DOCUMENT RESUME

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ABSTRACT

This document contains 395 abstracts of presentations on the theme of changing the image of chemistry, made at a conference on chemical education. Included with the abstracts are the presenters' names and addresses. The conference included the following sessions: Lecture and Learning: Are They Compatible?; ChemSource; Relevant Chemistry for the Non-Science Major; Industry-Education Initiatives; Innovative Outreach Programs; Breaking the Bubble: New Thoughts on Testing and Evaluation; Enhancing the Role of the High School Laboratory; Empowering Student Success; New Courses in Chemistry; Finding and Retaining Future Scientists; Bringing Women into Chemistry; and Writing in the Curriculum. (AA)

12th BIENNIAL CONFERENCE ON CHEMICAL EDUCATION

AUGUST 2-6, 1992

Changing the Image of Chemistry

ABSTRACTS

Arlene A. Russell, Editor
Program Chair

Sponsored by:
UC Davis, Department of Chemistry
ACS Division of Chemical Education
Two-Year College Chemistry Committee
California Association of Chemistry Teachers

Symposia

Sunday Evening

FREEBORN HALL
7:00--Welcomes and Introductions Theodore L. Hullar, Chancellor UC Davis; Kevin Smith, Chair Chemistry Department, Tom Sachse, State Department of Education
7:30--1. KEYNOTE ADDRESS: Chemistry in the 21st Century: It's Beauty, It's Utility, and It's Practioners Mary L. Good, Senior Vice President Technology, Allied-Signal, Inc, Morristown, New Jersey
9:00--Reception - sponsored by the Sacramento ACS Section and California Association of Chemistry Teachers

Monday, Morning

Lecture and Learning: Are They Compatible?
CHEMISTRY 194
Diane Bunce, Organizer, Presiding
8:30--Introductory Remarks
8:40--2. Lecture and Learning: Are They Compatible? Maybe for LOCS; Unlikely for HOCS U. Zoller
9:20--3. Adjusting the Lecture to Help Students Understand Difficult Concepts T.J. Greenbowe
9:40--4. A Test to Differentiate Conceptual Thinking from Algorithmic Problem Solving in Chemistry M.B. Nakhleh
10:00--Break
10:15--5. Setting the Stage for Innovating: Breakthroughs by not Lecturing T.L. Miller
10:35--6. The Value of New Technology in Helping Students Construct Chemical Understanding J.S. Krajcik
10:55--7. Predicting Academic Success in College Chemistry D.M. Bunce, K.D. Hutchinson
11:15--8. The Importance of Lecture in General Chemistry Course Performance J.P. Birk, J. Foster
11:35--Summary

ChemSource
YOUNG 198
Mary Virginia Orna, Organizer, Presiding
8:30--9. ChemSource: A Support Strategy for Pre-Service and Inservice Chemistry Teachers H.Heikkinen, M.V. Orna, D. Gabel, J.O. Schreck, M.J. Grabner
9:10--10 Chemical Safety in the ChemSource Program E.K. Mellon, K.O. Berry, W.H. Breazeale
9:30--11. ChemSource: Not Just for the Novice S.L. Gardlund
9:50--Break
10:15--12. Improving Chemistry Teaching Using the SourceView Videotapes D. Gabel

New Inorganic Materials
WELLMAN 2
Herbert D. Kaesz, Organizer, Presiding
8:30--13. New Routes to Refractory Materials; Conducting Polymers as Gas Separation Membranes R.B. Kaner
9:10--14. Deposition of Thin Films of Transition Metals and Their Group III (Group 13) Alloys by Organometallic Chemical Vapor Deposition (OMCVD) H.D. Kaesz
9:50--Break
10:15--15. Observing and Controlling the Nucleation and Growth of Thin Films of Aluminum W.L. Gladfelter
10:50--16. Sol Gel Route to New Inorganic Materials J.D. MacKenzie

Technology Education: Pathways to Chemical Technician Employment
CHEMISTRY 166
Kenneth M. Chapman, Organizer, Presiding
8:30--17. State of the Art or State of the Edict? Academic Courses Versus the Business of Quantitative Chemical Analysis L.R. Smith
8:50--18. Technician Reflections on Relationships Between Academic Courses and Their Work K.M. Chapman
9:10--19. Training Unemployed to be Chemical Technicians E.P. Benzing , T.G. Towns
9:30--20. Chemical Technology at CCRI: Curriculum Approaches Designed to Reflect the Demands of a Diverse Population Entering ChemTec Programs H.G. Hajian
9:50--21. Chemical Technology: Alive and Well! at Los Angeles Trade-Technical College T. Payne
10:10--Break
10:20--22. ChemTech in A Roller Coaster Economy W.J. Wasserman
10:40--23. A Baccalaureate Degree in Chemical Technology - A New Program J.C. Spille and F.J. Kryman
11:00--24. Partnership for Environmental Technology Education P.R. Dickinson
11:20--25. New Chemistry Curriculum in India for a Smooth Transition from a Secondary to Tertiary Level R.D. Shukla
11:40--26. City Chem: Chemistry in an Urban Technical College V.S. Strozak

Relevant Chemistry for the Non-Science Major
CHEMISTRY 176
Robert Ono, Presiding
8:30--27. Issues-Directed Chemistry - Teaching Chemical Fundamentals Using the Clean Air Act of 1990 D.L. Adams
8:50--28. Make Science Research Part of the Schedule C. Magnusson
9:10--29. Teaching Chemistry to the Non-Scientists: A Modular Approach M.A. Scharberg, L.A. Kelley
9:30--30. Project Time in the Old Chem Lab E.M. Donar
9:50--31. College "Introduction to Chemistry" Course with an Armchair Laboratory L.W. Shank
10:10--Break
10:20--32. Environmental Chemistry for Non-Science Majors D. Watson
10:40--33. Chemistry Affects Our Lives R.D. Place
11:00--34. Enhanced Learning in General Education Chemistry with Interactive Computer-Simulated Experiments C.M. Russell and J.W. Russell
11:20--35. A Role-Playing Exercise Using A Computer Simulation D.M. Whisnant
11:40--36. Testing by Objectives in a Liberal Arts Chemistry Course M.F. Bailey and R.E. Kohrman

New Experiments
CHEMISTRY 172
James Hill, Presiding
8:30--37. An Environmental Radioactivity Lab R.F. Stout
8:50--38. The Use of Accurate Solubility Measurements, Activity Coefficients, and the Ion Association Model to Test the Calculation of K_{sp} at High Ionic Strengths in the Physical Chemistry Laboratory A. Ewart and K.E. Hyde
9:10--39. The Use of Successive Approximation for Refinement in the Determination of the Equilibrium Constant of the Ferric Thiocyanate Ion A.J. Lata
9:30--40. Construction and Testing of a Variable-Temperature Chloride Concentration Cell K.E. Hyde
9:50--41. Inexpensive Laboratory Experiments in Frontier Areas of Chemical Research I. Das, A. Pushkarna, N. Agrawal, S. Chand, A. Sharma, K. Jaiswal, and P. Singh
10:10--Break
10:20--42. Analysis of A Binary Mixture of White Inorganic Compounds A.J. Lata
10:40--43. Illustrating the Photo-catalyst TiO_2 Using Solar Energy: An Outdoor Freshman Chemistry Experiment B. Hutchison, S. Fennekohl, K. Giglio, and D.B. Green
11:00--44. Stereochemistry of the Cyclopentadiene-Cinnamic Acid Cycloaddition L. McGahey
11:20--45. Preparation, Properties, and Analysis of the 1-2-3 $YBa_2Cu_3O_{7-x}$ Superconductor in Freshman Chemistry Laboratory D.B. Green, and B. Hutchison
11:40-46. Easy Spectral Demonstrations G.R. Franzen

Monday Afternoon

Noon -12:30 p.m. Lunch Diversions *Five-Minute Demonstrations*
CHEMISTY 194
David A. Katz, Presiding
Demonstrators: John Fortman, Rubin Battino, Pirketta Scharlin, Richard Hermens

Lecture and Learning: Are They Compatible? (cont)
CHEMISTRY 194
Diane Bunce, Presiding
1:30--47. The Social Construction of Science Understanding A.B. Champagne
1:50--48. Use of the Particulate Nature of Matter in Developing Conceptual Understanding D.L. Gabel
2:10-49. Motivation (or Lack of) in Students: Is it our Fault? R.J. Ward, G.M. Bodner
2:30-Summary

Industry-Education Initiatives (sponsored by $2YC_3$)
YOUNG 198
Linda Zarzana and Danny White, Organizers, Presiding
1:30--50. Hands-On, Minds-On Elementary Science: Dow's Committment J.B. Loveless
1:50--51. Partner's for Terrific Science A.M. Sarquis
2:10--52. Teaching the Teachers Environmental Science J.A. Kleinschmidt
2:30--53. You Scratch My Back... K.A. Henderson
2:50--Break
3:15--54. Partnership Between Business and Education D.B. Clutter

3:25--55. Project FLASK and Chem Camp - Two Industry/Education Initiatives in Central Pennsylvannia R.D. Minard and M.R. Bogdan
3:45--56. The National Plastics Center and Museum: A Local Resource, a National Resource V.R. Wilcox

Biochemistry and Biotechnology
CHEMISTRY 176
Barbara Sawrey and Toby Hall, Organizers
Barbara Sawrey, Presiding
1:30--57. Stacking the Deck for Biochemistry T.L. Schaap
1:50--58. Biotechnology Workshop for Science Teachers D.W. Pettigrew, R. Khan, E.A. Funkhouser
2:10--59. Yes! There is Protein in School Milk: How the Bio-Rad Protein Assay is Used in a Biotechnolgy Curriculum T.M. Horn
2:30--60. Densitometry: The Next Step n High School Electrophoretic Studies of DNA and Protein T.L. Schaap
2:50--Break
3:15--61. Fermentation Technology and Other Neglected Topics in Biotechnology C.L. Bering
3:25--62. Undergraduates Isolate and Analyze Plant Pigments and Sterols by GC-MS A.P. Toste
3:45--63. Teaching Biochemical Techniques With Multimedia G. Wienhausen, B.A. Sawrey

Public Relations: Helping the Media to Tell Your Story
WELLMAN 2
E. James Bradford, Organizer ,Presiding
1:30--64. Rail Misadventures: Political Reaction and Industry Response to the Dunsmuir and Seacliff Train Derailments P.A. Kronenberg
2:15--65. Public Relations E.J. Bradford
2:30--66. What the News Media Needs - a panel discussion

New Methods for Lab
CHEMISTRY 166
Arlyn Myers, Presiding
1:30--67. The Changing Laboratory: Team Work and Computers A. Verner
1:50--68. A User-Designed Laboratory for Wheel-Chair Bound Chemistry Students W. Grindstaff
2:10--69. Cooperative Chemistry Laboratories M.M. Cooper
2:30--70. Separation and Ident-ification as a Focus for the Integrated Laboratory Course K.J. Brown
2:50--71. A Project-Based Sophomore Organic-Inorganic Synthesis Laboratory H.A. Smith, Jr.
3:10--Break
3:20--72. Laboratory Practical Examinations in Quantitative Analysis: Measuring *Accuracy*, *Precision* and *Speed* J.E. Frey
3:40--73. Interpreting Data Statistically -- How It Might Change Your Labs J.T. Streator
4:00--74. Learning Basic Research Skills in the General Chemistry Laboratory J. Arce and E. Danielsen
4:20--75. Integrated Laboratory Experience for Undergraduates D.R. Kimbrough and R. Damrauer
4:40--76. Integrating Research into the Undergrad Lab: Resolving the False Dichotomy of Cookbook and Discovery B.P. Coppola

General Chemistry Solutions
CHEMISTRY 194
Loretta Jones, Presiding
3:00--77. The Problem with General Chemistry Is --Th y're Freshmen!! M.Z. Hoffman , P.L. Samuel
3:20--78. CHEMPROF - Experts and Individualized Tutoring A.A. Eggert, C.H. Middlecamp, A.T. Jacob
3:40--79. CHEMPROF in the Classroom: Teaching Chemical Literacy Skills with a Computer A.T. Jacob, C.H. Middlecamp, A.A. Eggert
4:00--80. Pre-service Teaching Assistant Training Program S.T. Marcus, J.F. Cullen,Jr
4:20--81. A Computer Intensive Approach Within a Traditional Curriculum G.E. Palmer
4:40--82. The General Chemistry "Tutorial" Center A.A. Hazari, F.A. Grimm

General Poster Session Including 5-Minute Talks
FREEBORN HALL
Beth Pulliam, Presiding
Introductory Presentations
1:30--83. Chemical Demonstrations at The Ohio State University M.H. Bailey
1:35--84. Graphical Representation of Redox Reactivity: A New Approach G.P. Wulfsberg
1:40--85. Evaluating the Relative Binding Abilities of Polycyclic Aromatics by Thin-Layer Chromatography P.Di Raddo
1:45--86. I've Looked at Equilibrium from Both Sides Now: Student "Discovery" of the PbI_2-H_2O System D.A. Lewis, D.K. Erwin, B.C. Pestel
1:50--87. Electron Withdrawing Ability and Chemical Shift -- A Hypothesis Testing Experiment D.H. Smith
1:55--88. A Modular Electronic Lecture Demonstration Apparatus G.D. Mercer
2:00 - 3:00--Open Discussion
3:00--Break
Introductory Presentations
3:15--89. Integrating Elementary (Lower Div.) Organic Chem into (Upper Div.) Organic Chem E.R. Matjcka, R.C. Banks
3:20--90. HMO Calculations on a Spreadsheet L. McGahey
3:25--91. The Dehydration of 4-Methyl-2-Pentanol -- A Hypothesis Testing Experiment D.H. Smith
3:35--92. Inorganic Qual Analysis Minimzing Hazardous Waste F.E. Wood, K. Ferrero, A. Gibson, N.A. Nguyen, M.S. Wilcox
3:40--93. Attracting Women Students into Chemistry I.S. Hartman
3:45--94. IBM + Chemistry Student ---> ??? T.L. Beam, E. DiMauro
3:50 - 5:00--Open Discussions

CHEMISTRY DEPARTMENT OFFICE
1:30--*Chemistry Department Open House featuring the Organic Chemistry Division*

Monday Evening

FREEBORN HALL
7:00 p.m. 95. PLENARY LECTURE What's New About Teaching Problem Solving? Donald Woods Feature Editor, "Problem Solving Corner" *Journal of College Science Teaching* Department of Chemical Engineering, McMaster University, Hamilton, Ontario, Canada

Tuesday Morning

FREEBORN HALL
8:30--96. BRASTED PLENARY LECTURE Chemistry, A Universal Science Ernesto Giesbrecht, Institute for Chemistry, University of Sao Paulo, Sao Paulo, Brazil

Consumer Products
MEMORIAL UNION II
Keith O. Berry, Organizer
Keith O. Berry and Tim Hoyt, Presiding
9:45--97. Consumer Chemistry: A Common Sense Course to Introduce Basics of Chemistry and Chemical Toxicology B. DasSarma
10:05--98. Chemistry of Chocolate L. Borer
10:25--99. Burning Calories in a Bomb D. Swauger
10:45--Break
11:00--100. Flammability of Liquids and Gases P.A. Rock
11:40--101. Surface Modification: The Ski-Snow Interface T.C. Donnelly

Whither Microscale?
CHEMISTRY 176
Sandra I. Lamb, Organizer, Presiding
9:45--102. Outcomes of Micro and Macro Approaches to the Chemistry Teaching Lab: A Student Perspective W. Beasley
10:05--103. What is the Future of Microscale in the Organic Laboratory? - a panel discussion D.L. Pavia, G.M. Lampman, and G.S.Kritz, and R.G. Engel

Innovative Outreach Programs
CHEMISTRY 166
Nancy Pyle, Presiding
10:40--104. Graduate Students for Chemical Education: A Community Outreach Organization S.D. Gammon
11:00--105. Scientists in Schools A. Verner
11:20--106. The Twelve Days of Chemistry C.M. Pharr, S.D. Gammon
11:40--107. Precollege Science Outreach Programs: "Chemists Visit Kids" and "Not So Late Night Chemistry with USD" M.D. Koppang

Breaking the Bubble: New Thoughts on Testing and Evaluation
CHEMISTRY 194
Lucy T. Pryde, Presiding
9:45--108. What Do Our Tests Tell Our Stu ents? S. Tobias
10:25--109. Evaluating Problem-Solving Proficiency Through Performance Assessments W. Bergquist
10:45--Break
11:00--110. Hands-On and Minds-On Testing I. Talesnick
11:20--111. Alternative Testing Format: The *ChemCom* Experience L.T. Pryde
11:40:--112. *SuperTest:* A Flexible, Computer-Based Assessment Project J.D. Eubanks

View from My Classroom
WELLMAN 2
Frank Cardulla, Organizer,Presiding
9:45--113. Pictures in the Mind H.M. Stone
10:05--114. What Can I Do For Extra Credit? M.R. White
10:25--115. A Laboratory-Centered Advanced Placement Course S.R. Marsdan
10:45--Break
11:00--116. Maximizing Student Involvement in Learning M.P. Noel
11:20--117. Adding Heart and Soul to the Chemistry Classroom S. Berman-Robinson

Macintosh Applications - I Organic and Physical Chemistry
HUTCHISON 14
Joseph Casanova, Betty Luceigh, Organizers
Joseph Casanova, Presiding
Introductory Presentations
9:45--118. An Expert System for Learning Organic Chemistry J.C. Brockwell
9:50--119. NMR Spectra Simulation K.A. Black
9:55--120. A Mulitimedia Organic Chemistry Tutor K.W. Raymond
10:00--121. Dynamic Visualizations in Chemical Education B.A. Luceigh
10:05--122. An Electronic Textbook for Physical Chemistry: Chemical Applications of *Mathematica* R.G. Kooser
10:10 - Noon Demonstrations

Revamping General Chemistry - I Studies and Suggestions
YOUNG 198
John J. Fortman, Organizer
James N.Spencer, Presiding
9:45--Opening Remarks J. Spencer
9:50--123. Missionaries for Change: The General Chemistry Task Force J.N. Spencer, J.J. Fortman
10:10--124. The Role of NSF in Promoting Innovation in General Chemistry R.F. Watson, C.T. Sears Jr., J.V. Clevenger, S.H. Hixson
10:30--125. Revolutionizing the Chemistry Curriculum: The Canadian Approach J. Takats
10:50--Break
11:00--126. General Chemistry: A Modular/Core Curriculum Approach T.Y. Susskind, R.J. Gillespie, J. R. Mohrig, L.H. Rickard, J.N. Spencer
11:20--127. Let's Use Dynamite O.L. Chapman
11:40--128. Why Do We Teach This Garbage? S.J. Hawkes

Tuesday Afternoon

Noon -12:30 p.m. Lunch Diversions *Five-Minute Demonstrations*
CHEMISTRY 194
David A. Katz, Organizer, Presiding
Demonstrators: Dale Alexander, Mary Butler, William C. Deese and Dale Alexander

Consumer Products (cont)
CHEMISTRY 194
Keith O. Berry and Tim Hoyt, Presiding
1:30--129. The Chemistry of Modern Petroleum Additives P.F. Vartanian
1:50--130. The Journal of Chemical Education's Column - *Products of Chemistry* G.B. Kauffman
2:10--131. From Salt to Bleach: The Story of a Typical Chemical Industry K.O. Berry
2:30--132. Chemistry of Household Consumer Products T.C. Hoyt
2:50--Break
3:00--133. Drugstore Iodine and Household Bleach: Consumer Products in Redox and Related Demonstrations C.H. Snyder
3:20--134. More Demonstrations with Consumer Products A.S.W. Sae

Funding Opportunities in Chemical Education
CHEMISTRY 176
Robert L. Lichter, Organizer, Presiding
1:30--135. What's Worth Funding? Finding Projects that Can Make a Difference E.A. Kean
1:50--136. Chemical Transformations: An Educational Context R.L. Lichter
2:10--137. School to School, Scientists to Scientist, Summer Partnerships B. Andreen
2:30--138. Approaches to Integrating Science Education N.O. Thorpe
2:50--Break
3:00--139. NSF Support: Continuing Research Related to ChemCom - An Example, F.X. Sutman
3:20--140. State of California Funding Opportunities for Chemistry Education T.P. Sachse
3:40--Panel Discussion R.L. Lichter - Moderator

Expanding the Audience for Chemistry - I
CHEMISTRY COURTYARD/ CHEMISTRY 194
E. James. Bradford and Lee Marek, Organizers and Presiding
1:30 - 3:30-A Science Carnival for Elementary School Kids *open to all participants and families; children under 8 should have adult supervision*
Coordinator E.J. Bradford
4:00--141. Son of Weird Science: A Phenomenonological Approach to Teaching L. Marek, R. Lewis, D. Lieneman, W. West

Microscale Experiments Poster Session Including 5-minute Demonstrations and Talks
FREEBORN HALL
M. Patricia Noel, Organizer, Presiding
Introductory Presentations
1:30--142. Chemistry Kits - More Demonstrations in Less Time G.L. Gilbert
1:35--143. Stoichiometry: A Microscale Experiment D.A. Kukla
1:40--144. Periodicity: A Microscale Experiment D.A. Kukla
1:45--145. Microscale Reaction Kinetics Experiments M. Carlberg
1:50--146. Two Microscale Labs Dealing with Boyle's Law R.A. Erdman
1:55--147. A Microscale Determination of Viscosity B. A. Gonzalez
2:00--148. Microscale Kinetics Laboratory A.M. Gomez
2:10--149. Macintosh Applications in a Microscale Investigative Lab N. Konisberg Kerner
2:05 - 3:00 Open Discussion

Revamping General Chemistry - II Content, Organization,and Models
YOUNG 198
John J. Fortman, Organizer
H. Taft, Presiding
1:30--Opening Remarks
1:35--150. New Goals for the General Chemistry Course and Their Implications R.J. Gillespie
1:55--151. Chemistry in Context: A Virus in the Service Course A.T. Schwartz
2:15--152. Concept Development for Chemical Literacy *vs* Concept Development in General Chemistry W.R. Robinson
2:35--153. A Challenge to Change General Chemistry - Turning it Inside-Out, Upside-Down, and Backwards J.J. Fortman
2:55--154. Highlights from "A Materials Chemistry Companion to General Chemistry": Lecture Demonstrations M.J. Geselbracht, A.B. Ellis, W.R. Robinson, M. Greenblatt, M.S. Whittingham, G.C. Lisensky
3:15--Break
3:20--155. Promoting the Relevance and Value of Chemistry: General Chemistry at the U.S. Coast Guard Academy K.A. Redig, T.J. Haas
3:45--156. The University of Michigan Undergraduate Program. Where Do We Stand After Three Years? B.P. Coppola
4:05--157. Are We Teaching the Right Things in General Chemistry? C.H. Atwood, J.A. Kreyenbuhl
4:25--158. Reasoning Skills and Misconceptions -- A Rationale for Revamping Chemistry Instruction J.P. Birk, J. Foster, M.J. Kurtz, S. Woodward
4:45--159. Using Educational Research Findings as a Guide to Curriculum Development F. Garafalo, V. LoPresti

