. MATH APPLICATIONS SHOULD BE CONTINUOUS SO THAT BIOLOGY MAKES USE OF MATHEMATICS UP TO (BEYOND?) THE H.S. MATH REQUIREMENTS (WHICH SHOULD INCLUDE COMPUTATIONAL MATH)
- LAB WORK MUST BE CLOSELY SYNCHRONIZED WITH COURSE WORK. INQUIRY REPLACES "COOK BOOK."
- SOME 20-30% OF EACH COURSE YEAR SHOULD EMPHASIZE "PROCESS" STORIES, BIOGRAPHY, SOCIETAL ISSUES..
- TEACHER PROF. DEVELOPMENT → UP TO 1 DAY A WEEK - COLLEGIAL WITH COLLABORATION WITH LOCAL UNIV. P-C-B-M TEACHERS MEET REGULARLY CONNECTIONS BETWEEN DISCIPLINES SHOULD BE CELEBRATED

- MUST EXAMINE AND COORDINATE K-8 SCIENCE AND MATH CURRICULA ESPECIALLY EARLY ALGEBRA AND INTRO. TO ATOMS.
- SCIENCE ELECTIVES MUST BE EXTENDED WITH HOPES FOR 4TH YEAR REQ'T RQ. EARTH AND SPACE SCIENCE, STATISTICAL SCIENCE
- EXTENSIVE P-C-B-M TEACHER INTERACTIONS SHOULD ENCOURAGE SOCIAL SCIENCES, HUMANITIES TO JOIN FOR PROJECTS, SEMINARS..

SINCE TEACHERS ARE CRUCIAL TO ANY NEW REFORM, WE MUST RAISE THE QUALITY OF TEACHERS AND INSURE LIFELONG, CONTINUOUS PROFESSIONAL DEVELOPMENT.

IT IS EXPENSIVE!
CAN WE AFFORD IT?

DOES IT WORK?

- THERE ARE 25,000 HIGH SCHOOLS IN THE U.S. THAT 99% STILL TEACH A CURRICULUM DESIGNED IN 1893 INDICATES A CERTAIN CONSERVATISM IN THE EDUCATION SYSTEM.
- WE ARE NOW AWARE OF ABOUT 300* SCHOOLS THAT HAVE CHANGED THE SEQUENCE AND ARE INSTALLING SOME OF THE CHANGES WE PROPOSE.
- THEY REPORT DRAMATIC IMPROVEMENTS IN THE LEARNING AND IN THE ENTHUSIASM OF STUDENTS.
- MANY HIGH SCHOOLS OFFER ELECTIVE SCIENCE COURSES: EARTH SCIENCE, ENVIRONMENTAL SCIENCE, ADVANCED PHYS-CHEM-BIOLOGY ETC. AFTER REVISING THE SEQUENCE SCHOOLS REPORT 3 TO 5 TIMES AS MANY STUDENTS CHOOSING THESE OPTIONAL COURSES.
- A SIGNIFICANT FRACTION OF THE STUDENTS SHOWING INTEREST ARE WOMEN AND MINORITIES.
- **CONCEPTUAL PHYSICS- EMPHASIZING GRASP OF CONCEPTS RATHER THAN ALGEBRA WORKS!**

* WE ESTIMATE THAT ANOTHER 100 OR MORE HAVE REVERSED SEQUENCE LONG BEFORE OUR PROGRAM.

ANECDOTAL REPORTS FROM EXPERIENCED SCHOOLS (WE HAVE ANECDOTAL DATA FROM ~80 SCHOOLS)

- ① NINTH GRADE CONCEPTUAL PHYSICS WORKS!
- ② ENROLLMENTS IN 4TH YEAR ELECTIVE SCIENCE COURSES, AP COURSES, S.T.S. COURSES INCREASES 3-5. FOLD.
- ③ HAS A LARGER IMPACT ON WOMEN AND ON MINORITY STUDENTS

DATA IS BEING COLLECTED ON SCHOOLS WITH >3 YRS OF EXPERIENCE.



WE NEED HELP IN EVALUATING
THE SUCCESSES OF THESE EXPERIENCED
SCHOOLS

OBSTACLES

THE RESISTANCE OF SCHOOL SYSTEMS TO CHANGE IS AWESOME!

65 YEARS AFTER IT WAS KNOWN THAT THE BASIS OF CHEMISTRY IS PHYSICS

45 YEARS AFTER THE DISCOVERY OF DNA

WE STILL TEACH BIOLOGY-CHEMISTRY-PHYSICS!
WHY DISCARD A 100 YR OLD TRIED AND TRUE CURRICULA?

THIS IS NOT THE ONLY ABSURD THING WE DO IN OUR SCHOOLS BUT IT IS AN OBVIOUS CRACK IN THE "BARRIER TO CHANGE"

REAL OBSTACLES

IT IS EXPENSIVE:

- NEW TEACHING MATERIALS
- MORE EDU TECHNOLOGY
- NEW ASSESSMENT TOOLS
- NEW TEACHER TRAINING
- CONTINUOUS PROF. DEV.
- MORE TIME FOR COLLEAGIAL WORK

TEACHERS DON'T LIKE IT
PARENTS GET NERVOUS
SCHOOL BOARDS ??