Enhancing the Role of the High School Laboratory
WELLMAN 2
Mary Johnson, Organizer, Presiding
1:30--160. Learning Cycles in the High School Laboratory J.P. Birk, A.E. Lawson
1:50--161. Cooperative Learning in the Lab: An Answer? J.G. Little
2:10--162. One Possible Role of Computers in the High School Chemistry Classroom J.A. Baron
2:30--163. One Resounding Vote for "Minds-On" Laboratory Experiences with Appropriate Assessments G. Good
2:50--164. Boxing the Examination: Using Small-Scale Activities to Assess Chemical Problem-Solving in the Classroom W. Bergquist
3:10--Break
3:20--165. Purdue Instrumentation Van Project: An Outreach to High Schools D.W. Burnett
3:45--166. The Place of Laboratory Work in the A.P. Course S.R. Marsden
4:05--167. Can We Teach High School Chemistry Exclusively Through Laboratory Work? T.A. Asunta
4:25--168. Hope College Laboratory Experiments on Computer Disks E.C. Jekel
4:45--169. Synthesis and Analysis of A Cu(II) Ammonia Complex Salt F.S. Quiring

IBM Applications - I General Chemistry
TEMPORARY BUILDING (TB) 114
Steven D. Gammon, Organizer, Presiding
Introductory Presentations
1:30--Introductory Remarks S.D. Gammon
1:35--170. Laboratory and Simulation - Partners in Learning J. Crook, J. Weyh, K. Bruland, J. Peterson, G. Gerhold, D. King
1:40--171. Multimedia Exercises for Science Laboratories D.M. Whisnant, T.E. Ferguson
1:45--172. Supplementing the Chemistry Lab Experience Using an IBM Computer-Assisted Interactive Videodisc Lab Program R.D. Gittler
1:50--173. Teaching General Chem with Digitized Video on a CD-ROM S. Smith, L. Jones
1:55--174. Project CATALYST A Progress Report J.W. Moore, P.F. Schatz, L.R. Hunsberger, J.C. Kotz
2:00 to 3:00 Demonstrations
3:00--Break
Introductory Presentations
3:15--175. PC-Based Materials for 1st-Year Chem S.K. Lower
3:20--176. CHEMPROF: An Intelligent Tutor A.A. Eggert, C.H. Middlecamp, A.T. Jacob
3:25--177. Chemical Equilibrium Calculations with Program EQULIB R.D. Allendoerfer
3:30--178. Student Plus Computer Equals Learner J.S. Martin, E.V. Blackburn, I. Safarik
3:35--179. Elementary Detective: An Interactive, MS-DOS Chemistry Program D.A. Kukla
3:40--180. A Computer Test of Reasoning Skills J.P. Birk

3:45--181. Computer-Based Learning Cycles for Descriptive Inorganic Chemistry D. Bardwell, J.P. Birk
3:50 -5:00 Demonstrations

General Poster Session Including 5-minute Talks
FREEBORN HALL
R. Erdman, B. Gonzalez, Presiders
Introductory Presentations
3:00--182. Resources to Make Life Easier for Chemistry Teachers M.K. Turckes
3:05--183. Can the Organic Laboratory be Computer Assisted? B.N. Campbell
3:10--184. Hands-On Activities from a Pre-College Teacher Workshop J.P. Williams, A.M. Sarquis, J.L. Sarquis
3:15--185. Practical Activities for the Assessment of Students M.R. Walsh
3:20--186. Fabrication of Inexpensive Analytical Laboratory Racks from PVC Pipe H.P. Williams
3:25--187. Empirical and Molecular Formulas: A Sporting Analogy C.M. Wynn
3:30--188. Modified PSI Format in the General Chemistry Course that Promotes Higher Order Thinking Skills J.Arce, N. Cordero, M.M. Muir, R. Betancourt
3:35--189. Cooperative, Self-paced, Bilingual General Chemistry J.B. Cairns, M.M. Muir
3:40--190. Modular Topic Approach to General Chemistry D.R. Kimbrough, R.P. Meglen
3:45--191. Infrared Spectra of Plastic Wraps for an Introductory Analytical Chemistry Lab K.A. Henderson
3:50 - 5:00 Open Discussion

CHEMISTRY DEPARTMENT OFFICE
1:30 -- Chemistry Department Open House featuring the Inorganic Chemistry Division

Tuesday Evening
6:00--Picnic at Putah Creek Lodge

Wednesday Morning

Revamping General Chemistry - III Approaches
YOUNG 198
John J. Fortman, Organizer
George Bodner, Presiding
8:30--Opening Remarks
8:35--192. Laboratory-Centered Instruction in Chemistry: Concept Introduction in the Laboratory J.A. Strong, R.S. Lamba
8:55--193. Promoting Student Learning Through Laboratory Centered Instruction R.S. Lamba, J.A. Strong
9:15--194. General Chemistry from a Learning Theory Approach B.C. Pestel, D.K. Erwin, D.A. Lewis
9:35--195. General Chemistry with a Unifying Principle D.K. Erwin, B.C. Pestel, D.A. Lewis
9:55--Break
10:15--196. Restructuring General Chemistry at the University of Redlands J.I. Selco, J.L. Roberts, D.B. Wacks, W.J. Zajdel
10:35--197. The MCP Project: Teaching Introductory Chemistry in a Curriculum Coordinated with Mathematics and Physics J.H. Reeves, C.R. Ward, J.H. Zimmer
10:55--198. Transformation of Introductory Chemistry Experiments into 'Real World Contexts' R. Bayer, B. Hudson, J. Schneider
11:15--199. The Sequence of Descriptive Inorganic Topics in the General Chemistry Course J.D. Hostettler
11:35--200. Designing Laboratory Curricula for the Large Course P. Samuel

New Technology for Chemical Education - I
WELLMAN 2
Ron Ulrich, Presiding
8:30--201. Making CAI Make a Difference In Introductory Chemistry S.K. Lower
8:50--202. Chemistry Lab Augmented by Interactive Videodisc J.E. Bauman, Jr.
9:10--203. Teaching Science in the Elementary School: Videodisc Materials for Pre-Service Teachers M.D. Joesten
9:30--204. The Use of Micro-wave Systems in Undergraduate Organic Laboratories R. Hicks and G. Majetich

Name that Compound: Old Rules, New Methods
WELLMAN 2
Homer A. Smith, Jr., Organizer, Presiding
10:00--Introductory Remarks H.A. Smith, Jr.
10:05--205. The Birth and Growth of the Blue Book of Rules: A User-Friendly Perspective J.G. Traynham
10:35--206. Teaching IUPAC Nomenclature in the Trenches: Can the Computer Help? G.M. Lampman
11:05--207. The Evolution of Organic Nomenclature to Meet Modern Needs H.A. Smith, Jr.
11:35--208. Name That Compound: A Workshop J.G. Traynham - leader, G.M. Lampman, H.A. Smith, Jr.

Macintosh Applications - II General Chemistry
HUTCHISON 14
Betty Luceigh, Joe Casanova, Organizers
Betty Luceigh, Presiding
Introductory Presentations
8:30--209. Computer Generated Animation Applications in Beginning Chemistry J. Buell, A.F. Montana, C.F. Prenzlow, P.A. Wegner
8:35--210. Computer Generated Graphics for Introductory Chemistry J.L. Gelder, N.S. Gettys, J. Wheeler
8:40--211. The Chemistry Navigator Hyperbook J.C. Kotz, J.W. Moore, P. Schatz
8:45--212. Equipping Students with a Chemical Eye A.J. Banks, T.Kems, S. Peck
8:50--213. Computer Excitement for Ground State Students G.L. Galloway
8:55--214. ChemTutor and ChemTutorProject M.C. Hallada
9:00--215. Visualizing the Abstract in Beginning Chemistry on the Mac and Videotape R.A. Paselk, M.P. Hanson, J.B. Russell
9:05--216. Hyperlabs: Computerized Ventures in the General Chemistry Laboratory D. Swauger
9:10 to noon Demonstrations

IBM Applications - II Laboratory
TEMPORARY BUILDING (TB) 114
Steven D. Gammon, Organizer, Presiding
Introductory Presentations
8:30 217. Curriculum Development Possibilities in a Computer Equipped Freshman Laboratory K.Emerson, J. R. Amend, J. B. Radke
8:35 218. IBM PSL Experiments from Interdisciplinary Perspectives J. R. Zimmer, G.G. Lugo, J.H. Reeves, C.R. Ward
8:40--219. Computerized Simulations, Demonstrations and Laboratory Interface Experiments for General and Physical Chemistry Classes P. L. Pavlik
8:45 220. Development of Sensors for Computer Interfacing R. P. Furstenau, M. Carroll, R. Moore, D. Wight
8:50 221. The IBM Multimeter in Electrochemical Computer-Interfaced Experimentation D. Malone
8:55 222. Automation in Undergraduate P. Chem Labs J. Giguere, J.-R. Martin
9:00 223. LIMSport: Spreadsheet Data Acquisition and Laboratory Information Management for General Chemistry E. Vitz
9:05 224. Measurement of Pressure, Temperature, and Volume During a Rapid Near Adiabatic Compression of Various Gases B. E. Lee
9:10 225. Making the Interfaced Computer More Than a Tool S. D. Gammon
9:15 226. Microstate: Demonstrating Molecular Order and Disorder R.W. York
9:20 227. Animated Illustrations of Atomic and Molecular Phenomena R.C. Rittenhouse
9:25 228. Incorporation of *Ab Initio* Calculations into the Physical Chemistry Courses W. Schwenz
9:30 to noon Demonstrations

Empowering Student Success
CHEMISTRY 166
Kathy Turner and Jim Bier, Organizers and Presiding
8:30--229. Empowering Students to Learn Chemistry C. J. Bier
8:45--230. Writing to Empower Learning in Chemistry M.J. Strauss, B.B. Lewis, H. Puglisi
9:00--231. Structuring Chemistry Courses for Success, not Stress D.L. Lewis
9:15--232. Restructuring the Quiz Section in General Chemistry C.N. Hurley
9:30--233. Keys to Success in Chemistry G.W. Everett
9:45--Break
10:00--234. Workshops to Reduce Student Lab Anxiety M. Kandel
10:15--235. Under Observation: The Pre-Med Organic Experience A.R. Morrill
10:30--236. Easing the Transition into Laboratory Research T.I. Spector
10:45--237. Undergraduate Research Programs in Chemical Education P.K. Dea
11:00--238. Interacting to Foster Scientific Self-Confidence K.E. Turner
11:15--Open Discussion - J. Bier - moderator

Problem Solving in Introductory Chemistry: Why and How
CHEMISTRY 194
Frank Cardulla, Organizer, Presiding
8:30--239. The Habit of Patient Thinking C.Stanitski
8:50--240. Problem-Solving Day G.M. Bodner
9:10--241. Expanded Dimensional Analysis: Understanding and Communicating Chemistry Without Memorizing Formulas R.DeLorenzo
9:30--242. Solving Qualitative Problems in the Classroom W.R. Robinson
9:50--Break
10:15--243. Where Good Students Go Wrong During Problem Solving: Mathematics Skills and Concepts, T.J. Greenbowe
10:35--244. Dimensional Analysis: *Requiescat in Pace* J.H. Burness
10:55--245. Making It Concrete Makes It Stick S.F. Wieland, D.J. Antion
11:15--246. A Generic Approach to Analytical Thinking J.E. Brady

11:35--247. The Neglected Step: How to Read a Problem F.P. MacKay

Microscale Experiments Poster Session Including 5-minute Talks and Demonstrations
FREEBORN HALL
Sandra I. Lamb Organizer, Presiding
Introductory Presentations
8:30--Introductory Remarks S.I. Lamb
8:35--248. Isolation of Piperine from Black Pepper W.W. Epstein, D.F. Netz, J.L. Seidel
8:40--249. The Dibenzalacetone Reaction Revisited L.A. Hull
8:45--250. Microscale Recrystallization/ Melting Point and Liquid/Liquid Extraction Experiments With Unknowns R.D. Minard and A.J. Freyer
8:50--251. Preparation of β-Angelicalactone: A Student Experiment Involving Synthesis, NMR Spectroscopy, Molecular Modelling and Spectrum Simulation D.L. Pavia, G.S. Kriz, C.Radzewich, and S.D. Crowder
8:55--252. Preparation of α-Angelicalactone: A Student Experiment Involving Synthesis, NMR Spectroscopy, Molecular Modelling, and Spectrum Simulation D.L. Pavia, G.S. Kriz, M.E.Brown, G.M. Knapp, and M.M.Seibel
9:00--253. Permanganate Oxidation of Trans-Stilbene to Benzoic Acid Using Phase Transfer Catalysis: A Microscale Organic Experiment C. N. Hammond
9:05 - 10:00 Open Discussion
10:00--Break
Introductory Presentations
10:15--254. Microscale Reactions in Sealed Tubes M.J. Kurtz and J.P. Birk
10:20--255. Microscale Esterification Reactions of Vanillin: A Surprise Product R. Fowler
10:25--256. A Different Approach to Microscale G. Rayner-Canham
10:30--257. Microscale Organic on a Shoestring: An Experience at WKU J.M. Reasoner and R.F. Forsythe
10:35--258. Small Scale, Low-Cost Experiments M.E.M. Pestana
10:40--259. Microscale Experiments For Use in Armchair Chemistry L.W. Shank
10:45--260. The Design of Versatile Microscale Discovery Kits and Implementation Procedures for Wide-Range Audiences K.E. Eichstadt and N.C. Grim
10:50 - Noon Open Discussion

Wednesday Afternoon

Noon -12:30 p.m. Lunch Diversions *Five-Minute Demonstrations*
CHEMISTRY 194
David A. Katz, Organizer, Presiding
Demonstrators: David A. Katz, Sheldon Knoespel, Andy S. Sae, Irwin Talesnick

ChemCom in Russia Five-Minute Talks and Poster Session
FREEBORN HALL
K. Michael Shea Organizer
Donald E. Jones Presiding
Introductory Presentations
1:00--261. ChemCom Workshop at Moscow School 455 A.M. Rennert
1:05--262. Moscow, P.S. #455 and ChemCom G.Pollock
1:10--263. ChemCom Town Meeting - Russian Style M.C. Bonneau
1:15--264. ChemCom Teacher Training in Russia V.Bono, F.B. Bramwell, and R. Silberman
1:20--265. ChemCom at P.S.N. 109 - Moscow H.O'Keefe
1:25--266. ChemCom Workshop at School N109, Moscow R. Dayton
1:30--267. Introduction to PS N109 Moscow, Russia J.A. Kovacs
1:35 - 2:30--Open Discussion
2:35--Break
Introductory Presentations
2:45--268. Video of School #615 Moscow D.C. Stoops, Jr.
2:50--269. Using up a Metal - A Micro-Technology Activity Demonstrating Corrosion - Shared with Russian Teachers S.J.Wachko
2:55--270. Reactions and Reflections on Inservicing Soviet Chemistry Teachers on Using ChemCom in Soviet Schools C.P. Clermont
3:00--271. Striking It Rich with Chemistry - A ChemCom Activity Shared with Russian Teachers F.P. Gray
3:05--272. ChemCom in Moscow D.E. Jones and S.A. Ware
3:10 - 4:00 Open Discussion

New Courses in Chemistry
CHEMISTRY 176
Jeff Pribyl, Presiding
1:00--273. *Fizz* - An Integrated Curriculum Design Project E.A. Mottel
1:20--274. Teaching Chemistry with the Newspaper P.M Jeffers, A.P. Zipp
1:40--275. Science Education Reform: A New Chemistry Course for Prospective Elementary Teachers C.W. Bowen
2:00--276. Applications-Oriented General Chemistry Course H.J. Muh, C.M. Utermoehlen, and R. P. Furstenau
2:20--277. Marine and Island Ecology L.L. Stephens and W.G. Lindsay, Jr.
2:40--278. Environmental Chemistry: A New Perspective L.E. Welch
3:00--Break
3:05--279. The Education of an Engineer for Scientific Literacy G. L. Swartz
3:25--280. Bringing Environmental Problems To the Classroom G. Mort, J.H. Swinehart
3:45--281. I. On the Reform of the Teaching of Basic Organic Chemistry at Teachers' Colleges and Universities in China W. Yong; II. Reform in Teaching Basic Organic Chemistry Experiments in Teachers' Colleges in China J-P. Wang
4:05--282.Chemical Transformations As the Focus of a Discovery-Based Introductory Course N. Devino, M.F. Holden, R.E. Leyon, G. Roper, C. Samet

Viticulture and Enology (sponsored by 2YC3)
YOUNG 198
William J. Wasserman, Organizer, Presiding
1:30--283. The California Wine Industry as Seen By Varietal Diversification J. Lapsley
2:00--284
2:30--285. An Olfactory Detector Interface for Gas Chromatographic Analysis of Wines T. Acree
3:00--286. An Academician in the Vineyard L. Replogle
3:30--287. Chemical Enology Training at UC Davis A.L. Waterhouse

Integrating Computational Chemistry Into the Curriculum
WELLMAN 2
Alfred J. Lata and Joseph Casanova, Organizers, Presiding
1:00--288. Predicting Selectivity in Organic Reactions W.J. Herre, T. Chao, S. Fiedler
1:30--289. Teaching Physical Chemistry with *THEORIST* G.L. Breneman, O.J. Parker
1:50--290. Teaching the Electronic Structure of Atoms and Molecules to Introductory Chemistry Students G.P. Shusterman
2:10--291. Visualizations in Teaching Chemistry: Exploring Concepts via Interactive Visualization N. Sabelli, I. Livshits
2:30--292. A Visual Interpretation of Chemical Structure, Properties, Reactivity G.D. Purvis III
3:00--Break
3:10--293. Quantum Mechanics with Mathcad 3.0 E. Rioux
3:30--294. Shapes of Atomic and Hybrid Orbitals O.J. Parker, G.L. Breneman
3:50--295. Mathematics and Computation in the Chemistry Curriculum A.L. Smith

New Initiatives in Organic Chemistry - includes panel discussion
CHEMISTRY 194
Sam Levine, Presiding
1:00--296. Relevancy in Organic Chemistry J.K. Whitesell, M. A. Fox
1:10--297. Bridging the General Chemistry and Organic Chemistry Courses F.A. Carey
1:20--298. Teaching Problem-Solving in Organic Chemistry L.G. Wade, Jr.
1:30--299. Putting the Horse Before the Cart: Using Principles of Structure and Reactivity for Introductory Chemistry Courses B.P. Coppola
1:40--300. Organic Chemistry -- Then and Now R.F. Daley
1:50--301. Will the Organic Laboratory Survive the Decade R.J. Fessenden
2:00--302. Organic Chemistry Education in the 1990's A. D. Baker, R. Engel
2:10--Panel Discussion S. Levine - moderator

Finding and Retaining Future Scientists
CHEMISTRY 166
Regis Goode, Presiding
1:00--303. Chemistry for the Gifted Student at Pike High School -- Year One M.R. Walsh
1:20--304. The U.S. Chemistry National Olympiad M.K. Turckes
1:40--305. Teaching Chemistry to LEP (Limited English Proficiency) Students D. McGann
2:00--306. Project Seed: How to Produce "The Experience that Can Change a Life" G.C. Good
2:20--307. Reaching the Talented Pre-College Students and Teachers Through the Millsaps College Summer Research Institute in Chemistry and Biology J.-M. Whitfield
2:40--308. Student Support for and Retention of Minority Students in Chemistry H.B. Silber
3:00--Break
3:10--309. Experiencing the Life of a College Professor as a Ford Fellow While Enriching and Expanding the Impact of the Faculty Mentor: The Millsaps College Ford Fellowship Program B.G. Barnett, J.-M. Whitfeld
3:30--310. Retaining Undergraduates Interested in Chemical Science. A Research-Oriented Section for First-Year Students B.P. Coppola

CHEMISTRY COURTYARD
1:30 - 3:30 A Chemistry Camival for Middle and High School Students *open to all participants and families; children under 8 should have adult supervision,* E. James Bradford, Coordinator

CHEMISTRY DEPARTMENT OFFICE
1:30--Chemistry Department Open House featuring the Physical and Analytical Chemistry Divisions

Wednesday Evening

CHEMISTRY 194
7:30--311. Dazzling Demos and Video Bloopers in Chemistry L.J. Fortman

Implementing the World of Chemistry: A Symposium Dedicated to the Memory of Isidore Adler and Marjorie Gardner (sponsored by $2YC_3$)
YOUNG 198
Margot K. Schumm, Organizer, Presiding
7:30--312. The Many Different Facets of the World of Chemistry N. Ben-Zvi
7:50--313. World of Chemistry for High Schools P.J. Smith
8:10--314. The IAC Program and the World of Chemistry R.J. Rusay
8:20--315. The World of Chemistry at Amarillo College A.G. Foster
8:40--316. An Honors Course for the Non-Science Major J.E. Bauman, Jr.
9:00--Round Table Discussion

History in the Chemistry Curriculum
CHEMISTRY 166
Geoff Rayner-Canham, Presiding
7:30--317. The Determination of the Contents of a Vial from the Civil War: General Chemistry at Work S.R. Goode
7:50--318. And I Quote.... D. Swauger
8:10--319. On the Shoulders of Giants.. R.S. Treptow
8:30--320. 50 Years of Organic Chemistry Texts-What's New? G. Brieger
8:50--321. Workshops in the History of Chemistry L.B. Friedman
9:10--322. Workshops in the History of Chemistry - Teacher's Perspective L.R. Marek, J.L. Ihde, D. Trapp

Programs and Workshops for Middle and Elementary School Teachers
CHEMISTRY 176
Peggy Carlock, Presiding
7:30--323. A Laboratory Experience for Middle School Teacher/Student Teams G.R.K. Khalsa
7:50--324. Project Interaction: An Effective Model for Continuing Education of High School Chemistry Teachers D.J. Antion and S.F. Wieland
8:10--325. Teaching Science with Toys -- A Hands-On Workshop for Pre-College Teachers J.L. Sarquis, A.M. Sarquis, J.P. Williams
8:30--326. Hands-On Science Workshops for Elementary Teachers A.A. Hazari
8:50--327. ChemFest: A Combination Workshop for Elementary Teachers and Students D. Watson
9:10--328. A "Hands-On, Minds-On" Science Workshop for K-8 Teachers M. Couretas, J. Funkhouser, A. Hapkiewicz, and S. Knoespel
9:30--329. A Constructivist Approach to Grade School Science in Vermont M.J. Strauss, B.B. Lewis, R. Agne, and H. Puglisi

Macintosh Applications - III General Chemistry (cont)
HUTCHISON 114
Betty Luceigh, Presiding
Introductory Presentations
7:30--330. Computer-Interfaced Experiments in General Chemistry J.R. Hutchison
7:35--331. The Macintosh in General Chemistry S.E. Hannum
7:40--332. Computer-Assisted Lab Instrument Operation and Principles Explanation (CALIOPE) R.D. Minard
7:45--333. Macintosh Based Lessons for First-Year Chemistry S.K. Lower
7:50--334. Multimedia and Mental Models in Chemistry J. Russell, R. Kozma, T. Jones, J. Wykoff
7:55--335. Seeing Through Chemistry P.G. Rasmussen, C. Derskimer, P. Wurman, M. Nowak, C. Buswinka
8:00--336. Macintosh With and Without Interface with Videodisc Player for Use in Chemistry Pre-lab, Homework, and Lecture Demonstration S.K. Airee
8:05 to 9:30 Demonstrations

New Approaches to Difficult Topics
MEMORIAL UNION II
Karen A. Henderson, Presiding
7:30--337. Visual Patterns for Stoichiometry H.P. Williams
7:50--338. Oxidation Numbers A. Duttaahmed
8:10--339. Focusing Students on Molecular Action Through Active Learning F.P. MacKay
8:30--340. Electron Waves, An Alternative to the Resonance and Molecular Orbital Models of Delocalization F.M. Klein
8:50--341. What No Orbitals! A New Approach to the Teaching of Bonding in General Chemistry R.J. Gillespie
9:10--342. A Valuable Tool for Delivering Speeches and Lectures: Thematic Maps E.A. Castro
9:30--343. Thermodynamics and Electrochemistry in General Chemistry A. Duttaahmed

Thursday Morning

C_{60} and Beyond: New Allotropes of Carbon
FREEBORN HALL
Robert L. Whetten, Organizer, Presiding
8:00--344. PLENARY LECTURE C_{60} Buckminsterfullerene: The Celestial Sphere that Fell to Earth Harry W. Kroto, Department of Chemistry, University of Sussex, Sussex, England.

C_{60} and Beyond: New Allotropes of Carbon (cont)
YOUNG 198
Robert L. Whetten, Organizer, Presiding
9:45--345. EPR Studies on Metal-Containing Fullerenes D.S. Bethune, C.S. Yannoni, M. Hoinkis, M de Vries, J.R. Salem, M.S. Crowder, R. Johnson
10:10--346. Alkali-Doped C_{60} - Structure and Superconductivity R.B. Kaner, J.B. Wiley, E.G. Gillan, S.-M. Huang, K. Min, R. Whetten, K. Holczer
10:35--347. Raman Studies of C_{60} at High Temperature and Low Pressures P. Alivisatos
11:00--348. Probing Fullerene Structure and Dynamics using NMR R.D. Johnson, D.S. Bethune, C.Y. Yannoni
11:25--349. Beyond C_{60}: The Higher Fullerenes R. L. Whetten

Bringing Women into Chemistry
MEMORIAL UNION II
Jody Chase, Organizer, Presiding
9:45--Introductory Remarks A.A. Russell
9:50--350. Women in Science: Where Do We Go From Here? J.Butler Kahle
10:30--351. Encouraging Young Women to Study Chemistry R. Perkins
10:50--352. Pioneer Women in Nuclear Science G Rayner-Canham, M. Rayner-Canham
11:10--353. Science and Humor: What Is The Message? R.W. Kleinman, L.K. Lee
11:30--354. Bringing Women into Chemistry and Encouraging Them to Stay K.E. Turner
11:50--355. Women in Science and Engineering: A Need for Action J. Chase, J.G. Danek

Curriculum Reform in the High School
WELLMAN 2
George E. Miller, Organizer, Presiding
9:45--356. Where Are We Going Nationally? E. Stage
10:05--357. Project 2061 G. Oden
10:25--358. Concepts of Curriculum: What are We Trying to Change? C.W. Bowen
10:45--359. Pacesetters - A College-Bound Initiative in SCience H. Taft
11:05--360. Teachers Beliefs and Classroom Interactions: Lessons from High School Chemistry A.J. Phelps
11:25--361. College Faculty Can Influence High School Chemical Education -- A Decade of Accomplishment in Mississippi J.H. Bedenbaugh and A.O. Bedenbaugh
11:45--362. The Golden State Examinations G.E. Miller

Implementing the World of Chemistry: A Symposium Dedicated to the Memory of Isidore Adler and Marjorie Gardner (cont)
CHEMISTRY 194
Margot K. Schumm, Presiding
9:45--363. Motifs in the World of Chemistry R. Hoffman
10:05--364. Using the World of Chemistry to Address Naive Models in Chemistry D.L. Frank
10:25--365. The Persistence of Print: Verbal-Visual Integration in Educational Television R. Kaper
10:45--366. A New Dimension for Evaluation of a Video Series M. Hilton-Kramer
11:05 Round Table Discussion

New Technology for Chemical Education - II
CHEMISTRY 166
Ron Ulrich, Presiding
9:45--367. Production and Utilization of Video in General Chemistry II: The Phase Changes of Carbon Dioxide K.E. Eichstadt, A.P. Lokie, Jr., L. Slates, and S.A. Hatfield
10:05--368. Using FT-IR in a Discovery-Based Approach to Sophomore Organic Chemistry W.D. Totherow
10:25--369. Self-Instructional Interactive Computer Programs: A Teaching and Learning Tool for Faculty Development R.S. Lamba and R.A. De La Cuétara
10:45--370. Reactions Under a Microscope - A Student Exploration D.J. Clevette
11:05--371. Chemical Literacy Through Science Fiction Films: A New Approach to an Old Problem S. Schreiner, J. Borgwald

11:25--372. Using Rockets to Teach Thermochemistry R.P. Furstenau
11:45--373. Chemical Topology: The Ins and Outs of Bonding D.M. Mitchell

Writing in the Curriculum
CHEMISTRY 176
Herbert Beall, Presiding
9:45--374. Understanding Chemistry Through Writing B.D. Mowery, L.C. Klein
10:05--375. Writing to Learn: Chemistry - At Clarion University P.E. Beck
10:25--376. Essay Writing in General Chemistry H. Beall
10:45--377. Writing to Improve Problem Solving E.P. MacKay
11:05--378. Innovative Writing to Facilitate Learning G.C. Good
11:25--379. An Individualized Weekly Assignment for a Liberal Arts Chemistry Course M.F. Bailey
11:45--380. Using the Literature to Create a Positive Image of Chemistry for Non-Majors T.A. Salerno

Macintosh Programs - IV Specific Applications
HUTCHISON 14
Joseph Casanova and Betty Luceigh, Organizers
Joseph Casanova, Presiding
Introductory Presentations
9:45--381. Crystallographic Courseware M.E. Kastner
9:50--382. Exploring Chemical Kinetics Using Interactive Computer Animation Sequences M.D. Lynch, T.J. Greenbowe
9:55--383. Exploring Electrochemical Cells Using Interactive Computer Animation Sequences M. McPhillen, T.J. Greenbowe
10:00--384. Frost Diagrams -- A Tool for Predicting Redox Reactions J.P. Birk, H. Hocker
10:05--385. Dynamic Simulation of the Sodium-Water Reaction J.P. Birk, J. Zitar
10:10--386. Coordination Compounds -- A Set of Hypercard Stacks J.P. Birk, J. Foster
10:15 to Noon Demonstrations

IBM Programs - III Specific Applications
TEMPORARY BUILDING (TB) 114
Steven D. Gammon, Presiding
Introductory Presentations
9:45--387. Computer Graphics Display of Molecular Orbital Surfaces R.H. Batt
9:50--388. Instructor Authored Courseware: Graphics Based Interactive Organic Chemistry Tutorials L.C. Butler
9:55--389. Charge Behavior of Amino Acids and Polypeptides S.F. Russo
10:00--390. Computer-Based Instruction: Pericyclic Reactions A.W.M. Lee
10:05--391. The Use of Symbolic and Numeric Processors in Chemical Education W. F. Coleman
10:10--392. Efficient English for Chemists and Chemical Engineers O.L. Chapman, A. A. Russell
10:15--393. Incorporating Structural Formulas into Chemistry Documents R. K. Kirkeley
10:20--394. A Computerized, Bar-Coded Student Record Keeping System T. Ladell, T. O'Connor
10:25--395. A Digitized Video Database of Chemical Demonstrations R. Wilson, S. Mills, S. Conley
10:30 to Noon Demonstrations

Addendum to The Program

Schedule Changes

Monday August 3

5-minute demos	*add David Koster to the list of demonstrators*
Paper # 83	*rescheduled to 12:30 p.m. in Chem 194 after the 5-minute demos*
Workshop # 12	*moved to Chem Annex 3345*
Workshop # 14	*moved to Chem 3*

Tuesday August 4

5-minute demos	*change Mary Butler to Mary H. Bailey*
Workshop #19	*moved to Chem 11*

Wednesday August 5

Paper # 283	*rescheduled at 2:00 p.m.*
Paper # 284	*withdrawn*
Paper # 286	*speaker change (see abstract below)*
New Initiatives in Organic Chemistry	*moved to Chem 176*
New Courses in Chemistry	*moved to Chem 194*
Workshop # 28	*moved to Chem 3*
Workshop # 29	*moved to Chem 3*

Thursday August 6

Paper # 390	*withdrawn*

Additional Abstracts

286 **THERE'S A PHENOL IN MY WINEGLASS** Grady S. Wann, Quivira Vineyards, 4900 West Dry Creek Road, Healdsburg, CA 95448

The importance of chemistry in the production of premium wine cannot be underestimated. An understanding of the chemical principles involved in winemaking provides a necessary background not only for the successful and consistent fermentation of grape juice, but also for many decisions in wine processing that are often attributed to experience and intuition. Examples will be drawn from the large group of phenolic compounds in wines which have important implications in grape quality, as well as oxidation reactions, color, flavor, and stability in the resulting wines.

349 **BEYOND C_{60} AND C_{70}: THE HIGHER FULLERENES** R.L. Whetten, Department of Chemistry and Biochemistry, UCLA, Los Angeles, CA 90024-1569

The fullerenes are a homologous series of all-carbon molecules, C_{2p+20}, whose structures are closed bonding nets comprised of 12 pentagonal and *p* hexagonal rings. The best known of these are C_{60} and C_{70} ($p = 20$ and 25), but others, from $p = 6$ up to about 1000, have been studied for years in molecular beams. More recently, C_{76}, C_{78} (two isomers!), C_{82} and C_{84} (three isomers) have been isolated in sufficiently large quantities so that structural and chemical properties could be determined.[1] These exhibit some remarkable differences to those of C_{60} and C_{70}, but also sufficient similarities to establish the systematics among the fullerenes that are sufficiently inert to be isolated. Giant fullerenes with very large *p*, may have many properties similar to those of a single, closed graphitic sheet -- an infinite, or periodic, extension of hexagonal rings, but their structures -- do they prefer to be spherical or tubular? -- have not been established. This lecture will recount the known systematics of the higher fullerenes -- their isolation, structural determination, and some notable electronic-optical-chemical properties -- and then the giant fullerenes -- their isolation or preparation from coalescence reactions of smaller fullerenes, and their known properties.

1. For a recent review, see: F. Diederich and R.L. Whetten, Acc. Chem. Res. **25**, 119-126 (1992)

5-Minute Demonstrations

Monday August 3

Growing Metal Crystals on An Overhead Projector Richard A. Hermens and Eric Stover, Department of Chemistry, Eastern Oregon State College, La Grande OR 97850-2899

Determination of Lifting Power of a Helium Balloon D. F. Koster, Department of Chemistry, Southern Illinois University, Carbondale, IL 62901

Inexpensive Substitutes for Expensive Demo Equipment John J. Fortman and Rubin Batttino Department of Chemistry, Wright State University, Dayton, OH 45435

Chemical Kinetics Made Easy and Dramatic Andy S.W. Sae Department of Chemistry, Eastern New Mexico State University, Portales, New Mexico

Tuesday August 4

The Reaction of Sodium Metal With Water Dale Alexander, Department of Chemistry, New Mexico State University , Las Cruces, NM 88003

Paramagnetic and Diamagnetic Salts Mary H. Bailey, Department of Chemistry, The Ohio State University, 120 West 18th Avenue, Columbus, OH 43210

Osmotic Pressure Mary H. Bailey, Department of Chemistry, The Ohio State University, 120 West 18th Avenue, Columbus, OH 43210

Demonstrating Graham's Law of Diffusion William C. Deese, Department of Chemistry, Louisiana Tech University, Ruston, LA 71272 and Dale Alexander, Department of Chemistry, New Mexico State University , Las Cruces, NM 88003

Wednesday August 5

The Breathalyzer Test Sheldon Knoespel Department of Chemistry Michigan State University, East Lansing, MI 48824-1322

Production and Reactivity of Silanes Sheldon Knoespel, Department of Chemisrry Michigan State University, East Lansing, MI 48824-1322

The Relative Strength of a Series of Chlorosubstituted Acetic Acids Sheldon Knoespel Department of Chemistry Michigan State University, East Lansing, MI 48824-1322

Cryophori, Hot Molecules and Frozen Nitrogen Sheldon Knoespel, Department of Chemistry Michigan State University, East Lansing, MI 48824-1322

Rolling Steel Spheres Down an Inclined Plane Irwin Talesnick, Faculty of Education, Queen's University, Kingston, Ontario K7L 3N6 Canada

An Atomic Clock Fueled by Orange Juice Irwin Talesnick, Faculty of Science Education, Queens University, Kingston, Ontario K7L 3N6 Canada

Keynote Address

001 **CHEMISTRY IN THE 21ST CENTURY: ITS' BEAUTY, ITS' UTILITY, AND ITS' PRACTITIONERS**

Mary L. Good, Sr. Vice President - Technology, Allied Signal Inc., Morristown, NJ 07862

Lecture and Learning: Are They Compatible? D. Bunce - Organizer, Presiding

002 **LECTURE AND LEARNING: ARE THEY COMPATIBLE? MAYBE FOR LOCS; UNLIKELY FOR HOCS**

Uri Zoller, Division of Chemical Studies, Haifa University - Oranim, Kiryat Tivon 36910,Israel

The development of students' ability to think *critically* in the context of the scientific content and processes of chemistry, requires the 'translation' of this purpose into appropriate, implementable teaching strategies accordingly. The current switch from the traditional focus on knowledge/understanding -- associated with low order cognitive skills (LOCS) -- to the emphasis on *evaluative* thinking to be followed by action-taking demands the fostering of students' higher-order cognitive skills (HOCS) such as problem-solving and decision-making. Indeed, both accumulated experience and research reveal that LOCS- and HOCS- oriented teaching models lead each to its corresponding learning outcomes. Selected successfully implemented relevant teaching strategies accompanied by in-class active research will be presented and discussed in terms of the conclusions reached and the implications for present and future chemistry (and science teaching. Our work suggests that traditional lecturing and learning in chemistry may be compatible for some LOCS but, clearly, incompatible with most HOCS.

003 **ADJUSTING THE LECTURE TO HELP STUDENTS UNDERSTAND DIFFICULT CONCEPTS**

Thomas J. Greenbowe, Department of Chemistry, Iowa State University, Ames, Iowa 50011

Do students learn in lecture? Instructors presenting general chemistry to students via the lecture method should be aware of some of the difficulties students experience. Even though an instructor thinks he or she has presented a concept or principle very clearly in lecture, instructors are often disappointed in the lack of understanding of the topic as revealed by exam answers that students write. Over the past five years, some attempt has been made to track and analyze errors made by freshmen on general chemistry exam problems. The lecture presentation was adjusted to address difficult areas and to help students. Demonstrations, specific problems requiring numerical calculations, and problems requiring conceptual understanding were incorporated into the lecture. For example, students typically will multiply E° values if the half-equation is multiplied. In subsequent classes, when demonstrating electrochemical cells, different size copper and zinc electrodes and different volumes of 1.0 M copper(II) nitrate and 1.0 M zinc nitrate are used to demonstrate the extensive properties of E° values. This demonstration coupled with a conceptual problem dealing with electrons seems to help students understand and or remember better. Students viewing this demonstration committed fewer errors when calculating $E°_{cell}$ values than students who did not. Other examples from crystal structure, thermochemistry, gas phase equilibrium, and acid-base equilibrium will be discussed. Initial qualitative results indicate that the extra work is worth the effort.

004 A TEST TO DIFFERENTIATE CONCEPTUAL THINKING FROM ALGORITHMIC PROBLEM SOLVING IN CHEMISTRY. M. B. Nakhleh, Department of Chemistry, Purdue University, W. Lafayette, Indiana 47907-1393.

In lectures and examinations in general chemistry courses, we often ask students to solve problems relating to chemical concepts. If they are successful, we assume that students have mastered the underlying concepts. The author investigated that assumption by a simple testing strategy. Three matched sets of test items were incorporated into the final examinations of the remedial, science/engineering major, chemistry major, and honors courses offered in the fall semester at a major midwestern university. Each set dealt with a specific area of chemistry, such as gas laws. One question of each set was phrased as a problem solving question which could be answered using an algorithm. The other question was phrased as a conceptual question which required understanding concepts rather than algorithms. Significant differences in performance between the conceptual and algorithmic questions were found in each course and between courses. Implications for the teaching of general chemistry are discussed.

005 SETTING THE STAGE FOR INNOVATING: BREAKTHROUGHS BY NOT LECTURING. Theodore L. Miller, Department of Chemistry, Ohio Wesleyan University, Delaware, OH 43015.

The structure of my courses has evolved into what I now call a demonstration-exploration-discussion format. Slowly over the past seven years formal lectures have been replaced by a more dynamic interaction with students. The classroom became a place to explore and evaluate, to create and synthesize, and to cover material from student questions and needs. Overall, the content of these courses matches that of lecture courses. However, the setting for learning is different; inquiry is more important than answers. The transactions between the instructor and students foster an atmosphere of cooperation while promoting the development of problem solving skills and critical thinking. As the students learn a specific body of information, they experience being a scientist. On standardized ACS examinations, the 109 students who have participated in these innovative courses achieved an average percentile rank of 69 which is 18 units higher than the average rank for 360 of my students in traditional lecture courses.

This paper will briefly explore the hypothesis that lecturing leads students to become more disposed to think in conformist, tradition-bound ways; while the demonstration-exploration-discussionformat and other non-authoritarian ways of teaching, lead students to become more innovative and creative, more likely to dare to think, see and feel for themselves, and to develop a stronger sense of attitudinal well-being.

006 THE VALUE OF NEW TECHNOLOGY IN HELPING STUDENTS CONSTRUCT CHEMICAL UNDERSTANDING. J. S. Krajcik, School of Education, University of Michigan, 610 E. University, Ann Arbor, MI 48109-1259.

A deep understanding of chemical concepts requires students to develop an integrated and differentiated understanding of the concepts. Studies reveal, however, that secondary and first year college chemistry students do not develop deep understanding of basic concepts. Although students learn information, they do not develop a conceptual framework that helps them explain, predict and apply chemical concepts.

The development of new technologies offers promising new tools for helping students develop their understandings. These new tools - including microcomputer-based laboratories, simulations of microworlds, and multimedia-based instructional packages - allow students to perform activities that complement and enhance chemistry learning. These tools help students construct understanding of chemical concepts by allowing them to interact with multiple representations of the phenomena. The uses of these new technology tools in helping students construct chemical concepts along with the research and theory that supports their uses are described.

007 PREDICTING ACADEMIC SUCCESS IN COLLEGE CHEMISTRY. D.M. Bunce, Department of Chemistry, The Catholic University of America, Washington, D.C. 20064

The GALT (Group Assessment of Logical Thinking) Test is a paper and pencil test constructed by Roadrangka, Yeany and Padilla to measure logical reasoning abilities. This test can also be used to predict success in introductory college chemistry courses.

The GALT Test was administered to three different populations of chemistry students including science majors, nursing students and non-science majors. In all populations, there is a significant positive correlation between GALT scores and student achievement. GALT scores are also significantly correlated to students' math and verbal SAT (Scholastic Aptitude Test) scores. Since SAT scores are often difficult for a professor to obtain for large classes, the GALT test offers an alternative means of identifying students who may be at risk during a course with the idea that this information can be used to alert the student and teacher to the need for early intervention.

008 THE IMPORTANCE OF LECTURE IN GENERAL CHEMISTRY COURSE PERFORMANCE. James P. Birk and John Foster, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

We have examined the relationship between the style of lecture during the first semester of general chemistry and performance of students in the second semester. We have also carried out statistical studies on possible correlations between attendance in lecture and performance in exams based on lecture material. Results of these studies will be presented and discussed in terms of the probable influence of lecture on learning in general chemistry.

ChemSource M.V. Orna - Organizer, Presiding

009 CHEMSOURCE: A SUPPORT STRATEGY FOR PRE-SERVICE AND INSERVICE CHEMISTRY TEACHERS. Henry Heikkinen, University of Northern Colorado, Greeley, CO 80639, Mary Virginia Orna, College of New Rochelle, New Rochelle, NY 10805, E.K. Mellon, Florida State University, Tallahassee, FL 32306, Dorothy Gabel, Indiana University, Bloomington, IN 47405, James O. Schreck, University of Northern Colorado, Greeley, CO 80630, Mary Jo Grabner, Utah State University, Logan UT 84322.

ChemSource is an array of linked products designed to provide innovative experiences and effective strategies for preservice and inservice teachers of chemistry that will improve their effectiveness as teachers. It consists of two major parts, SourceBook and SourceView. It is designed to be an integrated resource for teachers which utilizes and anticipates developments in high-technology communication in education. When completed, SourceBook will contain resources in over thirty curricular topics accompanied by general practical methodologies and collected practical information in both hard copy and electronic format interfaced with a comprehensive planning toolkit. SourceView, the second component consists of videotapes providing examples of specific and generic teaching skills for a variety of classroom settings. This symposium session will introduce some of the major aspects of ChemSource, including the content modules, user's guide, safety aspects, pedagogical aspects, and dissemination plans. A workshop on SourceView follows this paper, and workshops on the CD-ROM technology aspects of ChemSource will take place on Tuesday and Wednesday afternoons. ChemSource should be ready for distribution by late 1992.

010 CHEMICAL SAFETY IN THE CHEMSOURCE PROGRAM. Edward K. Mellon, Department of Chemistry, Florida State University, Tallahassee, FL 32306; K. O. Berry, Department of Chemistry, University of Puget Sound, 1500 N-Warner, Tacoma, WA 98146-0320; W. H. Breazeale, Department of Chemistry, Francis Marion College, Florence, SC 29501.

The ChemSource Project produces materials for beginning high school chemistry teachers. This paper presents a description of the joint interaction between the ChemSource Project and the High School Safety Subcommittee of the ACS Board/Council Committee on Chemical Safety aimed towards the review of ChemSource documents for proper and timely chemical safety, storage, and waste disposal information and towards the production of safety materials for teachers, administrators, and local emergency response personnel.

ChemSource materials are developed under Grant No. TPE 88-50632 from the National Science Foundation.

011 CHEMSOURCE: NOT JUST FOR THE NOVICE S.L. Gardlund, Macomb Community College, Warren, Michigan 48093

ChemSource was initially targeted at presenting a compendium of chemistry knowledge and skills for the use of the inexperienced high school teacher. This talk will describe how a mixed audience of veteran and novice chemistry educators, junior high through the community college level, found the SourceBook topic modules to be an excellent inservice vehicle. SourceBook topic modules, one portion of the ChemSource package, were used as the basis of ten day-long workshops. The module material examined, performed, or viewed was found to be appropriate to all introductory chemistry classes.