- NOT ENOUGH PHYSICS TEACHERS
- FEAR OF AP, UNIV. ADMISSIONS, ETC

~ 16,000 School Districts !!

AND NO MINISTER OF EDUCATION

THE GREATEST OBSTACLE IS THE LACK OF

A WRITTEN THREE YEAR CURRICULUM WITH:

- (1) MANY MODULAR OPTIONS
 - (2) HISTORY, BIOGRAPHY, STORIES IN ALL 3 DISCIPLINES
 - (3) LINKS TO EARTH SCIENCE, ENGINEERING, ENVIRONMENTAL SCIENCES, PROBABILITY AND STATISTICS, ETC
 - (4) EMBEDDED WITH CONNECTIONS, LINKS TO HUMANITIES.
- EXPERTS TELL ME A NEW CURRICULUM IS
A >5 YEAR, >10M\$ PROJECT

BUT THERE IS A GREAT DEAL OF GOOD MATERIAL OUT THERE. CAN WE ASSEMBLE, CUT & PASTE, ADD MODULES, ETC? ARE THERE SHORTCUTS?

AT THE PRESENT RATE OF 2-3 H.S.'s MAKING THE P-C-B CHANGE PER WEEK WE HAVE 214 YEARS TO GET THEM ALL.

Why Do Our Schools Fail?

1. TEACHER TRAINING! TOO MANY TEACHING OUT-OF-FIELD ETC
2. TEACHER MORALE
3. LACK OF CONTINUOUS PROFESSIONAL DEVELOPMENT
4. INADEQUATE TEACHER EVALUATION (CHICAGO: 0.2% RATED UNSATISFACTORY)
5. TEACHERS ARE NOT REWARDED FOR BEING GOOD TEACHERS OR FOR TEACHING MORE DEMANDING SUBJECTS AND CONVERSELY... DIFFICULTY IN FIRING POOR TEACHERS
6. OUTDATED AND LARGELY IRRELEVANT CURRICULUM (SEE INDUSTRY MANAGERS AND COLLEGE ADMISSION OFFICERS)
7. A DYSFUNCTIONAL SCHOOL MANAGEMENT SYSTEM
8. POVERTY, LACK OF PRE-SCHOOL PREPARATION, LOW PARENTAL EDUCATION, MOTIVATION * BUT - - - -
9. NOT NEARLY ENOUGH PARENTAL CHOICE eg. CHARTER SCHOOLS, SUBURBS ...
10. SOCIAL PROMOTION PROBLEM, RETENTION IN GRADE? SUMMER SCHOOLS
11. INABILITY TO USE EDUCATIONAL TECHNOLOGY

EDUCATION TECHNOLOGY

THE POSSIBILITIES ARE BREATHTAKING

HISTORY: MASS-PRODUCED TEXTBOOKS

WORKBOOKS

PENCIL (WITH ERASERS FOR THEORISTS)

CHEAP PAPER

BLACKBOARDS (NOW WHITE)

CLASS ROOM CLOCK

THE BELL

ELECTRIC LIGHTS

CENTRAL HEATING

ADMITTEDLY A FACTORY MODEL BUT EACH OF THESE WAS A TRANSFORMING TECHNOLOGY FOR SCHOOLS OF THE 18TH + 19TH CENTURY

NOW: THE LAPTOP, INTERNET, SIMULATION AND VISUALIZATION, INFORMATION ACCESS

REMOTE LEARNING, WEB-ENABLED CONTENT, STUDENT CENTERED LEARNING (SELF GUIDED INSTRUCTION)

YET, A FEW YEARS AGO, WE HAD, IN CHICAGO, CLOSET COMPUTERS.

THIS REVOLUTION, AS PROFOUND AS ANY IN THE PAST, IS BARELY TOUCHED IN U.S. SCHOOLS.

FOR EXAMPLE, THE DEADLIEST ASPECT OF NCLB (LEARN IT!) IS THE AWFUL ASSESSMENT REQUIREMENTS (HIGH STAKES TESTING) CONSTRUCTIVE TESTING IS OR SHOULD BE DIAGNOSTIC NOT PUNITIVE.

TECHNOLOGY CAN CREATE EMBEDDED ASSESSMENT TO PROVIDE INSTANTANEOUS FEEDBACK

COMMENT ON NEWTON MINNOW'S PROJECT
"DOIT"

DIGITAL OPPORTUNITY INVESTMENT TRUST

FINANCED BY PROCEEDS FROM AUCTIONS AND FEES FOR COMMERCIAL LICENSES TO USE THE PUBLICLY OWNED ELECTRONIC SPECTRUM

THE PROCEEDS: EVERY INNER CITY SCHOOL WILL HAVE ACCESS TO THE RESOURCES OF THE GREAT UNIVERSITIES. ENABLE SCHOOLS, COMMUNITY COLLEGES, LIBRARIES, MUSEUMS, CULTURAL, ARTS + HUMANITIES CENTERS CAN REACH OUTSIDE THEIR WALLS ...