012 IMPROVING CHEMISTRY TEACHING USING THE SOURCEVIEW VIDEOTAPES. Dorothy Gabel, Indiana University, Bloomington, IN 47405 and Mary Virginia Orna, College of New Rochelle, New Rochelle, NY 10805

The SourceView videotapes contain 21 episodes of chemistry teaching by outstanding high school chemistry teachers in their own classrooms. Some episodes deliberately include teaching behaviors of inexperienced teachers, whereas in other episodes, teaching and learning is presented as it occurs naturally. This workshop will use two episodes from the series as catalysts for initiating discussion among participants on effective chemistry teaching. After viewing each episode in its entirety and discussing major strengths and weaknesses, participants will focus on specific teaching behaviors by viewing smaller segments of the episodes. They will use skill coding sheets to identify those practices that promote or hinder conceptual understanding as shown in the video and discuss these in small groups. Additional information about the entire 21 episodes will be provided.

013 NEW ROUTES TO REFRACTORY MATERIALS AND CONDUCTING POLYMERS AS GAS SEPARATION MEMBRANES. Richard B. Kaner, Department of Chemistry & Biochemistry University of California, Los Angeles, CA 90024-1569.

(1) New routes to refractory materials by metathesis (exchange) reactions in mixtures of solid precursors have been found.The desired material is easily separated from a salt by-product. Molybdenum sulfide is synthesized in seconds in the reaction of molybdenum pentachloride and sodium sulfide. Zirconium nitride (m. pt. ~3000 °C) is produced from zirconium tetrachloride and lithium nitride. (2) Gas separaions based on polymer membranes whose pore sizes can be controlled are becoming important energy efficient alternatives to cryogenic separations of such gas pairs as H_2/N_2, O_2/N_2, and CO_2/CH_4.

014 DEPOSITION OF THIN FILMS OF TRANSITION METALS AND THEIR GROUP 13 ALLOYS FROM ORGANOMETALLIC PRECURSORS. Herbert D. Kaesz, Department of Chemistry & Biochemistry University of California, Los Angeles, CA 90024-1569.

High purity films of Pt, Ir, Rh, Ni, Re and W have been grown by organometallic chemical vapor deposition (OMCVD) in the presence of H_2. Intermetallic compounds such as $PtGa_2$, PtGa and CoGa are needed as thermodynamically stable and lattice-matched conductors for electronic devices based on the III/V seminconductors (GaAs for example). Such films have been grown by OMCVD comparing depositions from single-source precursors with those obtained by mixing streams of separate organometallic precursors.

015 Nucleation Here, There, and Everywhere: Observing and Controlling the Nucleation and Growth of Aluminum Films. Wayne L. Gladfelter, Department of Chemistry, University of Minnesota, Minneapolis, MN 55455

A summary of the importance of nucleation phenomena to the chemical vapor deposition of aluminum will be described. Avoiding nucleation altogether can be accomplished by growing Al films on metallic substrates. Optimization of this process allows the CVD of Al films selectively on metals in the presence of nonmetallic surfaces. If deposition on nonmetallic substrates such as oxides, polymers, or semiconductors is desired, pretreatment of the surface with $TiCl_4$ is necessary. Evidence supporting the mechanism of action of $TiCl_4$ is will be presented. Finally, nucleation in the gas phase can lead to the growth of large (usually unwanted) particles of aluminum. Particle formation during the manufacture of microelectronic devices is recognized as a serious problem. Methods of observing and characterizing particles entrained in the gas stream of a CVD reactor will be described.

016 SOL-GEL ROUTES TO NEW INORGANIC MATERIALS. John D. Mackenzie, Department of Materials Science and Engineering, University of California, Los Angeles, CA 90024-1595

Traditionally, inorganic engineering materials such as ceramics and glasses are made by high-temperature reactions and fabrication using powders as the starting materials. Recently, there has been increasing emphasis on using low temperature liquid solution techniques, the so-called "Sol-Gel" method. For example, mixtures of metal alkoxides can be dissolved in alcoholic solutions and caused to form porous gels. These gels are then densified to give crystalline ceramics or glasses. The porous gels themselves are used as ultrafilters. Organic dyes and polymers can be added to the solutions either to form mixtures or chemically reacted compounds. These are known as "ORMOCERS" (organically modified ceramics) and they have unique properties. Oxide gels have also been utilized as the matrix for ultrafine particles (less than 100 Å) of metals and semiconductors to give new nonlinear optical solids. The sol-gel process and examples of such materials will be presented.

Technology Education: Pathways to Chemical Technician Training K. M. Chapman - Organizer, Presiding

017 STATE OF THE ART OR STATE OF THE EDICT? ACADEMIC COURSES VERSUS THE BUSINESS OF QUANTITATIVE CHEMICAL ANALYSIS. Leverett R. Smith, Department of Chemistry, Diablo Valley College, 321 Golf Club Road, Pleasant Hill, CA 94523.

Academic analytical chemistry and commercial chemical analysis labs can be thought of as occupying parallel universes, in which each frequently ignores the other. Although there are many techniques in common, there are major differences in priorities. Academic analytical chemists typically value originality and extensions of techniques over the routine generation of data. Commercial laboratories, in contrast, are tightly regulated, and certifying agencies demand standardized methodology and reporting. Traditional quantitative analysis courses generally provide appropriate technical training for entry level positions in commercial laboratories, such as environmental labs. However, quant courses could be improved by including selected information about the special requirements of chemical analyses which many analytical chemists must routinely perform to meet government regulations. This paper will discuss the regulatory context, sources of methods, quality control requirements, and pressures encountered by chemists working in a commercial laboratory, analyzing water, soil, and hazardous wastes.

018 TECHNICIAN REFLECTIONS ON RELATIONSHIPS BETWEEN ACADEMIC COURSES AND THEIR WORK, Kenneth M. Chapman, Education Division, American Chemical Society, Washington, DC 20036

Chemical Technicians have heterogeneous educational backgrounds, from B.S. degrees in chemistry to high school graduates with little formal training in chemistry. Their assignments vary from doing repetitive procedures offering little opportunity for innovation to requiring invention. National policymakers are emphasizing the need to reorganize the work place and the work force, if the United States is to maintain strong competitiveness in the world economy. This report presents views technicians have of the value of past academic experiences, with a view toward educational changes they may advise for future technicians.

019 TRAINING UNEMPLOYED TO BE CHEMICAL TECHNICIANS. E. PETER BENZING, Miles, Inc., PITTSBURGH, PA & THEODORE G. TOWNS, PPG Industries, Inc., Pittsburgh, PA

The Bidwell Training Center, Inc. in Pittsburgh, PA trains unemployed and places them in jobs in the local economy. Its programs are market driven. It works closely with employers in establishing training curricula specific to employer needs and only where employment opportunities exist at the time. Occupations have included pharmacy assistants, hospital workers, culinary specialists, cable TV technicians and computer repair technicians.

In 1991 nine Pittsburgh chemical companies joined Bidwell to create a one year training program for entry level chemical technicians. The program includes instruction in mathematics, chemistry, laboratory work and a one month internship for each participant at one of the companies. The current Program Director/ Instructor is on loan from one of the companies. Approximately 20 formerly unemployed of diverse age, economic and racial background will graduate from the program in May 1992 and are expected to find jobs at one of the chemical companies. This paper reports on the curriculum, problems experienced and solved and future plans.

020 Chemical Technology at CCRI; curricula approaches designed to reflect the demands of a diverse population entering ChemTec programs. H. G. Hajian, Department of Chemistry, Community College of RI, 400 East Avenue, Warwick, RI 02886.

Over the past decade, the population base that community colleges serve has become highly diverse. The days of freshmen entering directly from high school continues but has been augmented to a great degree by those who are returning for initial or further education and training after being away from formal education in some cases for over 10 years. Socio-economic reasons on the part of this diverse population dictates curricula strategies be developed to meet their needs. At CCRI, the Chemistry Department, in its efforts to deliver its ChemTec Program to this diverse population, has designed a number of pathways. These alternatives will be discussed.

021 CHEMICAL TECHNOLOGY: ALIVE AND WELL! AT LOS ANGELES TRADE-TECHNICAL COLLEGE. T. Payne, Science and Mathematics Department, Los Angeles Trade-Technical College, Los Angeles, CA 90015.

A full Chemical Technology Program has been offered at Los Angeles Trade-Technical College since Spring, 1968, but not without difficulty. Strategies for keeping the program viable are discussed in this talk. Solutions to problems such as recruiting Asian, Latino, and African-American students into a highly technical program, attracting White students to a Chemical Technology Program located at an inner city college, maintaining a high rate of retention, motivating all students to succeed in the program and developing a dedicated ChemTec Alumni Association are discussed. Strategies for overcoming the difficulties of obtaining and maintaining instruments necessary to teach chemical technology effectively during budget crisis years are also discussed. Finally, the ease of placing chemical technician graduates during periods of severe recession is discussed.

022 CHEM TECH IN A ROLLER COASTER ECONOMY. W. J. Wasserman, Science Division, Seattle Central Community College, Seattle, WA 98122.

Chemical Technicians will be required to show their adaptivity in current and likely future employment patterns. Training programs should diversify to bring in elements of biotechnology, environmental science, material science, etc. Continuing education schemes should be devised to teach both employed, unemployed, and underemployed technicians about developing new techniques and technologies. Distance learning methods should be created to facilitate delivery into company laboratories or meeting rooms.

023 A BACCALAUREATE DEGREE IN CHEMICAL TECHNOLOGY - A NEW PROGRAM. John C. Spille and Fritz J. Kryman, Department of Chemical Technology, College of Applied Science, University of Cincinnati, 2220 Victory Parkway, Cincinnati, Ohio 45206-2822.

With increasing industrial competition, a competitive workforce is vital. To meet this challenge numerous task force reports have recommended major curriculum revision in chemical education. Traditional baccalaureate chemistry programs prepare students for graduate school; consequently fewer of them are available for industrial laboratory research and development. Traditional programs also concentrate less on analytical chemistry skills while industry need for these skills is evident. Responding to national needs for qualified laboratory staff, a new educational program is proposed, a Baccalaureate degree in Chemical Technology.

Two themes will be evident. (1) The program will emulate European models and be laboratory-driven since chemistry is a laboratory science. The laboratory will be developed as a central academic experience and supported with theoretical and practical information. (2) A second theme will be chemical analysis which recognizes the heart of chemistry-based technology as accurate analysis, collection and presentation of data, and effective communication of results. This paper will explore the details of program rationale and its curriculum.

024 PARTNERSHIP FOR ENVIRONMENTAL TECHNOLOGY EDUCATION. Paul R. Dickinson, Lawrence Livermore Laboratory, Livermore, CA 94550.

The need for broad cooperative effort directed toward the enhancement of science and mathematics education, including environmental science and technology has been recognized as a national priority by government, industry, and the academic community alike. In an effort to address the need, the Partnership for Environmental Technology Education (PETE) has been established in the five western states of Arizona, California, Hawaii, Nevada and Utah. PETE'S overall objectives are to link the technical resources of the DOE, EPA, and NASA Laboratories, professional societies and private industry with participating community colleges to assist in the development and presentation of curricula for training Environmental-Hazardous Materials Technicians (which includes Allied Health Chemistry) and to encourage more transfer students to pursue studies in environmental science at four-year institutions. The program is cosponsored by DOE and EPA. PETE is being evaluated by its sponsors as a regional pilot with potential for extension nationally.

025 NEW CHEMISTRY CURRICULUM IN INDIA FOR A SMOOTH TRANSITION FROM SECONDARY TO TERTIARY LEVEL - R.D. Shukla, Professor of Chemistry, Department of Education in Science & Mathematics, NCERT, Sri Aurobindo Marg, New Delhi - 110016, INDIA.

The new policy on education introduced only recently stresses the need to improve the quality of Science and Technology Education. Accordingly, Science Education is being strengthened so as to develop in child well defined abilities and values such as spirit of inquiry, creativity, objectivity, courage of questioning, problem solving and decision making; and discover the relationship of science with health, agriculture, industry and other aspects of daily life. Chemistry is an integral part of science teaching at secondary level and major objective at this stage is to prepare students as good knowledgeable citizens. However, at senior secondary level, emphasis is laid on development of basic concepts and to expose the students with inter-disciplinary and applied areas of Chemistry to enable them to cope up with professional and academic courses at tertiary level. The present paper provides an analysis of innovative practices introduced at Senior Secondary level.

026 CITY CHEM: CHEMISTRY IN AN URBAN TECHNICAL COLLEGE. Victor S. Strozak N.Y. City Technical College, Brooklyn, New York 11201.

Computers are playing an increasingly more important role in chemistry education at all levels. New developments in computing provide fantastic opportunities to introduce urban students to real world science by incorporating microcomputers and modern instrumentation into the chemistry laboratory. This talk will discuss the results of a comprehensive, two year, curriculum development project which introduced microcomputer based exercises into General, Organic, and Analytic Chemistry laboratories. The project was supported by a $225,000 grant from the U.S. Dept. of Education through the Minority Science Improvement Program. Sample materials and experiments will be presented. Equipment acquisitions, faculty development, and curriculum revisions will be described. Evaluation data will be presented along with a description of the project's longitudinal study which will continue through 1994.

General Papers : Relevant Chemistry for Non-Science Majors Robert Ono - Presiding

027 ISSUES-DIRECTED CHEMISTRY - TEACHING CHEMICAL FUNDAMENTALS USING THE CLEAN AIR ACT OF 1990

David L. Adams, Chem. Dept. Babson College, Babson Park, MA 02157-0310

Abstract - Chemistry courses for non-science majors must demonstrate the utility and importance of chemistry to the students. One manner of accomplishing this is to place the fundamentals of chemistry in the context of interesting issues - the "issues-directed approach". The Clean Air Act of 1990, an expansive law that is both an environmental and energy bill, provides an issue within which to develop many fundamentals of chemistry. The topics of acid/base chemistry, catalysis, kinetics and equilibrium, and thermochemistry are conveniently discussed within this context. This presentation will discuss the lecture approach used to present this information and the demonstrations and laboratories developed to support the lecture. The issues-directed chemistry course within which the Clean Air Act of 1990 is one of three issues explored, will be briefly described.

028 MAKE SCIENCE RESEARCH PART OF THE SCHEDULE· Carol Magnusson, Sacramento High School, Sacramento, CA 95817, Londa Borer, C.S.U.S, Sacramento, CA 95819.

Provide an opportunity for your students to DO science, not just memorize it. Students can carry out original science research as they study the regular curriculum. Students can question, experiment, collect data, gather and interpret results on science problems they select. Or, the whole class can work c one science problem with everyone contributing information or data using the scientific method. Build critical thinking skills, increase self-confidence and self-esteem of your students. Create interest in science for those students who would not normally take science, and provide an opportunity for accelerated students to excel further than they would in a regular classroom. Solving original science problems is fun and has potential for increasing science student enrollment. We will discuss the research opportunities we have provided the students in chemistry at Sacramento High School this past academic year.

029 TEACHING CHEMISTRY TO THE NON-SCIENTISTS: A MODULAR APPROACH. M.A. Scharberg, L.A. Kelley, Department of Chemistry, San Jose State University, San Jose, California, 95192-0101.

A system of fifteen unit modules is used successfully to teach chemistry to the the non-scientists at San Jose State University. This modular system furnishes the qualitative fundamentals in chemistry as applied to chemistry found in everyday life. The goals of this course are not only to improve chemical literacy among the non-scientists, but to provide a foundation in chemistry for those who decide to pursue science degrees. Each unit consists of a list of objectives, a glossary, discussion followed immediately by drills, and a practice exam. Two weekly one-hour lectures and one weekly three-hour laboratory compliment the modules. At the beginning of each laboratory, a 30-minute exam is given to assess students' progress for the previous week's module. Also, a student has an opportunity to retest an unit at a later date if he/she scores below 80%. The curriculum for this course is being updated to further enhance teaching strategies in chemistry for the non-scientists.

030 PROJECT TIME IN THE OLD CHEM LAB. Edna M. Donar, Science Dept., Columbine High School, Littleton, Colorado 80123

Using groups of three or four students, I assigned a topic to each group (making every effort to assign students to topics in which they had expressed interest). Some class time was used for preparation and each class member was required to go to the LMC at least once to get personalized instruction in how to find information on a technical subject. This had been arranged in advance with the LMC Director and I never sent more than six students at any one time. Also, the students had access to my own reference materials in our classroom. Each group was responsible for preparing a presentation for the class and was allotted three class periods for that presentation. They could use lecture, demonstration, lab(s), speakers, or whatever their choice was and they were required to administer some type of evaluation for the lesson (quiz, lab report, etc.) This turned out to be very effective.

031 COLLEGE "INTRODUCTION TO CHEMISTRY" COURSE WITH AN ARMCHAIR LABORATORY.
Lowell W. Shank, Department of Chemistry, Western Kentucky University, Bowling Green, KY 42101

Glenn Crosby states, "Chemical educators have forgotten the non major" and "that we cleverly avoid mentioning anything relevant in our beginning chemistry courses because it's too damned interesting." He further states "that laboratories are uninteresting because there's not enough emphasis on colors, explosions and smells."

Western Kentucky University has a three hour "Introduction to Chemistry" course which is taken by non-science majors in order to meet a university science requirement. A laboratory is not required except for education majors. Joesten's "World of Chemistry" textbook is used, and we have added an armchair laboratory component in the classroom setting in an attempt to address Crosby's concerns.

The presentation will describe the mechanics involved in starting this program and teaching classes of up to 84 students each. The students do seven experiments with each lasting no more than 40 minutes and emphasizing synthesis, reactions, colors, smells and observations. Students make glue, soap, silly putty and slime at their lecture room seats using microscale techniques. They also perform chromatography and simple chemical reactions involving mostly household chemicals. A course syllabus will be available.

032 ENVIRONMENTAL CHEMISTRY FOR NONSCIENCE MAJORS.
Dr. Darrell Watson, Chemistry Department, University of Mary Hardin-Baylor, P.O. Box 8013 UMBH Station, Belton, TX 76513

An environmental chemistry course was developed by the faculty of the Chemistry Department of the University of Mary Hardin-Baylor to serve as the second course in a two semester laboratory science sequence for nonscience majors. Unlike other environmental science courses for non-science majors, the emphasis is placed on chemistry involved in environmental issues. This is possible because students enrolling in the course are required to have a prerequisite of at least one chemistry course before enrolling. Some of the topics covered in this course include: air pollution and atmospheric chemistry, water pollution, water treatment and clean up, incineration, land fills, hazardous waste management, governmental regulations, and environmental analysis techniques and limitations. A laboratory portion of the course includes various laboratory investigations, demonstrations and field-trips. Details of program will be discussed.

033 CHEMISTRY AFFECTS OUR LIVES.
R.D.Place, Department of Chemistry, Otterbein College, Westerville, Ohio 43081.

I teach this course to 150 college juniors and seniors. It is one option fulfilling a graduation science requirement at Otterbein. It is a popular course, written up in Columbus Monthly and Ohio magazines. I will share how I try to motivate, manage and evaluate a large class efficiently while personalizing it (photographs to learn names in one week, small groups to fight "bigness", full-class discussions, participatory outside assignments). I use Hill's text, Chemistry for Changing Times. The term divides into three sequenced segments: Entropy (pollution, standard of living, resources, population, greenhouse and ozone depletion); Basic Chemical Concepts; Relevant Chemistry (food, energy, drugs, sports, cosmetics and biochemistry). Class sessions are broken into 10-15 minute times addressing different student learning styles: films, lectures, demonstrations, discussions, help sessions and course clarification. Grades are carefully weighted to challenge and motivate. Homework, popular reading, attendance and projects count, but comprehensive testing counts most.

034

ENHANCED LEARNING IN GENERAL EDUCATIONCHEMISTRY WITH INTERACTIVE COMPUTER-SIMULATED EXPERIMENTS. C. M. Russell, Department of Chemistry, College of DUPAGE, Glen Ellyn, IL 60137 and J. W. Russell, Department of Chemistry, Oakland University, Rochester, MI 48309.

Four of nine experiments in a one quarter community college Introductory Chemistry course were developed using simulations from the Smith and Jones "Exploring Chemistry" series. Students completed similar laboratory reports for all experiments. Most students did not have any prior chemistry experience and expressed high levels of anxiety for the laboratory and lecture. The same instructor taught the lecture and laboratory for five sections and used the simulations in three sections. Students in these three sections showed enhance mastery of course material as tested by the normal examinations. In addition, their laboratory anxiety was overcome more rapidly than those in the control sections. Most students were observed to form groups of either three or four for the simulated experiments. The improvement on exams by the computer groups was confounded by the carry-over to study groups which formed during the computer labs.

035 A ROLE-PLAYING EXERCISE USING A COMPUTER SIMULATION David M. Whisnant, Wofford College, Spartanburg, SC 29303-3663

In a recent report of the Project on Liberal Education and the Sciences, one of the recommendations was that "the ethical, social, economic, and political dimensions of science" be included in science courses. One possible way of doing this is by the use of role-playing exercises. For the past two years I have made a computer simulation, BCTC, the basis for such an exercise. The students first gather and analyze "experimental" data from the environmental simulation, which is modeled after the dioxin controversy. They then assume roles appropriate to one of four groups -- environmentalists, corporate officials, townspeople, or members of the news media -- and participate in a "news conference" during one class period. I will describe the simulation and the details involved in working with a role-playing exercise. I also will describe the advantages of using Windows 3.0 authoring tools, such as Microsoft Visual Basic, in which this simulation has been rewritten.

036 TESTING BY OBJECTIVES IN A LIBERAL ARTS CHEMISTRY COURSE. Marcia F. Bailey and Robert E. Kohrman, Department of Chemistry, Central Michigan University, Mt. Pleasant, MI 48859

A testbank, objectives and worksheets have been developed for Chapters 1-14, 17-18 of the World of Chemistry Text by Joesten, et.al, 1991 edition. These objectives are designed for a one semester Liberal Arts Chemistry course. The test questions correlate directly with the objectives so that test item analysis can reveal areas needing improved instruction and/or test item modification. This student-centered course design also included 14 individualized writing assignments based on 14 text chapters, timely use of 16 of the World of Chemistry video programs, plus extensive in-class discussion and demonstrations. Details of the above tests, objectives and worksheets as well as student response and performance in this 1990-92 course will be presented.

General Papers: New Experiments J. Hill - Presiding

037 AN ENVIRONMENTAL RADIOACTIVITY LAB, Robert F. Stout, Science Department, Bucks County Community College, Newtown, PA 18940

Radioactivity sometimes gets shifted to the "back burner" in college freshman chemistry, but should now be coming into its own. Irradiation of food, trouble with nuclear reactors, radioactive waste, and nuclear medicine all point the way for the modern chemistry student. This lab concerns itself with background radiation, shielding and radioactivity in our atmosphere as well as the difference among the types of radioactivity.

038 THE USE OF ACCURATE SOLUBILITY MEASUREMENTS, ACTIVITY COEFFICIENTS, AND THE ION ASSOCIATION MODEL TO TEST THE CALCULATION OF K_{sp} AT HIGH IONIC STRENGTHS IN THE PHYSICAL CHEMISTRY LABORATORY. Alan Ewart and Kenneth E. Hyde, Chemistry Department, SUNY Oswego, Oswego, NY 13126

It is difficult to find experiments for the physical chemistry laboratory that use activity coefficients to rationalize the behavior of ions in aqueous solutions. The experiments that do measure activity coefficients are usually conductivity measurements or E.M.F. measurements on fairly dilute solutions (<0.1 M).

This talk will describe the determination of accurate solubility measurements by a novel technique involving titration by weight. The solubilities are measured up to an ionic strength of 1 M. The data will be analyzed using the extended Debye-Huckel equation and the semi-empirical equation of Davies for the calculation of activity coefficients. An ion-association equilibrium constant will be used in conjunction with the activity coefficients to test the consistency of the measured solubility product constant over a range of ionic strengths.

039 THE USE OF SUCCESSIVE APPROXIMATION FOR REFINEMENT IN THE DETERMINATION OF THE EQUILIBRIUM CONSTANT OF THE FERRIC THIOCYANATE ION. Alfred J. [illegible] Department of Chemistry, University of Kansas, Lawrence Kansas 66045

The spectrophotometric determination of the equilibrium constant of formation, K_f, of $FeSCN^{+2}$ is a familiar experiment in the General Chemistry Laboratory. However, assumptions made about the concentrations of some of the species involved often lead to values for K that are not consistent, nor close to literature values.

Initially, using a large concentration of ferric ion and a small concentration of thiocyanate ion, it is assumed that all of the cyanate is reacted to form the complex ion. Using increasingly dilute solutions of ferric ion, the concentrations of the complex and other species are calculated, and values of K at each concentration are determined.

To improve the results, the average of the values of K is used to determine an improved initial concentration of the complex, and the calculations are repeated. Using successively refined values of K narrows the resulting range of values and gives equilibrium constant values in good agreement with literature.

A computer program involved in the calculations will be discussed, student experimental results, and class results over a number of semesters, will be shown.

040 CONSTRUCTION AND TESTING OF A VARIABLE-TEMPERATURE CHLORIDE CONCENTRATION CELL.

Kenneth E. Hyde, Department of Chemistry, State University of New York, College at Oswego, Oswego, New York 13126

A concentration cell consisting of two concentric threaded-glass vessels and two silver/silver chloride electrodes was constructed and used in the temperature range 0 to 100 C. A spreadsheet template was developed to simplify the calculations associated with the dilutions that occur in the test compartment as a potentiometric titration progresses. The cell and associated spreadsheet template provide a convenient means of verifying proper cell operation at different temperatures. Results on these Nernst titrations at 25, 50 and 100 C are reported. Standard spreadsheet functions perform the linear regression and display plots of the logarithm of the amount of titrant added versus the cell potential. The plots produced straight lines with slopes approximating the theoretical Nernstian values expected at that temperature.

041 **INEXPENSIVE LABORATORY EXPERIMENTS IN FRONTIER AREAS OF CHEMICAL RESEARCH**

Iswar Das, Anal Pushkarna, Namita Agrawal, Sudha Chand, Archana Sharma, Kiran Jaiswal and Pushpa Singh, Department of Chemistry, University of Gorakhpur, Gorakhpur, India - 273009

Inexpensive and novel experimental techniques have been developed to study dynamical properties of heterogeneous systems in flow reactors. Experimental results on crystal growth on thin films of water soluble and insoluble substances in gel media have also been reported.

042 ANALYSIS OF A BINARY MIXTURE OF WHITE INORGANIC COMPOUNDS.

Alfred J. Lata. Department of Chemistry, University of Kansas, Lawrence Kansas 66045

To help illustrate chemical logic, an introductory General Chemistry experiment involving chemical and physical properties of six white inorganic compounds, and subsequent analysis of a binary mixture of these compounds using the observed properties, has been developed.

Small amounts of six white compounds are tested individually for solubility in water. In each case the resulting solution, or solid and supernatant, is tested with Universal Indicator, reacted with Nitric Acid, and then, after division into two parts, with Silver nitrate solution and Barium nitrate solution. The student is then given one of a set of several binary mixtures of these compounds. Using the procedures above, the student proceeds to test the mixture, and from the properties observed identifies the components of the mixture.

Student observations, difficulties, and results based on several years use of this experiment will be discussed.

043 ILLUSTRATING THE PHOTOCATALYST TiO_2 USING SOLAR ENERGY: AN OUTDOOR FRESHMAN CHEMISTRY EXPERIMENT.

Ben Hutchinson, Shelley Fennekohl, Kim Giglio, and David B. Green, Natural Science Division, Pepperdine University, Malibu, CA 90263

Titanium dioxide, the pigment used in white paint, is a semi-conductor that furnishes electrons in aqueous solution when activated by ultraviolet radiation(<350nm). Upon activation, a slurry (0.1%) of anatase TiO_2(Degussa Chemical) has been shown to form OH radicals which decompose a variety of organic molecules to carbon dioxide and water. A freshman level experiment will be described which illustrates the action of TiO_2 by following the decomposition of malachite green with visible spectroscopy and formation of carbon dioxide using $BaCO_3$ analysis. Solar radiation is used to supply the energy needed by the photocatalyst.

044 STEREOCHEMISTRY OF THE CYCLOPENTADIENE-CINNAMIC ACID CYCLOADDITION.

Lawrence McGahey, Department of Chemistry, College of St Scholastica, Duluth, MN 55811-4199.

This typical Diels-Alder cycloaddition can be effected at room temperature by reaction of cinnamoyl chloride and cyclopentadiene, or by heating cinnamic acid and dicyclopentadiene in an appropriate solvent. After hydrolysis of the adduct acyl chloride and removal of any neutral materials, the crude product mixture is analyzed directly by proton NMR. Iodolactonization of the *endo* acid followed by NMR analysis of the recovered *exo* isomer permits complete assignment of the vinylic resonance bands in the original product mixture. The experiment can be presented to students at several levels of complexity: as an example of a reaction run at room temperature to provide mostly the kinetic adduct; as a study of kinetic versus thermodynamic control when two reaction temperatures are used; or as a mini-research project in which all the relevant spectra must be obtained and the products identified by the student. The talk will address the experimental details, spectral analysis, and the adaptation of the original literature work to a small-scale classroom exercise.

045 PREPARATION, PROPERTIES, AND ANALYSIS OF THE 1-2-3 $YBa_2Cu_3O_{7-X}$ SUPERCONDUCTOR IN FRESHMAN CHEMISTRY LABORATORY.

David B. Green; Ben Hutchinson, Natural Science Division, Pepperdine University, Malibu, California 90263.

The relatively small cost, ease of preparation, and novelty of demonstration of the $YBa_2Cu_3O_{7-x}$ high-temperature superconductor has allowed our Honors Freshman General Chemistry students to participate in this exciting scientific advance. In a five-week laboratory module, students prepare the 1-2-3 superconductor as well as determine its critical temperature and measure the percentage copper and barium. This laboratory module brings to the freshman level aspects of ceramics, cryogenic liquid handlin and temperature measurements, and precision chemical analysis. The pedagogy used and results obtained by students over two years will be presented.

046 EASY SPECTRAL DEMONSTRATIONS. Gerald R. Franzen, Department of Chemistry Thomas More College, Crestview Hills, KY 41017

The Milton Roy Educational Absorption Spectral Kit employs a glass transmission grating which is used with an overhead projector to display the spectrum of visible light. With the use of a petri dish placed over a portion of the slit (a rectangular opening in a mask on the stage of the projector), the absorption of a portion of the visible spectrum by a colored solution can be easily demonstrated. Household products, acid/base indicators and solutions of fluorescent materials can be demonstrated. Solid samples can also be used.

Lecture and Learning: Are They Compatible? (cont) D. Bunce - Presiding

047 THE SOCIAL CONSTRUCTION OF SCIENCE UNDERSTANDING. A. B. Champagne, Department of Chemistry and School of Education, University at Albany, State University of New York, Albany, New York 12222.

A study conducted by the Committee on Assessment at Harvard University revealed that successful science students are more likely to study science in groups than alone. Furthermore, the tendency is for male students to study in groups while female students study alone. This observation is consistent with research conducted by social scientists demonstrating the role of discourse in the development of scientific knowledge and in learning science. Scientists and students alike seek to understand how new information relates to existing knowledge. Scientists propose new theories when existing theories fail to accommodate new data. Educators assume that students will modify their personal theories of the natural world when challenged by scientific explanations. Experienced educators know that passive listening or reading does not challenge existing ideas sufficiently to bring about the desired change. While much is still not understood about the conditions that trigger students or scientists modify or refine their conceptions, social discourse seems to be powerful factor. Through discussions of scientific observations and possible explanations for the observations, students examine their personal theories in light of explanations proposed by their peers and those presented in lectures and text. In the course of examining alternative explanations for scientific phenomena, individual's explanations are open to elaboration and refinement making group problem solving and discussion powerful educational partners with conventional lecture and laboratory.

048 USE OF THE PARTICULATE NATURE OF MATTER IN DEVELOPING CONCEPTUAL UNDERSTANDING D.L. GABEL, Science Education, Indiana University, Bloomington, Indiana 47405.

Chemistry can be taught on a variety of levels. Johnstone describes these as sensory, atomic/molecular, and symbolic. All too frequently teachers emphasize and spend considerably more time in presenting chemistry using symbols rather than integrating all three approaches in their teaching. Yet research has shown the students compartmentalize their learning and fail to see the relationships between chemical phenomena and its atomic and symbolic representations. This results in memorizing rather than in understanding, and in solving problems by rote instead of in a reasoning manner. A study in which teachers increased their emphasis on the particulate nature of matter by using transparencies and hands-on activities with models which resulted in a greater understanding of all three levels of chemistry will be described. The instruments used as well as a new instrument that has been developed to measure students' understanding of the sensory, atomic/molecular, and symbolic levels will be presented.

049 MOTIVATION (OR LACK OF) IN STUDENTS: IS IT OUR FAULT?! Randy J. Ward and George M. Bodner, Department of Chemistry, Purdue University, West Lafayette, IN.

A problem that has become increasingly more apparent is the declining numbers of students enrolling in chemistry classes. Furthermore the students who enroll in these classes seem to show less aptitude for the material, and their motivation to do well seems nonexistent at times. Does this all too familiar problem have its roots in our own actions? Research would suggest that, in fact, it does. The educational system itself has created a situation which encourages students to be less interested in subjects and material, and more interested in grades and performance. Is this trend too late to stop? No, there are several steps that can be taken to help encourage your students in a direction that reverses this trend. This paper will discuss aspects of motivation research that will attempt to explain this problem and will propose several opuons for reversing this trend in your classroom.

Industry-Education Initiatives (sponsored by 2YC3) L. Zarzana, D. White - Orgainzers, Presiding

050

HANDS-ON, MINDS-ON ELEMENTARY SCIENCE: DOW'S COMMITMENT

For the past four years, The Dow Chemical Company and The Dow Chemical Company Foundation have been working in partnership with the National Science Resources Center to reform the teaching of science at the elementary school level. Although Dow has supported innovative teaching at the secondary and university level for a long time, the company has recently realized that those were ineffective without a major thrust to help teachers and administrators interest much younger students in science.

This talk will include an explanation of the work of the National Science Resources Center, (a joint venture of the National Academy of Sciences and the Smithsonian Institution), the critical elements of an effective elementary science program and the specifics of Dow's plan to catalyze reform in elementary science instruction. Handouts will be available to persons interested in replicating these efforts.

051 PARTNERS FOR TERRIFIC SCIENCE A. M. Sarquis, Dept. of Chemistry, Miami University, 4200 E. University Blvd., Middletown, OH 45042

The *Partners for Terrific Science* is an academic/industrial partnership that actively works to advance science and technology in our schools. Started in 1988, *Partners* originated in Southwest Ohio and has grown throughout the region having directly reached over 285 precollege teachers and 25,000 students. Over 20 industries and professional societies are actively involved in the partnership whose goal is to convey the importance of science and technology to our industrial society. Numerous resource materials including hands-on activities and demonstrations that relate industrial science and technology to school settings were developed in the program. A brief overview of the program will also be given. Several of these and the general operations of the partnership and its numerous programming opportunities will be discussed.

052 **TEACHING THE TEACHERS ENVIRONMENTAL SCIENCE** J. A. Kleinshmidt, Hach Company, P. O. Box 389, Loveland, CO 80539-0389

Working with state and local school systems, Hach company is helping to "teach the teachers" about water and soil analysis. Hach Company is working with educators to take the mystery out of teaching these subjects. Among areas to be covered at the presentation will be slides of the Hach Training Centers that provide free, hands-on seminars for teachers in basic water and soil analysis. Additional material will cover pilot laboratory projects that are currently being developed in various states.

053 YOU SCRATCH MY BACK ... Karen A. Henderson, Physical Sciences Division, Scarborough College, University of Toronto, 1265 Military Trail, Scarborough, Ontario, Canada M1C 1A4

When 'real money' is hard to come by, educators do without desirable but costly professional development and training. And Industries put research projects on back burners. This paper presents the 'barter' alternative. A study leave proposal has a chemical educator spend six months doing methods development research for a large analytical instrument company. The result is beneficial to both parties and establishes a valuable link with Industry for the teacher. This paper will discuss the project from the initial approach to Varian, through the research projects to the invaluable material gleaned which led to the development of new, exciting experiments for my undergraduate analytical chemistry course.

054 **PARTNERSHIP BETWEEN BUSINESS AND EDUCATION** Daniel B. Clutter, Perkin Elmer Corp., 2305 Bering Dr., San Jose, CA 95131

Historically companies have provided funding and/or equipment for various education pursuits, such as, research projects, scholarships, teaching labs, etc. This type of monetary support for education is critical but it should not define the boundary between business and education. business and education share common goals: continuous improvement and continuous innovation. It is not enough to just refine our current skills, we must continually look for new techniques and technologies to carry us into the future. Education has an obligation to prepare students for the future and business has an obligation to be involved in planning the future of education. working together we can make a difference by fostering educational innovation.

055 Project FLASK and Chem Camp - Two Industry/Education Initiatives in Central Pennsylvania Robert D. Minard and Michael R. Bogdan, Penn State University, University Park, PA 16802 & Bioanalytical Systems Inc., State College, PA 16801

Last year, the Central Pennsylvania Section of the ACS initiated the formation of a coalition of 6 local industries and Penn State faculty to create Project *FLASK* (Fun & Learning Activities in Science for Kids). Each industrial or academic participant created a *FLASK* unit that allowed hands-on activities in 3rd to 6th grade classes. The activities included: 1.) Liquid Nitrogen; 2.) Polymers and Slime; 3.) Size Separation and Filtration; 4.) Acids/Bases & pH; 5.) CO_2 in Breath, Rocks and Dry Ice; 6.)Light-emitting Reactions; 7.) Food Science; and 8.) "Kool-Aide" Chromatography. The classroom activities were so successful that it was decided to put them all together for *ChemCamp*, a 5 morning or afternoon commuter camp in which 3 groups of 33 students participated. Area elementary teachers also were involved. The activities were also used for a hands-on Science Trail at a local mall. Hundreds of young people went through this trail as part of the local section's National Chemistry Week activities.

056 THE NATIONAL PLASTICS CENTER AND MUSEUM: A LOCAL RESOURCE, A NATONAL RESOURCE. V.R. Wilcox, Executive Director, National Plastics Center and Museum, Leominster, MA, 01453.

The mission of the National Plastics Center and Museum is to preserve the past, address the present, and promote the future of plastics through public awareness and education. Based in Leominster, MA, the birthplace of the plastics industry in the United States, the National Plastics Center and Museum opened its doors in June, 1992. Dynamic, interactive exhibits and program are planned, as well as a hands-on "discovery corner." Even before the Museum opened, a National Outreach Program was initiated with the production of the very successful video, "Passing Through." This paper will describe the local and national polymer and plastic education programs, both present and future. Opinions and suggestions will be solicited from the educators present.

Biochemistry and Biotechnology B. Sawrey, T. Horn - Organizers, B Sawrey - Presiding

057 STACKING THE DECK FOR BIOCHEMISTRY. Timothy L. Schaap, Elk Grove High School, Elk Grove, IL 60007.

The North Suburban Shared Technology Consortium, a group encompassing 8 high school districts and approximately 25 high schools in the northwest and northwest suburban area of Chicago, has undertaken a project to take the concepts of Biotechnology and pull together video, audio, printed material and experiments via hypercard stacks.

Hypercard is an excellent tool to coordinate various media platforms such as video disk, MacIntosh Computer, CD Ram, etc. By coordinating these instructional modes with commercially-produced laboratory kits, teachers with minimum background can institute biochemistry and biotechnology units.

058 BIOTECHNOLOGY WORKSHOP FOR SCIENCE TEACHERS, Donald W. Pettigrew, Raza Khan and Edward A. Funkhouser, Department of Biochemistry & Biophysics, Texas A&m University, College Station, Texas, 77843-2128.

The Biotechnology Workshop For Science Teachers is a hands-on, in-service training program in recombinant DNA concepts and methodology for secondary science teachers. The program has been presented at the College Station campus and at the Texas A&M University Research and Extension Centers at Weslaco, Overton, Beaumont, Dallas and San Angelo. Seventy-one secondary teachers and sixty-six Center personnel have participated in workshops to date. The twenty-four hour workshop is conducted in a two consecutive Friday evening-Saturday format. There is no charge to participants, and the teachers receive Advanced Academic Training credit. The workshop consists of an introduction, practice with laboratory equipment, plasmid DNA miniprep, restriction enzyme digestion, agarose gel electrophoresis, preparation and transformation of competent bacterial cells, and plating on selective media to establish phenotypes, followed by discussion of the results, inexpensive means to introduce the experiments into classroom, and bioethics. Questionnaires will be used to determine the actual use of the materials that were developed.

059 YES! THERE IS PROTEIN IN SCHOOL MILK: HOW THE BIO-RAD PROTEIN ASSAY IS USED IN A BIOTECHNOLOGY CURRICULUM. Toby Mogollon Horn, Life Sciences and Biotechnology Laboratory, Thomas Jefferson High School for Science and Technology, Alexandria, VA

Proteins are often the products of a biotechnology process. Among the assays used for protein estimation, the Bio-Rad Protein Assay is rapid, sensitive and cost-effective for classroom use. We use this method as a laboratory activity in the Grade 9 course, Introduction to Biotechnology, which is part of our Technology rotation program. Students also learn how to work with microbes and animal and plant cells, in addition to learning important methods for studying proteins. The Bio-Rad Protein Assay needs little in the way of equipment: test tubes, racks, pipettes, pipettors and the Reagent. If a visible wavelength spectrophotometer is available, students can utilize this device, but they can obtain a good estimate of protein content by eye alone. Students hone their technical and mathematical skills and learn to translate scientists' instructions into step-by-step operations. By using consumer products as the assay materials, students learn how the information on the label came to be. Students can use this protein assay as a method to conduct interesting science projects and to learn how basic research becomes a technology. This is an excellent teaching lab for any level student and is a test real scientists use.

060 DENSITOMETRY, THE NEXT STEP IN HIGH SCHOOL ELECTROPHORETIC STUDIES OF DNA AND PROTEIN. Timothy L. Schaap, Elk Grove High School, Elk Grove, IL 60007.

Recent adaptations of science technology have made it feasible for high school students to perform sophisticated experiments on proteins and DNA. Several companies have developed kits dealing with electrophoretic studies. These kits perform "state of the art" separations which allow students to learn quickly that migratory variations in electrophoretic patterns in DNA and protein relate to genetic and physical differences in organisms.

One concept that has been dealt with on a limited basis is that the concentration of DNA or protein in a given migration fragment also relates to genetic and/or physical differences. The concentration and distance of migration fragments can be easily measured by inexpensive densitometers. The concepts of densitometry are no more difficult than those of colorimetry which are commonplace in many high school programs. Electrophoretic gels of grains will be examined along with their densitometric patterns. Teachers will be able to examine graphs produced by a home-made densitometer, as well as low-cost densitometers.

061 FERMENTATION TECHNOLOGY AND OTHER NEGLECTED TOPICS IN BIOTECHNOLOGY. C. Larry Bering, Department of Chemistry, Clarion University, Clarion, PA 16214.

Although biotechnology is as old as man's first attempts at fermenting wine or leavening bread, it has only been in the past several years that advances in molecular genetics have raised biotechnology to the status of a revolution. Bacteria are used as host organisms for the genes from a variety of species because they are amenable to rapid growth on a large scale. Students are often made well aware of the techniques in biotechnology at the microscale or lab bench scale. But in industry, production of a marketable commodity requires fermentation vessels on the order of 4-6000 liters. Chemical engineers, microbiologists and biochemists are all involved in this process. It is important that biochemists understand some of the basic principles of large scale fermentation. Several topics including media preparation, sterilization, aeration and downstream processing will be addressed in this paper.

062 UNDERGRADUATES ISOLATE AND ANALYZE PLANT PIGMENTS AND STEROLS BY GC/MS. Anthony P. Toste, Chemistry Department, Southwest Missouri State University, Springfield, MO 65804.

A project on the bioanalysis of phytolipids, including GC/MS analysis, has been developed and tested for the undergraduate curriculum in an advanced biochemistry lab course. Students begin by disrupting spinach leaves and isolating a phytolipid extract. Silica gel column chromatography of the crude extract, using a suite of solvents and solvent mixtures of increasing polarity, yields 13 fractions, many of which are heavily pigmented. UV/VIS spectrophotometry of the fractions reveals that carotenoids and other accessory photosynthetic pigments elute in the medium polarity fractions, followed by the chlorophylls in the most polar fractions. Analytical thin layer chromatography (TLC) reveals that the phytosterols co-elute with certain carotenoids in several medium polarity fractions, which are then combined to yield the crude sterol fraction. Preparative TLC of this crude fraction, after trimethylsilylation, separates several carotenoid bands, yielding a purified TMS-sterol fraction. Gas chromatography (GC) analysis, followed by GC/mass spectrometry (GC/MS), reveals the presence of β-sitosterol and several other minor components. Recent advances in user friendly, menu-driven data systems on research-grade instruments, makes GC/MS accessible to the undergraduate student. Partial support for this work was provided by the National Science Foundation's ILI Program through Grant USE-9051582.

063 TEACHING BIOCHEMICAL LABORATORY TECHNIQUES USING MULTIMEDIA. G. Wienhausen and B.A. Sawrey, Departments of Biology and Chemistry, UCSD, La Jolla, CA 92093-0303.

Multimedia allows students to access information in a very innovative way because it provides the basis for concept-driven, non-linear learning. It is therefore ideal to teach modern biochemical laboratory techniques because it allows the presentation of the material in a web-like structure. Many different layers of information are linked together and can be accessed based on individual needs, and visual-aids (graphics, animation, video, computer generated images) support the context of individual computer screens.

Courseware designed by the authors for upper-division university students will be explained and demonstrated.

Public Relations: Helping the Media Tell Your Story E.J. Bradford - Organizer, Presider

064 RAIL MISADVENTURES: POLITICAL REACTION AND INDUSTRY RESPONSE. Paul A. Kronenberg, Chemical Industry Council of California, 1121 L Street, Suite 904, Sacramento, California 95814

In the aftermath of Southern Pacific Railroad's back-to-back chemical spills in Dunsmuir and Seacliff, California the entire question of safe transport of hazardous materials received intense public, legislative and industry scrutiny. While the cause of the two derailments has been attributed to mechanical and operational failures, these findings have not lessened the desire to tighten restrictions on hazardous material distribution. Against the backdrop of an industry initiative called Responsible Care, which includes specific codes of management practices for distribution, new regulatory efforts are underway. This talk will outline the events of the two spills, the regulatory and legislative response, and ongoing efforts to improve rail transport of hazardous materials.

065 EXPANDING THE AUDIENCE FOR CHEMISTRY: PUBLIC RELATIONS Edmund J. Bradford, National Chemistry Week, American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036

The newly formed ACS Division of Public Outreach will host three sessions presenting the hows and whys of reaching out to the public and getting media coverage of your efforts. A public relations mini-workshop will set the stage for two carnivals for children on Tuesday and Wednesday. This first session will present effective means of reaching out to local communities through science activities for children and their parents. A special feature of the presentation will be a focus on attracting media attention to these activities. Presenters include ACS staff working in the Division of Public Outreach.

066 WHAT THE NEWS MEDIA NEEDS - A PANEL DISCUSSION Moderator: Edmund J. Bradford, National Chemistry Week, American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036

Public perception of chemistry involves disasters and public danger. Bad news makes good press. Practicing media representatives will hold a panel discussion on what *they* need in order to tell good news about chemistry.

067 THE CHANGING LABORATORY: TEAM WORK AND COMPUTERS. A. Verner, Physical Sciences Division, Scarborough Campus, University of Toronto, 1265 Military Trail, Scarborough, Ontario M1C 1A4 Canada

Integrating a limited number of computers into a large General Chemistry course represents quite a challenge. In the laboratory new experiments have been developed where students are divided into small working groups and within the group each person is designated a task. Therefore only a small number of students at any time during the laboratory require the use of the computers to analyze their data. Through a rotation schedule, each student is given the opportunity to interact with the computers. This approach has been found to have many advantages.

068 A USER DESIGNED LABORATORY FOR WHEEL CHAIR BOUND CHEMISTRY STUDENTS. Wyman Grindstaff, Department of Chemistry, Southwest Missouri State University, Springfield, MO 65804.

Southwest Missouri State University has only an average number of chemistry students in wheel chairs. In past years, they worked with partners most of the time and had the primary responsibilities of observing and recording. Recently we formed a committee of two students in wheel chairs to help design a laboratory table that would fit into our labs and allow future students to do more nearly independent lab work. The design of the tables will be presented and the results reported.

069 COOPERATIVE CHEMISTRY LABORATORIES. Melanie M. Cooper, Department of Chemistry, Clemson University, Clemson, SC 29634.

Most traditional chemistry labs tend to reinforce many students' preconception that science is simply a body of information to be memorized, and that obtaining the "right" answer is the most important aspect of the lab. Attempts to solve this problem, such as the introduction of guided inquiry labs, have met with varying amounts of success. One aspect that has been not[illegible]y lacking from most solutions has been that the support and feedback necessary for less structured, research type laboratories has been absent. We have developed a viable plan for our large enrollment (1,500 students) general chemistry courses, which attempts to overcome the deficiencies in the laboratory experience and supply the structure and support so necessary to students in their early stages of intellectual development.

Our students forgo a semester of twelve, individually performed, traditional one-period exercises, to work in groups on several research oriented projects per semester. Instead of learning a technique as an end in itself, techniques are learned as a means to an end. Over the course of the semester, students apply their problem solving skills to projects approximating the research process as closely as possible. The students also use both their written and oral communication skills to plan, critique, and evaluate their experiments.

070 SEPARATION AND IDENTIFICATION AS A FOCUS FOR THE INTEGRATED LABORATORY COURSE. Kenneth J. Brown, Department of Chemistry, Saint Mary's College, Moraga, CA 94575.

A lecture and laboratory course entitled "Theory and Practice of Separation and Identification" has steadily evolved over the past few years out of the former "Qualitative Organic Analysis". Its emphasis on chromatography and spectroscopy provides a unifying theme for a more up-to-date treatment of key experimental methods that extend across inorganic, biological, as well as organic chemistry. This breadth allows plenty of flexibility in adapting the course to fit the particular needs and interests of the students as well as to mesh with the remaining curriculum in the department.

The current structure of the course, the topics covered, and sources of examples used for in-class discussion will be described. The types of experiments performed, including a few particuarly successful ones, will be discussed in some detail. Other options and possible extensions will also be outlined.

071 INTERPRETING DATA STATISTICALLY--HOW IT MIGHT CHANGE YOUR LABS James T. Streator Department of Chemistry Manchester College North Manchester, IN 46962

For the past three years, we have been systematically incorporating the use of statistics in a five term sequence. These start with the two terms of beginning chemistry, follow into a one term analytical course and continue with two terms of physical chemistry. We have used Quattro as our primary tool in this development. This presentation will describe what we have done, how we changed some of our lab work and what effect we have had on our students.

072 A PROJECT-BASED SOPHOMORE ORGANIC-INORGANIC SYNTHESIS LABORATORY. Homer A. Smith Jr., Department of Chemistry, Millikin University, Decatur, Illinois 62522

Since 1986 the entire chemistry laboratory program at Millikin University has operated on the basis of individual projects with integrated content. A cornerstone of this program is a sophomore-level synthesis lab. This one-credit lab, which operates as a separately-graded course, consists of three advanced projects, one involving preparation of a coordination compound and two involving preparation of organic products via organometallic intermediates. The project method facilitates use of modern methods, for example, inert atmospheres and organolithium reagents. The principal goal of the lab is process, not content: that is to develop skill in the **design** of synthesis reactions and workup, not to cover superficially a maximum number of reaction types. Experience in using journal procedures as models, choosing reagent quantities and reaction conditions, and characterizing products help the student gain the independence needed to pursue synthesis work in undergraduate and graduate research and in industrial work. Support of this program by NSF grants in the CSIP and ILI programs is gratefully acknowledged.

073 LABORATORY PRACTICAL EXAMINATIONS IN QUANTITATIVE ANALYSIS: MEASURING ACCURACY, PRECISION AND SPEED. John E. Frey, Department of Chemistry, Northern Michigan University, Marquette, Michigan 49855.

The achievement of accuracy, precision and speed in a course of quantitative analysis is promoted and evaluated by means of laboratory practical examinations (practicums) and a titration race. The results of student analyses are graded by subscores based on (1) accuracy (absolute deviation of reported values from the "true" value), (2) precision (based on the 90% confidence interval of the mean of students' reported values) and (3) speed (based on time cutoffs and placement in a titration race). The "true" value for an unknown is taken as the mean of student results; the dispersion of accuracy subscores is based upon the standard deviation of the mean of students' results. The 90% confidence interval as a measure of precision rewards students who use a larger number of analyses in calculating a mean value. The speed subscore provides an overall assessment of students' organizational ability and experimental skill. Equations for calculating subscores are given and the results of a typical practicum are discussed.

074 **LEARNING BASIC RESEARCH SKILLS IN THE GENERAL CHEMISTRY LABORATORY.** Josefina Arce and Edgar Danielsen, Department of Chemistry, University of Puerto Rico, Río Piedras, PR 00931

A series of experiments have been designed for the General Chemistry Laboratory to develop the basic **higher order thinking skills** needed for scientific research. These experiments and the laboratory setup also promotes **creativity, cooperation**, and enhance **communication skills**. Each laboratory experience is generally stuctured around the following sequence of events: a) review of the necessary basic conceptual knowledge, b) presentation of the problem to be solved, c) student groups design an appropriate experiment with the available materials, d) the proposed experiment is carried out, and f) a general discussion is ensued where each group of students present and discuss their results. The experiments are designed to be short to allow ample time for the group discussion that is the key element in this format. Students are also required to analyze each lab experience by means of the epistemological Gowin Vee. Examples of the experiments and results of the project evaluations will be presented.

075 INTEGRATED LABORATORY EXPERIENCE FOR UNDERGRADUATES. Doris R. Kimbrough and Robert Damrauer, University of Colorado at Denver, Denver, Colorado 80217-3364

In the fall of 1992, the Chemistry Department at CU-Denver wil embark on a new program, funded by the Dreyfus Foundation, that removes eight undergraduate chemistry majors from the traditional laboratory sequence after their completion of general chemistry laboratory. We will place them instead in research laboratories to work on projects in areas related to their lecture coursework. They will each spend one year doing research in an organic/biochemistry research lab, one year in an analytical/physical lab, and one year on a project in the lab of their choice. By exposing them to research early in their chemistry career, these students will develop an understanding of how research is done. More importantly, they will develop an appreciation of the integrated nature of all of chemistry's subdisciplines: analytical techniques and instrumentation requirements for an organic or biochemical laboratory for example. This program should provide excellent preparation for students continuing into graduate school or beginning a career in industry.

076 INTEGRATING RESEARCH INTO THE UNDERGRADUATE LABORATORY. RESOLVING THE FALSE DICHOTOMY OF COOKBOOK AND DISCOVERY

Brian P. Coppola, Department of Chemistry, The University of Michigan, Ann Arbor, Michigan, 48187.

In laboratory courses, the curricular pendulum swings from the unstructured "discovery" method to the pedantic "cookbook" approach. In restructuring our new undergraduate laboratories, we have tried to reconcile this dichotomy by creating a laboratory environment where the students discover the need to know how to solve problems by accessing the methods that already exist to do so. We have used our experience in directing undergraduate research projects as the basis for our introductory laboratory courses. This begins by posing questions that are comprehensible to the student. Starting on the first day of class of the first term of chemistry, students learn that laboratory techniques and instrumentation are the tools developed by other human beings in order to help answer questions which are otherwise unresolvable. By the second term, a class of up to 700 students engages in open-ended projects that possess an authentic research component. We have observed that more expert level laboratory skills are developed by these students compared with their counterparts in traditional courses. We have also observed that these students retain these skills as they participate in summer research experiences and in their upper level courses.

General Papers: General Chemistry Solutions L. Jones - Presiding

077 THE PROBLEM WITH FRESHMAN CHEMISTRY IS -- THEY'RE FRESHMEN!! Morton Z. Hoffman and Patricia L. Samuel, Department of Chemistry, Boston University, Boston, MA 02215.

Although we should never stop trying to make general chemistry more effective, exciting, and relevant, we must not lose sight of the fact that the students are, in the main, freshmen. They are away from home, many for the first time, they are alternately exhilarated and terrified, and, most importantly, they are teenagers. Many are emotionally delicate, and, most often, decidedly uncertain about what they want to do in life, except have FUN and make thousands of new friends on campus. They have probably not been intellectually active since the previous December when their college applications were sent out. In September, the summer seems endless, and general chemistry appears to be a simple repeat of high school. Is there any wonder that some students get turned off to chemistry when they discover that they have actually to do some work? We are always moaning and groaning about the dropouts; why aren't we rapturously enthused about those that are attracted to chemistry from other fields by its rigor, excitement, and opportunity? Freshmen need kindness and sensitive concern from their professors and teaching assistants. A little TLC goes a long way toward success in general chemistry.

078 CHEMPROF - EXPERTS AND INDIVIDUALIZED TUTORING Arthur A. Eggert, Catherine H. Middlecamp, & Anthony T. Jacob Chemistry Learning Center, University of Wisconsin-Madison, Madison, WI 53706

It is said that artificial intelligence (AI) holds great promise to improve education, but how will that promise be realized? CHEMPROF explores the use of AI in two ways, in its use of topic experts and in its capacity to individualize tutoring.

Experts encapsulate subsets of chemical knowledge to address specific chemical topics. For example, CHEMPROF experts can name chemicals, write chemical formulas, assign oxidation numbers and balance redox equations. The development of an expert dictates the thorough study and axiomization of a topic.

Individualized tutoring requires the abstraction of many pieces of both chemical and educational knowledge to permit the evaluation of a student's performance over diverse parts of the chemical curriculum and a tailoring the education experience for his/her needs.

Both experts and individualized tutoring will be discussed in order to demonstrate the potential of AI in educational software for general chemistry.

079 **CHEMPROF IN THE CLASSROOM: TEACHING CHEMICAL LITERACY SKILLS WITH A COMPUTER** Anthony T. Jacob, Catherine H. Middlecamp, and Arthur A. Eggert, Chemistry Learning Center University of Wisconsin-Madison, Madison, WI 53706

Which elements are diatomic? What is the chemical formula for ammonia? How do you recognize an ionic compound? To answer such questions, general chemistry students need to know certain facts, understand a number of chemical concepts, and apply certain rules for writing names and chemical formulas.

Our classroom experiences with CHEMPROF, an intelligent tutor for general chemistry, suggest that chemical classification, formula writing and nomenclature are neither easy to learn, nor easy to teach. We will explain why, drawing from our experiences using CHEMPROF for several semesters in large general chemistry courses at UW-Madison and from designing the name/formula experts that CHEMPROF employs. We will also present the results of measures of student literacy (pre and post general chemistry), typical student errors (as archived by CHEMPROF while students worked at the computer), and practical suggestions how (and how not) to teach literacy skills with a computer.

080 PRESERVICE TEACHING ASSISTANT TRAINING PROGRAM. Stanley T. Marcus and John F. Cullen, Jr., Baker Laboratory of Chemistry, Cornell University, Ithaca, NY 14853-1301.

Cornell University has offered a preservice teaching assistant training program for its entering Chemistry graduate students each year since the summer of 1979. Currently five weeks long, it includes a wide variety of components, most important of which is practice teaching in Summer Session chemistry courses. Before doing any actual teaching, the trainees are grounded in educational pedagogy and techniques, are taught a bit of learning theory, and are given microteaching experiences in which they are videotaped while teaching each other. Faculty members and experienced graduate students discuss differences in the responsibilities of teaching assistants in different chemistry courses. Also, there is training in handling toxic chemicals and laboratory safety, an orientation to the library, a course in first aid (including CPR), and a human relations workshop. The most recent addition is extensive training in writing and the evaluation of scientific writing.

081 A COMPUTER-INTENSIVE APPROACH WITHIN A TRADITIONAL CURRICULUM. Glenn E. Palmer, Department of Chemistry, University of Prince Edward Island, Charlottetown, P.E.I. C1A 4P3 Canada

In an effort to reduce the attrition rate in Freshman Chemistry, we have introduced extensive application of computer technology to all aspects of the course. This has been done within the traditional format of course presentation and grading, and with no alteration of course content. The methods and techniques applied and their effects on student attitudes and results, as well as their contribution to the lecturer's understanding of class dynamics, will be discussed.

082 THE GENERAL CHEMISTRY "TUTORIAL"CENTER. Al A. Hazari and Fred A. Grimm, Department of Chemistry, University of Tennessee, Knoxville, TN 37996.

The Department of Chemistry is providing "free" tutorial assistance to students who are registered in our General Chemistry courses. The Tutorial Center is open Monday through Friday from 9 a.m. to 4 p.m. with up to 3 Graduate Teaching Assistants (GTAs) on duty each hour. For a variety of reasons, all GTAs are required to schedule at least one of their office hours in the Tutorial Center. The benefits, problems encountered as well as possible solutions will be discussed.

General Papers: Poster Session E. Pulliam - Presiding

083 CHEMISTRY DEMONSTRATIONS AT THE OHIO STATE UNIVERSITY. Mary H. Bailey, Department of Chemistry, The Ohio State University, 120 West 18th Avenue, Columbus, Ohio 43210

The organization and presentation of lecture demonstrations in general chemistry and organic chemistry classes at The Ohio State University will be described. Various methods for effectively presenting demonstrations in a large lecture room will be illustrated.

084 GRAPHICAL REPRESENTATION OF REDOX REACTIVITY: A NEW APPROACH. Gary P. Wulfsberg. Department of Chemistry and Physics, Middle Tennessee State University, Murfreesboro, TN 37132.

Arbitrary, difficult-to-remember sign conventions bedevil students trying to learn redox and electrochemistry. Graphical representations of standard reduction potentials should help students, but Latimer, Frost, and Pourbaix diagrams each present pedagogical difficulties. Acid-base reactivity alone is easily represented by horizontal *predominance diagrams*, in which acidic species are present only at the *left* (at low pH), and basic species are at the *right* (high pH). We propose that redox reactivity be represented for students by vertical *redox predominance diagrams*, in which oxidizing agents are at the *top* of the diagram, and reducing agents are at the *bottom*. Two reasons will be given why this convention is non-arbitrary and hence easily remembered. A set of redox predominance diagrams for the elements of the periodic table will be shown and some uses of them indicated. It will be shown how they can be derived from tables of standard reduction potentials and how they can be merged with acid-base predominance diagrams to give Pourbaix diagrams.

085 EVALUATING THE RELATIVE BINDING ABILITIES OF POLYCYCLIC AROMATIC HYDROCARBONS BY THIN-LAYER CHROMATOGRAPHY. P. Di Raddo, Department of Chemistry, Carthage College, Kenosha, WI 53140-1994.

There exists a paucity of undergraduate experiments dealing with topics of chemical carcinogenicity. We describe here an experiment dealing with the relative binding abilities and carcinogenicities of several polycyclic aromatic hydrocarbons, a class of ubiquitous environmental pollutants known to cause cancer.

Binding abilities of hydrocarbons were evaluated by their R_f values on silica gel coated chromatographic plastic plates impregnated with caffeine. The R_f values are inversely related to the binding abilities of the hydrocarbons for the caffeine. Binding constants (B) were evaluated from R_f values for several polycyclic aromatic hydrocarbons differing from each other with respect to the size and shape of the aromatic ring system and degree of saturation. The values of B were found to approximate the relative abilities of these compounds to cause cancer.

The experiment proved to be short (2 h), safe (< 1 mg. hydrocarbon used) and instructive in dealing with the topic of structure-activity relations in biology and chemistry.

086 I'VE LOOKED AT EQUILIBRIUM FROM BOTH SIDES NOW : STUDENT "DISCOVERY" OF THE LEAD(II) IODIDE-WATER SYSTEM, D. A. Lewis, D. K. Erwin and B. C. Pestel, Department of Chemistry, Rose-Hulman Institute of Technology, Terre Haute, IN 47803

At Rose-Hulman Institute of Technology, we have forsaken the traditional lecture and/or in-class demonstration to introduce the concept of chemical equilibrium in General Chemistry. Instead, we take our students directly into the laboratory, where they individually carry out a series of chemical reactions involving the lead(II) iodide-water system, and attempt to write balanced chemical equations for what they observe. It is very important to note that there is no mention of equilibrium in the experimental procedure. Also, the instructor provides very little assistance during this period of discovery; the students bring their lab notebooks to the next class session and, in small work groups, discuss their findings with the instructor. We have been extremely pleased as to how well this approach provides the instructor with direct insight into how the students interpret their data and attempt to formulate a logical thought process. We have observed that this approach also instills student self-confidence. Details of the experimental procedure, as well as the questions the students are prompted to consider, will be discussed.

087 ELECTRON WITHDRAWING ABILITY AND CHEMICAL SHIFT--A HYPOTHESIS TESTING EXPERIMENT. David H. Smith, Department of Chemistry, Doane College, Crete, NE 68333

A common image used by organic chemistry instructors is that the chemical shift of protons in nmr is closely related to electronegativity. Two experiments are presented here that test that idea. In the first, used as our students' first introduction to nmr, pooled class data is used to test the hypothesis that "chemical shift is directly proportional to the electronegativity of neighboring functional groups". A second experiment explores the Hammett equation as a more sophisticated measure of electron withdrawing ability.

088 **A MODULAR ELECTRONIC LECTURE DEMONSTRATION APPARATUS.**
Gary D. Mercer, Departr. of Chemistry, Boise State University, Boise, Idaho 83725

The design and construction of a modular electronic instrument for measuring a variety of properties of chemical systems such as temperature, pH, pressure, light intensity, redox potential, and conductivity will be described. The instrument utilizes a single display unit to which a series of input modules for processing the signals from the various sensors are connected. This design results in a versatile and expandable instrument while minimizing the cost. The display unit can be constructed for under $60 and each input module costs about $10. The output has been designed to provide a very visible and nonnumeric display that is ideally suited to high school, introductory, and nonmajors chemistry courses. Full schematic diagrams and construction tips will be provided along with some example demonstration applications.

089 INTEGRATING ELEMENTARY (LOWER DIVISION) ORGANIC CHEMISTRY INTO (UPPER DIVISION) ORGANIC CHEMISTRY. E. R. Matjeka and R. C. Banks, Department of Chemistry, Boise State University, Boise, ID 83725.

At Boise State University, the lower division Elementary Organic Chemistry course has been successfully integrated into the upper division Organic Chemistry course. The resulting course is taught using a very different approach than that used in other upper division Organic Chemistry courses. That teaching approach, and the successes, the problems and the merits of teaching Organic Chemistry to all majors in one course will be presented from the perspectives of both the instructors and the students.

090 HUCKEL MOLECULAR ORBITAL CALCULATIONS ON A SPREADSHEET. Lawrence McGahey, Department of Chemistry, College of St Scholastica, Duluth, MN 55811-4199.

Common spreadsheet programs for personal computers can be used to introduce students to basic Huckel Molecular Orbital calculations, obviating the purchase of more sophisticated software. With a pattern or template provided by the instructor, students can find the molecular orbital energy levels and coefficients for individual atoms in each MO. The relative contribution of each atom to a particular MO is easily visualized with the graphing application that accompanies the spreadsheet. Using just two simple templates, MOs for linear and carbocyclic arrays can be constructed. The numerical results of these calculations can lead students to discover the qualitative symmetry properties of molecular orbitals, calculate electron and charge densities, and explore Frontier Orbital analysis of pericyclic reactions.

C91 THE DEHYDRATION OF 4-METHYL-2-PENTANOL--A HYPOTHESIS TESTING EXPERIMENT. David H. Smith, Department of Chemistry, Doane College, Crete, NE 68333

A capillary gas chromatograph allows the old experiment, the dehydration of 4-methyl-2-pentanol, to reveal a more detailed look at the composition of the mixture of the methylpentenes produced. Pooled class data and class discussion are used to determine if this dehydration and rearrangement reaction is under kinetic or thermodynamic control. The class is then lead in discussion to designing a test of the thermodynamic hypothesis, which is then performed.

092 **INORGANIC QUALITATIVE ANALYSIS PROGRAM MINIMIZING HAZARDOUS WASTE,** E. F. Wood, K. Ferrero, A. Gibson, N.A. Nguyen, and M. Wilcox, Department of Chemistry, University of California, Davis, CA 95616

Few general chemistry laboratory experiments generate a more heated debate than does qualitative analysis. One common objection concerns the chemical waste created by many of the experiments appearing in laboratory manuals. Environmental concerns and the severity of the hazardous waste regulations in California led to the creation of an inorganic qualitative analysis program, which minimizes the waste produced by over 2,000 undergraduates each year. The development and implementaion of this program will be discussed.

093 ATTRACTING WOMEN STUDENTS INTO CHEMISTRY. Iclal S. Hartman, Simmons College Department of Chemistry, 300 The Fenway, Boston, MA 02115.

Women are under represented in sciences in general and physical sciences in particular. One important factor appears to be being advised out of math, physics, and chemistry in high school. Visits to high schools for talks or demonstrations as well as having programs in our colleges for 9-12th grad students and their teachers may be possible remedies. The paper will discuss specific types of endeavours which have been successful. Another important component is the advising, monitoring, and mentoring of women students already at college. Quite often, a potential chemistry major will be in a program like nursing and physical therapy, perhaps on the advice of a parent or teacher, because it is a concrete field of study with immediate job applicability. Such students often are surprised and pleased when we recognize their scientific bent and potential, and advise them into science. A third approach involves developing programs such as environmental science studies and joint majors such as chemistry and management or chemistry and communications that offer broader options that appeal to diverse interests.

094 IBM + CHEMISTRY STUDENT$_{(lab)}$ --> ??? Terri L. Beam and Eileen DiMauro, Department of Chemistry, Mount San Antonio College, Walnut, California 91789.

Preliminary experimentation and observation of computer-aided data acquisition with the SCI Technologies, Inc. Labworks system in the general chemistry laboratory are reported. The Labworks system includes software for the IBM PC, an interface panel which supports many different experimental sensors and probes, and tutorial information for both instructors and students. The successes and pitfalls experienced through the progression of using demonstration programs, to instructor-designed programs, to student-created programs in wet chemistry experiments will be presented. Computer experiments included measurements of physical properties, pH, titrations, and electrochemical cells. Future plans for experiments will utilize interface accessories such as thermistors, pH electrodes, drop counters, geiger counters and colorimeters.

Plenary Address

095 **WHAT'S NEW ABOUT TEACHING PROBLEM SOLVING?** Donald R. Woods, Department of Chemical Engineering, McMaster University, Hamilton Ontario, Canada L8S 4L7

Historically, the major methods that educators have used to develop problem solving skills have been to give the students many problems to solve, to give open-ended problems and projects, to work sample solutions on the board, to select enrichment books like Schaum's Outlines that have a lot of problems and solutions and to have students work problems on the board. Over the past 10 years, the research findings are that no problem solving skills are developed using these techniques. True, the students collect sample solutions and new application experience. But their ability to define problems, to think up options, to make decisions, or to create hypotheses remains unchanged over the four or five year University experience. Furthermore, their confidence in their problem solving skills remains low and unchanged.

Beginning in 1975, McMaster Problem Solving program was created to develop problem solving skill systematically, explicitly and effectively. The program has been demonstrated to give statistically significant increases in students' marks and the students' confidence in their problem solving ability has improved by 1 to 2 standard deviations. Control group studies have shown no improvement in confidence. The full MPS program develops about 30 skills.

Brasted Plenary Address

096 **CHEMISTRY: A UNIVERSAL SCIENCE** Ernesto Giesbrecht, Instituto de Quimica, Universdade de São Paulo, Box 20780, 01498 - São Paulo, SP Brazil

The public in general and even the majority of college and university students are unaware of the social, economic, and political importance of Chemistry. Despite the evident importance of Chemistry to respond to the human necessities, the general public sees Chemistry with a mixture of suspicion and fear.

By the end of this century we will witness social, political, economic, and educational events of major importance for humanity. Profound changes are already occurring rapidly and with such magnitude that it becomes extremely difficult to follow the developments closely. We are observing several movements of integration and disintegration as a consequence of adjustments involving nations or groups of nations of differing politico-economic principles. The objective of these movements is, in the final analysis, to promote human well-being and national progress. In these processes Chemistry plays a substantial role since it makes it possible for nations to solve the basic survival problems of food production, medicine manufacture for disease control, building-material construction for shelter, transportation, clothing, sanitation, *etc*; in short - everything connected with the improvement of human life.

Chemistry as a universal science, can aid this progress, but it must do so within a context of a deep respect for the environment.

Consumer Products K.O. Berry - Organizer, K.O. Berry, T. Hoyt - Presiding

097 CONSUMER CHEMISTRY: A COMMON SENSE COURSE TO INTRODUCE BASICS OF CHEMISTRY AND CHEMICAL TOXICOLOGY. B. DasSarma, Department of Chemistry, West Virginia State College, Institute, WV 25112

"Consumer Chemistry" has been developed as a science component of General Education at West Virginia State College to introduce simultaneously the basics of chemistry and chemical toxicology so that latent "toxic" is not presumed as prefix to the noun chemical. Chemistry is defined as study of chemicals. Chemicals are consumer products that can be stored for future use. Chemical reactions are visualized as loss, gain and/or exchange of electrons between atoms of a dozen elements that constitute over 99% of the human body. Matter is a trivial name for chemicals. Energy is a function of, and can be stored only as matter. Dose-response curve (dose of a consumer product and its effect on human body) is emphasized not only for toxicology, but also in cosmetology, pharmacology, and dietetics as well. Consumer products covered are air, water, food, and fuel that we much consume (with ambient carcinogens), and a few over-the-counter products we use as health and beauty aids.

098 CHEMISTRY OF CHOCOLATE, Londa Borer, Department of Chemistry, California State University, Sacramento, 6000 J. St., Sacramento, CA. 95819

The chemical and physical properties of a very familiar food item, chocolate, will be presented. The experiments that are performed in a general consumer chemistry course will be outlined.

099 BURNING CALORIES IN A BOMB. Dennis Swauger, Physical Science Department, Ulster County Community College, Stone Ridge, NY 12484

Most students, as consumers of a variety of foods (many of which may be found in the vending machine down the hall), are quite aware of the claimed caloric content of many foods. At Ulster County Community College, general chemistry students perform a bomb calorimetry experiment entitled The Caloric Content of Foods that allows them to "check up" on these claims. This talk will describe the experimental procedure, the results obtained by students, and the educational value of the experiment.

100 FLAMMABILITY OF LIQUIDS AND GASES. Peter A. Rock, Department of Chemistry, University of California, Davis, California 95616

Flammable liquids and gases present major fire hazards in both the laboratory and the home. An understanding of the flammability characteristics of liquids and gases enables us to decrease the risks associated with such materials. The presentation will cover ignition sources, flash points, flammability composition limits, autoignition, spontaneous combustion, fire hazard identification, common fire hazards, flame arrestors and key features of combustion mechanisms.

101 SURFACE MODIFICATION: THE SKI-SNOW INTERFACE. Timothy C. Donnelly, Department of Chemistry, University of California, Davis, California 95616

This presentation will explore the use of surfactants to modify interfaces between two surfaces. The use of surfactants in consumer products is well known. Our particular areas of interest are in the addition of surfactants to paraffin and microcrystalline waxes to create continually varying interfaces between ski and snow. This in effect allows the base of the ski to continually adjust to differing snow conditions. Also we will briefly discuss some applications of surfactants to liquid systems. This research has been applied to a number of interesting consumer products that we have developed.

In addition, the value of consumer product research and development to classroom teaching will be discussed. Students relate very well to a thematic lecture approach built around consumer products.

Whither Microscale? S. Lamb - Organizer, Presiding

102 OUTCOMES OF MICRO AND MACRO APPROACHES TO THE CHEMISTRY TEACHING LABORATORY: A STUDENT PERSPECTIVE Warren Beasley, The University of Queensland, Australia 4072

Recent trends in the laboratory component of freshman chemistry courses suggest a growing movement towards the provision of small or micro scale laboratory experiments for students. This trend has been rationalised in terms of economy of scale, safety and the disposal of waste problem. However, the fundamental question remains: What outcomes are possible and desirable from such an approach to the freshmen laboratory?

The outcomes of more conventional or macro approaches to the teaching laboratory have been documented over a long period. This paper reports the findings of a recent study in two North American universities offering similar courses - only the scale was different. Student development was maintained over the course using the Laboratory Learning Questionnaire and the outcomes compared following a factor analysis of the reported results. The factors accounted for fifty percent of the variance. These were named Designing an Experiment, Laboratory Skills Development and Laboratory Skills Application. Comparisons between the two groups of students are made in reference to this factor analysis.

103 WHITHER MICROSCALE: WHAT IS THE FUTURE OF MICROSCALE IN THE ORGANIC LABORATORY?

Donald L. Pavia, Gary M. Lampman, and George S. Kriz, Department of Chemistry, Western Washington University, Bellingham, Washington 98225; and Randall G. Engel, Green River Community College, Auburn, Washington 98002.

An examination of the future of microscale experiments in the organic laboratory will be developed. Topics to be discussed include: effectiveness of microscale experiments in the instructional laboratory, obstacles to conversion, problems with glassware kit design, scale of experiments and student success, and how best to teach distillation and extraction in microscale.

General Papers: Innovative Outreach Programs N. Pyle, Presiding

104 GRADUATE STUDENTS FOR CHEMICAL EDUCATION: A COMMUNITY OUTREACH ORGANIZATION

S.D. Gammon, Department of Chemistry, University of Idaho, Moscow, ID 83843

In the Chemistry department at the University of Idaho a graduate student organization was formed to provide a community resource for chemical education. The group is called "Graduate Students for Chemical Education." The group has been very active in promoting science in the local community. Activities include, Christmas chemical demonstration shows, trips to local schools, running summer science camps, "expert" teachers, interactions with local teachers and administrators. This group has been highly successful; the level of requests for services exceeds our manpower. This presentation will discuss the establishment, organization and activities that make this group successful.

105 SCIENTISTS IN SCHOOLS.

A. Verner, Physical Sciences Division, Scarborough Campus, University of Toronto, 1265 Military Trail, Scarborough, Ontario M1C 1A4 Canada

Concern for the quality of science education in the elementary schools and the lack of "hands on" science activities, has led many parents with a background in science to volunteer to present science demonstrations for their children's classes. Two Scientists, Erica Bruce and Nancy Williams, recognized the potential of organizing such a group of scientists in their community and thereby sharing the resources and presentations with many schools in the Durham Region. Through the Canadian Federation of University Women of Ajax and Pickering, they applied to Industry, Science and Technology Canada for a grant to start this project. The schools pay a nominal fee for the presentations and the presenters are given a small honoraria. This program, involving the use of community members in the implementation of the science curriculum in the elementary schools, has proved to be very successful.

106 THE TWELVE DAYS OF CHEMISTRY. C. M. Pharr, S. D. Gammon, Department of Chemistry, University of Idaho, Moscow, ID 83843.

Children scream! Women laugh! Grown men cheer! Department Chairmen smile!...and all because of chemistry!!! Graduate students at the University of Idaho recently presented a Christmas Chemistry Show entitled "The Twelve Days of Chemistry". The program consisted of chemical demonstrations interspersed with short scientific skits performed by "Dr. Frankenstein" and "Igor". The mechanics of the program, including organization, promotion and performance, were done entirely by the graduate students in conjunction with a faculty advisor. This presentation will discuss the logistics of putting together a chemistry outreach program that is both fun and educational!

107 PRECOLLEGE SCIENCE OUTREACH PROGRAMS: "CHEMISTS VISIT KIDS" AND "NOT SO LATE NIGHT CHEMISTRY WITH USD". Miles D. Koppang and Rekha Srinivasan, Department of Chemistry, University of South Dakota, Vermillion, SD 57069.

The University of South Dakota's Department of Chemistry has developed two precollege science outreach programs. "Chemists Visit Kids" for elementary and middle school students uses chemical demonstrations in order to increase interest in science and to aid students in recognizing the relationship between chemistry and daily life. The second program, "Not So Late Night Chemistry with USD" for high school chemistry students and their instructors, consists of evening sessions of pizza followed by "hands-on" work with modern instrumentation in the department's laboratories. The purpose of this latter program is to augment high school chemistry studies and provide the students with a more realistic view of what modern chemistry entails. A more complete description of the programs will be presented including numbers of participating schools and precollege students and the results of student and teacher surveys regarding the effectiveness of the programs toward increasing interest in chemistry and science in general.

Breaking the Bubble: New Thoughts on Testing and Evaluation L. T. Pryde - Organizer, Presiding

108 WHAT DO OUR TESTS TELL OUR STUDENTS?
Sheila Tobias, 724 North Campbell Avenue, Tucson, AZ 85719

"What do our tests tell our students?" about themselves? about the discipline? The third volume of the Research Corporation series on neglected problems in science education will deal with this question. At this session several short-term experiments in modifying in-class examinations (Chico State University, CA, and Purdue University, West Lafayette, IN) will be described. What are the barriers to reform of current testing will be described. What are the barriers to reform of current testing design and practice? The research agenda, the action agenda, Discussion.

109 EVALUATING PROBLEM-SOLVING PROFICIENCY THROUGH PERFORMANCE ASSESSMENTS. Wilbur Bergquist, BSCS, 830 **North Tejon Street**, Suite 405, Colorado Springs, CO 80903.

Performance assessment tasks, designed evaluate chemical problem solving, have been developed that utilize small-scale laboratory activities. To solve a TEST CUBE™ assessment task students must first generate the necessary data and then interpret their results. Tailoring the complexity of the task makes it possible to create a range of hands-of items suitable for the assessment of students' ability to apply information as they engage in problem-solving. The process involved in developing these materials as well as examples of the test kits will be presented.

110 **HANDS-ON AND MINDS-ON TESTING** Irwin Talesnick Faculty of Education, Queen's University, Kingston, Ontario, Canada K7L 3N6

Since very expensive time and facilities are used in the teaching of chemistry, the laboratory must also be used for the purposes of evaluating students. Be prepared to share some of your practical ideas with other participants.

We will examine, both in theory and in practice, a number of ways of using the laboratory and laboratory procedures to teach as well as to evaluate student progress in chemistry. General ideas for various laboratory evaluation procedures as well as some very specific examples will be demonstrated and discussed. Participants will leave the session prepared to use these techniques in their own classrooms.

111 ALTERNATIVE TESTING FORMATS: THE *CHEMCOM* EXPERIENCE
Lucy T. Pryde, ACS DivCHED Examinations Institute,
107 Physical Sciences, Oklahoma State University, Stillwater, OK 74078

The American Chemical Society's *Chemistry in the Community* (*ChemCom*) curriculum emphasizes both traditional chemistry content *and* decision-making concerning science-society issues. This duality of purpose makes assessing student mastery of *ChemCom* course objectives even more difficult than for traditional courses. When the decision was made to develop an end-of-course standardized test, it was clear that this also meant the development of assessment methods other than the traditional single-answer multiple-choice questions used almost exclusively in the sixty-year history of ACS tests. Experience with the preparation, production, and scoring of this machine-scorable, standardized test will be shared.

Evaluation of the test data shows that alternative questioning formats have been successfully incorporated into this first *ChemCom* test. Further refinements will take place in subsequent editions, and other standardized tests of the Examinations Institute are expected to show change as well. Individual teachers may wish to employ these methods, particularly the use of grid questions and linked questions, as part of their classroom assessment activities.

112 *SUPERTEST*: A FLEXIBLE, COMPUTER-BASED ASSESSMENT PROJECT

I. Dwaine Eubanks, ACS DivCHED Examinations Institute,
107 Physical Sciences, Oklahoma State University, Stillwater, OK 74078

Students often perceive that instruction and assessment in chemistry are not congruent. In many cases, that perception may be correct! We must work to change the assessment climate through a variety of new assessment processes. One approach being used by the ACS DivCHED Examinations Institute is to develop a *SuperTest*. This is a SuperCard™–based test shell which will make it possible for developers to construct tests that extend the range of student attributes that can be successfully measured in an objective testing environment. The computer-based testing environment allows incorporation of symbols, definitions, equations, tables, graphs, animation, and videodisc images that may be called for by students in approaching each assessment activity. Laboratory skills and knowledge and science decision-making skills are areas of initial implementation. Some prototype materials will be demonstrated during the presentation.

View from My Classroom F. Cardulla Organizer, Presiding

113 PICTURES IN THE MIND. Helen M. Stone. 2815 Lenoir Drive, Greensboro, North Carolina 27408

Use Chemical Pictionary, Chemistry Jokes, Cartoons to help students develop mental pictures or models that allow them to understand chemistry. Students, particularly those with weak backgrounds, need to sketch lab equipment and use it to measure, meaSURE, MEASURE. Without mental pictures of "volume" containers and their units and of "mass" instruments and their units, parrotting "D = M/V" is meaningless as is a lab on density. Help your weaker students SEE!

114 WHAT CAN I DO FOR EXTRA CREDIT? Miriam R. White Chestnut Hill Academy, 500 W. Willow Grove Ave., Philadelphia, PA 19118

Students are always asking, "What can I do for extra credit?" It is convenient if you have thought through some good projects that will be good learning experiences for them. I have four projects, one for each quarter. They are described at the beginning of the year and can be done by any student. These will be described and some sample work will be shown.

115 A LABORATORY-CENTERED ADVANCED PLACEMENT COURSE. S.R. Marsden, Harvard-Westlake School, 3700 Coldwater Canyon Ave., North Hollywood, CA 91604

A second-year high school chemistry course at the Advanced Placement level has been developed including a significant laboratory component and omitting the traditional lecture. This talk will give an overview of the course and detail a few of the experiments used during the year. Samples of materials will be available for discussion.

116 **MAXIMIZING STUDENT INVOLVEMENT IN LEARNING** M. Patricia Noel Harvard-Westlake School, 3700 Coldwater Canyon , N. Hollywood, CA 91604

It is always a challenge to get students involved in learning chemistry. To keep students actively participating for a full class or laboratory period is a daily goal. Different approaches and techniques for achieving this goal will be discussed as well as how these approaches vary when dealing with girls, boys, public school students, and private school students.

117 **ADDING HEART AND SOUL TO THE CHEMISTRY CLASSROOM** Sherry Berman-Robinson, Carl Sandburg High School, Orland Park, Illinois 60462

Help an adolescent improve his self image and learn chemistry at the same time. Mnemonic devices can be useful in remembering difficult chemistry concepts and may be integrated into your curriculum. Group testing, cooperative learning, and study groups are some of the techniques I use to make chemistry a little easier. Of course, we celebrate "Mole Day" make "gold pennies", holiday ornaments, slime, ice cream in test tubes, and tie-dye shirts. Come learn about these ideas and share some of you own.

118 **AN EXPERT SYSTEM FOR LEARNING ORGANIC CHEMISTRY**

Joyce C. Brockwell, Northwestern University, Department of Chemistry, 2145 Sheridan Road, Evanston, IL 60208-3113.

Much of the content of an elementary organic chemistry course consists of sets of descriptive rules, such as those for drawing and naming structures, counting electrons and drawing resonance structures, determining absolute stereochemistry, identification of nmr signals, and determining sites of reactivity. Application of a limiting set of rules to solving problems is the structural basis for expert systems, so it follows that an expert system is one source for aid in learning the rules of organic chemistry. A neophyte may ask the computer to solve problems which explore the system, demonstrating the limitations and interactions of the various rules.

We have developed such a computer program and will show how a student may work with the system to get a basic understanding organic chemistry. The expert system (Beaker™) is a very compact, fast program which is useful for learning such simple but critical concepts as oxidation state change, absolute stereochemistry, and nomenclature as well as more complex concepts such as nmr, structural isomers, resonance forms and reactions and mechanisms.

119 NMR SPECTRA SIMULATION. Kersey A. Black, Keck Science Center, Claremont McKenna, Scripps and Pitzer Colleges, Claremont, California 91711.

Spectrum Simulator, software which simulates proton NMR spectra, can be an aid to students learning how to correlate proton NMR spectral data with molecular structure. The software user can design and create organic structures on the screen of a Macintosh™ microcomputer using the mouse to select from a palette of molecular pieces, or can open previously prepared files. Alkanes, alkenes, aromatics, halides, alcohols, ethers, ketones, aldehydes, acids, esters, amines, and amides can all be easily constructed in this manner. The program then generates a simulated proton NMR spectrum using empirically based rules for chemical shift calculation and assignment of coupling constants. The simulation provides a spectrum reflecting first- and some second-order effects. The spectrum can be expanded, scrolled, and integrated, and can be generated for any of several common field strengths. Correlations between protons and signals in the spectrum can be revealed, along with a "splitting tree" showing the results of spin-spin coupling for a particular signal. Files of compounds can be created and stored on disk such that the structure can be either "known" or "unknown" to a user opening the file. Multiple spectra can be displayed in separate windows, and some help on interpretation is provided through help screens.

120 A MULTIMEDIA ORGANIC CHEMISTRY TUTOR. Kenneth W. Raymond, Department of Chemistry and Biochemistry, Eastern Washington University, Cheney, WA 99004.

In 1991, as part of a U. S. Department of Education Title III grant, Eastern Washington University initiated a five year program to develop a core of faculty who will develop computer aided instruction courseware and integrate it into the curriculum. "Organic Chemistry Tutor," one of the products from the first year of this program, will be described. This courseware, designed for the beginning organic chemistry student, is intended to provide assistance with such basic concepts as Lewis structure, formal charge, molecular geometry, dipole moment, resonance, curved-arrow "electron pushing," and energetics. Developed using the "Authorware Professional" multimedia authoring system, the courseware makes use of animation and user-movable objects. Each of the subsections of "Organic Chemistry Tutor" provides a tutorial, a set of practice problems, and a quiz. Automatic record keeping allows student progress to be easily monitored.

121 DYNAMIC VISUALIZATIONS IN CHEMICAL EDUCATION. Betty A. Luceigh, Department of Chemistry and Biochemistry, University of California, 405 Hilgard Avenue, Los Angeles, California 90024

Dynamic visualizations of chemical processes have been created using a combination of molecular modelling and animation programs. The computer-generated demonstrations are designed for two main applications: 1) as a visual aid to supplement a lecture in which the factual and explanatory details are provided by the individual instructor, and 2) as part of an individual student study program correlated with accompanying worksheets for active participation by the student. Demonstrations use both color and sound effects and include still images and molecular model animations. Introductory examples include organic chemistry (e.g., S_N and E reactions), general chemistry (e.g., acidity) and biochemistry (e.g., bacteriorhodopsin). A demonstration of the application of the dynamic visualizations to enhance student understanding and involvement in the lecture setting will be given.

122 AN ELECTRONIC TEXTBOOK FOR PHYSICAL CHEMISTRY: CHEMICAL APPLICATIONS OF MATHEMATICA. Robert G. Kooser, Chemistry, Knox College, Galesburg, IL 61401

A prototype of an interactive, "what-if?", graphically-active, computer-based physical chemistry textbook will be presented based on the platform of the powerful application Mathematica. Using Mathematica notebooks, the entire physical chemistry contents of the experimental and theoretical section on the behavior of gases will be covered. The benefits of an electronic textbook include the ability of the student to test model parameters to see the results graphically (e.g. van der Waals constant), to see data trends graphically and to draw conclusions from them (e.g. find viral expansion coefficients). The awesome mathematical ability of Mathematica at the stroke of a few keys means that very complicated mathematical manipulations can be required of students without the usual 'calculus lock' or time involved. This, in turn, means that more realistic models of gas behavior can be examined and the students can participate actively in complex derivations, banishing forever the phrase "it can be shown." All is not sweet in candy land, though; Mathematica is a finicky and unforgiving program and the hardware costs are very high. The balance between learning gain and program, time, and hardware costs will be discussed.

Revamping General Chemistry: I Studies and Suggestions J. J. Fortman - Organizer; J. N. Spencer - Presiding

123 MISSIONARIES FOR CHANGE: THE GENERAL CHEMISTRY TASK FORCE, James N. Spencer, Franklin & Marshall College, Lancaster, PA 17604-3003, and John J. Fortman, Wright State University, Dayton, OH 45435.

Citations from recent national reports of the ACS, AAAS, Sigma Xi, Research Corporation, CPT, and NSF will be surveyed which document the need for reforms in general chemistry courses. Similar problems have been noted beginning in the 1960's. However, little has been done except to add still more topics and further increasing the difficulty level by making the courses even more oriented towards the mathematical and abstract. The General Chemistry Task Force of the ACS Division of Chemical Education intends to do more than document the problem; its mission is to do something about the problem by encouraging, identifying, developing, and publicizing alternative and innovative approaches which are, or promise to be, successful in making general chemistry more interesting, meaningful, and effective.

124 THE ROLE OF NSF IN PROMOTING INNOVATION IN GENERAL CHEMISTRY,
Robert F. Watson, Curtis T. Sears, Jr., John V. Clevenger, Susan H. Hixson, Division of Undergraduate education, National Science Foundation, 1800 G Street NW, Washington, DC 20550

Many of the awards in chemistry by the Division of Undergraduate Education under the aegis of the Undergraduate Course and Curriculum, and the Instrumentation and Laboratory improvement Programs are designed to effect change in general chemistry courses. Four themes for promoting improvement are evident: 1) course content and organization; 2) laboratory; 3) technology; 4) learning environment structure. Ongoing efforts based on these themes should stimulate others to contemplate how they might revitalize their own instructional programs.

125 REVOLUTIONIZING THE CHEMISTRY CURRICULUM: THE CANADIAN APPROACH.
Josef Takats, Department of Chemistry, University of Alberta, Edmonton, Alberta, Canada T6G 2G2

The need for changes in the Introductory Chemistry Course and in the Chemistry Curriculum in general has been recognized and debated for the past several years.

The Canadian Society for Chemistry has also been active in this regard with the organization of two symposia focussing on Revolutionizing the Chemistry Curriculum. The first symposium, held last year, was a 'Call for Action'. The second symposium, which will take place at this year's annual Conference in June, solicits concrete responses to this call, i.e., innovative approaches and novel initiatives for program changes.

The talk will give a synopsis and evaluation of the two symposia, especially as they relate to the changing face of the Introductory Chemistry course.

126 GENERAL CHEMISTRY: A MODULAR/CORE CURRICULUM APPROACH,
T.Y. Susskind, Natural Science Department, Oakland Community College, Auburn Hills, MI 48326; R.J. Gillespie, Department of Chemistry, McMaster University, Hamilton, ON, Canada L8S 4M1; J.R. Mohrig, Department of Chemistry, Carleton College, Northfield, MN 55057; L.H. Rickard, Department of Chemistry, Millersville University, Millersville, PA 17551; J.N. Spencer, Department of Chemistry, Franklin & Marshall College, Lancaster, PA 17604.

A subcommittee of the General Chemistry Task Force has been working on designing a thin text of "core" material, which will contain those concepts and principles fundamental to the understanding of chemistry. This "core" might provide as much as ninety percent of the course material in one institution, and a mere fifty percent in yet another. The core material could be supplemented with subject area modules, which would allow instructors and students to investigate topics in greater depth and in ways suited to the backgrounds, interests and needs of the students. The Task Force's suggested outline of core topics to general chemistry will be described together with examples of core material and possible accompanying modules.

127 LET'S USE DYNAMITE. Orville L. Chapman, Department of Chemistry and Biochemistry, UCLA, 405 Hilgard Ave., Los Angeles, CA 90024-1569

Every college and university student in the United States must understand science and technology as they relate to our national economy. We must send out students who address issues rationally and consider costs--students who can articulate their views in the political arena. Our failure to produce such students has cost us dearly. We suffer from a nation-wide anti-chemistry bias; we endure seriously flawed legislation such as the 1990 Clean Air Act; and we now face the destruction of our chemical industry by the New Jersey EPA initiative. How important is the chemical industry to the U. S. economy? The chemical industry is our only non-subsidized industry with a positive balance of payments, 15.9 billion dollars. Our chemical industry contributes twice as much to the U. S. economy as does the automotive industry. The consequences of our failure to educate our students is staggering. We must obliterate our existing lower division courses--first-year chemistry does not stand alone--and create entirely new courses. These courses must educate all students. Lower-division chemistry courses must feature ideas not facts. We must rid ourselves of the mind-set and self-interest that plague our existing courses--I suggest dynamite. The university is a market place for ideas, chemistry must have a booth.

128 WHY DO WE TEACH THIS GARBAGE? Stephen J. Hawkes, Department of Chemistry, Oregon State University, Corvallis, Oregon 97331-4003.

There are two principal forms of garbage taught in the introductory course -algorithms that are unreliable and information of too little value to warrant study. A rarer form is information that is false. Examples of all three will be given. The history of one error, the theory of complete dissociation of salts, will be given to show how it became current and why it persists. It's dangers in real-world chemistry will be illustrated.

Computer programs used in undergraduate courses eliminate mathematical approximations, but leave devastating chemical inaccuracies which could easily be avoided. pH algorithms produce errors up to half a pH unit, while complexation calculations often produce thousand-fold errors.

Eliminating nonsense from introductory chemistry is a necessary function of the ACS Task Force.

Consumer Products K. O. Berry and T. Hoyt - Organizers, Presiding

129 THE CHEMISTRY OF MODERN PETROLEUM ADDITIVES, Paul F. Vartanian, Chevron Research and Technology Co., 100 Cenvron Way, Richmond, CA 94802.

Modern petroleum products, whether gasoline, grease, lubricating oils, heating oils, etc. not only contain the various hydrocarbons required for their efficient use, but also contain additives that affect the properties of the product. Properties such as detergency, dispersancy, viscosity, or inhibition are among those of greatest interest. The major fuel types obtained from crude oil are liquefied petroleum gas, gasoline, diesel fuel and heating oil, kerosene and jet fuel, and residual fuels. Each of these is suitable for a oarticular use, but the end use requires additional components be added either to change the properties or to enhance them. Here, we will describe some of those additives and processes by which they are incorporated into the final product. We will consider the uses for the various types of fuels and the properties most often sought for them.

130 THE JOURNAL OF CHEMICAL EDUCATION'S "PRODUCTS OF CHEMISTRY" FEATURE. George B. Kauffman, Department of Chemistry, California State University, Fresno, Fresno, CA 93740.

This Secondary School feature was initiated in 1987 at the behest of Arlyne M. ("Mickey") Sarquis, Editor of the Journal of Chemical Education's Secondary School Chemistry Section. The feature deals with the chemistry of everyday commercial items (foods, toiletries, cleaners, cosmetics, toys, etc.) readily recognizable to the high school and college student. Articles about these products may discuss their manufacture, the chemical principles underlying their use, how they may be used to teach a specific concept, and ideas for modifying them for safe but unusual purposes. Papers may also provide background or supplementary information for teachers of high school or introductory college chemistry. Under the editorship of George B. Kauffman, since September, 1988 sixteen articles have appeared, twelve are in various stages of publication, and several are currently being written. A number of these articles are discussed.

131 FROM SALT TO BLEACH; THE STORY OF A TYPICAL CHEMICAL INDUSTRY; Keith O. Berry, University of Puget Sound, Tacoma, WA 98416.

One major group of common household products are those such as bleaches, chlorinating agents, swimming pool chemicals, disinfectants, and others which utilize the useful properties of chlorine. One mineral for which we are ever likely to have a shortage is salt; on the contrary, salt often causes great distress because there is too much of it and often in the wrong place. In this ppresentation we will consider the intermediate chemicals that are produced and sold by the "Chlor-alkali Industry", all of which are derived from salt and other common, inexpensive minerals. We will follow the pathway of the chemicals as they make their way from raw material to the products sold to other chemical manufacturers for incorporation into the household chemical.

132 CHEMISTRY OF HOUSEHOLD CONSUMER PRODUCTS. Timothy F. Hoyt, Department of Chemistry, University of Puget Sound, Tacoma, WA 98416.

There have been many articles, some including laboratory experiments, some including demonstrations, as well as other information on the integration of common household products into the general chemistry class. This discussion centers on various methods of presenting this information to a variety of audiences. The initial development of this material was for a course to help train the local firefighters to become more aware of the possible hazards they might encounter in a house fire due to the presence of some of the common household products commonly found in the modern home. Demonstrations of the potential hazards are presented with some spectacular effects and experiments utilizing some common household products for adaptation for the general chemistry laboratory will be presented.

133 DRUGSTORE IODINE AND HOUSEHOLD BLEACH: CONSUMER PRODUCTS IN REDOX AND RELATED DEMONSTRATIONS. Carl H. Snyder, Department of Chemistry, The University of Miami, Coral Gables, FL 33124

The highly visible color, easy commercial availability and good redox properties of iodine make tincture of iodine (drugstore iodine) a convenient oxidant for lecture demonstrations. Its reduction to colorless iodide anion is readily reversed by liquid chlorine (household) bleach with reappearance of the characteristic color of the tincture. Use of these consumer products is described for the redox reaction of iodine and zinc (galvanized tacks), and iodine and iron (metal scouring pads), and the utility and action of antioxidants (ascorbic acid) as food additives. Tincture of iodine also serves to demonstrate the relative degrees of polyunsaturation of triglycerides (peanut and sunflower oils) and the chemistry of isopropyl and ethyl (rubbing) alcohols.

134 MORE DEMONSTRATIONS WITH CONSUMER PRODUCTS; Andy S. W. Sae; Department of Physical Sciences, Eastern New Mexico University, Portales, NM 88130

The "top-40" 1-minute chemical demonstrations were presented at the CHEM ED'91 conference, more of the same will be presented. Only consumer-product chemicals will be used. A hand-out will give instruction on how to do each of the demonstrations.

Funding Opportunities in Chemical Education R. L. Lichter - Organizer, Presiding

135 WHAT'S WORTH FUNDING? FINDING PROJECTS THAT CAN MAKE A DIFFERENCE: Elizabeth Kean, Center for Science, Mathematics, and Computer Education, 27 Henzlik Hall, University of Nebraska-Lincoln, NE 68588-0355.

Grantors interested in real (not cosmetic) change should look for projects that potentially alter the institutions in which learning takes place or the culture of chemistry. Here are some examples: technology that makes 80% of the introductory chemistry curriculum obsolete; content which crosses disciplinary lines, emphasizing chemistry as a human enterprise; anything that has students doing more than repeating information or pulls new players into the classroom; anything which involves underrepresented persons on their own terms (not trying to make them just like us). Consider for funding only those projects with sustained time frames, programs studied in depth (no "black box" projects), and anything that includes multiples of the above. Ultimately: consider what would change or stay the same if the program is wildly successful.

136 CHEMICAL TRANSFORMATIONS: AN EDUCATIONAL CONTEXT. Robert L. Lichter, The Camille and Henry Dreyfus Foundation, Inc., 555 Madison Avenue, New York, New York 10022-3301

Common assumptions underlying chemistry education have been derived under conditions that may not necessarily obtain under today's circumstances or those of the foreseeable future. How or whether subject matter is compartmentalized, the respective roles and expectations of teachers and students, and the varying emphases on the teaching and research components of education at institutions of higher learning are some of the issues that are now under vigorous scrutiny. Approaches to chemical education need to progress from its revision and reform to its transformation, with new assumptions articulated by chemistry educators at all levels. Incentives and encouragements designed to legitimize faculty commitment to this challenge, especially at the college and university level, but also at the pre-college level, need to be developed, so that the same kind of intellectual energy that has served the chemical research endeavor so magnificently can be applied to larger educational issues, of which research is a part. Grantsmaking organizations can take the lead in providing pathways for this transformation. This symposium will explore some of these themes.

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SCHOOL TO SCHOOL, SCIENTIST TO SCIENTIST, SUMMER PARTNERSHIPS

Brian Andreen, Research Corporation,
6840 E. Broadway Blvd., Tucson, AZ 85710-2815

There is a great gulf between science education at the high school level and at the collegiate level. By default, precollege science education has been relegated to science education departments and specialists. High school teachers rarely participate in research, are unaware what scientists do, and seldom are included as members of the community of scientists. They are too often bystanders, purveyors of science history without the benefit of experience in doing science. University scientists are for the most part ignorant of the special needs and opportunities which high school teachers face. Efforts to address these issues will be discussed.

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APPROACHES TO INTEGRATING SCIENCE EDUCATION

Neal O. Thorpe, M. J. Murdock Charitable Trust, Vancouver, WA

Science education is often compartmentalized and disjointed, both within centers of training as well as within communities and regions. The Murdock Trust is promoting those efforts in science education that bring together formal and informal channels and facilitate a heightened interaction between academic levels. Special attention is paid to programs that renew, invigorate and sustain teachers and researchers and that employ hands-on approaches in making science attractive to young people. Efforts underway in the region and those anticipated for the future will be discussed along with funding opportunities provided by the Trust to support these approaches.

139 **NSF SUPPORT: CONTINUING RESEARCH RELATED TO CHEMCOM - AN EXAMPLE**
E. X. Sutman Room 635A, National Science Foundation, 1800 G Street, NW, Washington DC 20550

NSF-EHR supplied the major support for the development of *ChemCom*, a high school chemistry program giving major emphasis to societal and social applications of chemistry. The independent evaluation of student learning of *ChemCom* (involving 3800 students and 78 teachers) indicated some surprising results. For example, *ChemCom* students and those enrolled in more traditional college preparatory chemistry, performed equally on chemistry content items, while *ChemCom* students out performed traditional students on items which called for applications of chemistry. Now NSF has funded a small pilot study as as first step in determining the impact of *ChemCom* on motivating students, especially women, to pursue advanced science courses at the school level. Additional funding opportunities will be considered.

140 State Funding Opportunities for Chemistry Education. T.P. Sachse, California Department of Education, Sacramento, CA 95814

Few teachers or university faculty are aware of state and local precollege education funding sources that can be used to improve chemistry education. Most such funds are "categorical," in that they are designed for use by identified categories of students and/or teachers, but the basic need for chemistry education makes most of these categorical funds within reach of chemistry educators. This paper will list and describe several regular funding mechanisms and how to access them for improving chemistry education.

Expanding the Audience for Chemistry Lee Marek - Organizer, Presiding

141 SON OF WEIRD SCIENCE: A PHENOMENOLOGICAL APPROACH TO TEACHING.
Lee Marek, Bob Lewis, DeWayne Lieneman, Bill West, CHEM WEST, Naperville North H.S., 899 N. Mill St., Naperville, IL 60563

Those sultans of chemical high jinks are back with a new [or almost so] series of demonstrations and teaching tips that will turn on even the most comatose students. Students learn best when they want to learn. It is our job at the high school level to awaken their desire to learn--to keep the students mentally coming back. You can't communicate with people who are not present. If you want "presence", you have to capture attention. Four members of Chemistry West, a Chicago area chemistry teachers' alliance network group, will present a NEW AND DIFFERENT number of short, easy and sometimes "weird" demonstrations and ideas on chemical/physical phenomena. These demonstrations and ideas are taken from their monthly meetings. The demonstrations are used to grab or hook the students into thinking about the day's topic and to convince the class that their teacher is an eccentric. This program is cosponsored by Fermilab and Chicago Drug & Chemical Association.

142 CHEMISTRY KITS - MORE DEMONSTRATIONS IN LESS TIME, G. L. Gilbert, Department of Chemistry, Denison University, Granville, OH 43023

A strategy of organizing the basic necessities for the performance of a chemistry demonstration in a small kit, coupled with methods of quickly measuring amount of materials used in the demonstration, have allowed the author to present many more demonstrations than time formerly allowed. Some specific examples of these organizational patterns and other means of achieving time-savings will be shared with the hope of encouraging greater use of demonstrations as well as soliciting ideas for inclusion in such kits.

143 **STOICHIOMETRY: A MICROSCALE EXPERIMENT** David A. Kukla North Hollywood High School, North Hollywood, CA

The experiment involves the reaction of sodium carbonate with dilute hydrochloric acid. Using a "salsa" cup as a reaction chamber and 0.40 g of sodium carbonate, the students, working individuallly, determine the mass difference between reactants and products. The mass difference is due to the evolution and dissipation of carbon dioxide. Using a word equation, the students are to translate the equation into a balanced chemical equation and to compute the theoretical yield of carbon dioxide. They then compare the expected yield to the actual yield.

144 **PERIODICITY: A MICROSCALE EXPERIMENT** David A. Kukla North Hollywood High School, North Hollywood, CA

The experiment involves the redox reactions between water solutions of the halogens and the halide ions. Chloride, bromide, and iodide ions will be tested with chlorine, bromine, and iodine water. The ability of the halogen solution to oxidize the halide ions is related to the element's position on the periodic table. The experiment is carried out in a 24-well microplate. The students also will be asked to predict the reactivity of fluorine, given its position on the periodic table.

145 MICROSCALE REACTION KINETICS EXPERIMENTS, M. Carlberg, Cornelia Connelly High School, 2323 W. Broadway, Anaheim, CA 92804

Traditional Iodine Clock Reactions are performed simultaneously using different reactant concentrations, each in duplicate or triplicate, utilizing two 12-well micro strips, Beral droppers, and a simple timer. Reaction rates versus concentration of thiosulfate mixed with hydrochloric acid to form colloidal sulfur are also demonstrated. Data are graphed directly to show qualitative change, or can be manipulated and plotted to determine order of the reactions.

146 **TWO MICROSCALE LABS DEALING WITH BOYLE'S LAW** Richard A. Erdman
Venice High School, 13000 Venice Blvd., Los Angeles, CA 90066

Two simple hands-on setups to illustrate Boyle's law will be demonstrated using common micro-chemistry equipment which should be readily available to high school chemistry teachers. Both produce verifiable data that students can use to interpret and plot the pressure-volume relationship in gases.

147 A MICROSCALE DETERMINATION OF VISCOSITY. Barbara L. Gonzalez, Bishop Montgomery High School, Torrance, CA 90503.

The viscosities of three different liquids are determined by measuring the time required for a set amount of each liquid to drain from modified Beral pipets. Conclusions about the nature of viscosity are drawn from the results. This activity is designed to address a variety of educational levels. Students in advanced chemistry courses may supplement the basic procedure with experiments that investigate the effect of such variables as temperature, and polarity upon viscosity.

148 MICROSCALE KINETICS LABORATORY
Gómez, A.M., Saint John's School, Santurce, P.R. 00907-1560

The rate of a chemical reaction depends on several factors. Most reaction rate laboratories take into account only one factor, the effect of concentration. In addition most laboratories are very long and time consuming. This high school laboratory has been designed to be carried out in a 45 minute period. It takes into account the effect of the nature of the reactants, the concentration, the temperature and the effect of a catalyst. In the first part of the experiement the student will compare the rate of the reaction of permanganate ion with ferrous ion and with oxalic acid. He will study the effect of a catalyst on the reaction with oxalic acid and the effect of temperature. In the second part, the student will determine the order of an iodine clock reaction, thereby studying the effect of concentration.

149 MACINTOSH APPLICATIONS IN A MICROSCALE INVESTIGATIVE LAB; Nancy Konigsberg Kerner
Department of Chemistry, The University of Michigan, Ann Arbor, Michigan,48109.

Investigative labs conducted on a microscale level with students assigned to "research groups", yield a large amount of data in a short period of time. Each research group generates group data and/or analyses based on the individually generated data of each team member. Each research group uses different reagents to carry out the same and/or varying aspects of an investigation. The computer provides a means of collecting, organizing and linking data.

Revamping General Chemistry: II Content, Organization, and Models J.J. Fortman - Organizer; H. Taft - Presiding

150 NEW GOALS FOR THE GENERAL CHEMISTRY COURSE AND THEIR IMPLICATIONS R.J.Gillespie, Dept. of Chemistry, McMaster University, Hamilton, Ontario, Canada, L8S 4M1

The primary goal of the general chemistry course should be to provide science and engineering students with an introduction to modern chemistry. This introduction should demonstrate that chemistry is an exciting, relevant science that plays a central role in many other sciences, that will be useful, indeed essential, to them in their further studies outside chemistry and that will enable them to function as chemically literate citizens. The present course is much too strongly focused on the perceived needs of the chemistry major and must be replaced by a course with more relevance to the other sciences and to everyday life, less material, more integration, less arithmetic and more balance.

151 CHEMISTRY IN CONTEXT: A VIRUS IN THE SERVICE COURSE? A. Truman Schwartz, Department of Chemistry, Macalester College, St. Paul, Minnesota 55105

Chemistry in Context is a college-level chemistry text being prepared under ACS sponsorship for use with nonscience majors. As the name implies, the chemistry is imbedded in its social, economic, and political context. Chapters focus on a socially relevant issue such as global warming, energy generation from fossil fuels, or the discovery and development of new pharmaceuticals. The chemistry is introduced on an as-needed basis to inform the readers' understanding of the subject. Special decision-making activities are an important feature of the text. The second trial edition of *Chemistry in Context* was class tested during the 1991-92 academic year, and it has proved to be quite successful with the intended audience. The question to be posed here is "Can some of the same materials, organization, pedagogical approach, and teaching strategies used in *Chemistry in Context* be transferred successfully to a traditional chemistry course designed primarily for science majors?" Speculation will be supplemented with evidence from a limited experiment.

152 CONCEPT DEVELOPMENT FOR CHEMICAL LITERACY VERSUS CONCEPT DEVELOPMENT IN GENERAL CHEMISTRY. William R. Robinson, Purdue University, West Lafayette, Indiana 47907-1393

"A world of living cells and synthetic materials; a modern world in which society and technology are interdependent; a world of structure and phenomena; this is the World of Chemistry...", so reads a promotional piece for The World of Chemistry telecourse. A promotional piece for chemical literacy would carry a very similar message. Consequently, we have used The World of Chemistry as a convenient base to identify those concepts that might be considered central to chemical literacy. We will compare these with concepts presented in the average general chemistry course in order to determine how well the introductory course meets the need of preparing a chemically literate college graduate.

153 A CHALLENGE TO CHANGE GENERAL CHEMISTRY - TURNING IT INSIDE-OUT, UPSIDE-DOWN, and BACKWARDS, John J. Fortman, Dept. of Chemistry, Wright State University, Dayton, OH 45435.

General Chemistry has changed little over the last 25 years except to continually add more physical chemical calculations and theory and the return of limited amounts of descriptive chemistry. Although the majority of chemists practice organic chemistry it is lightly treated if at all. Applications are secondary to abstract theory. How to do chemistry is taught without showing what is done with chemistry. Reforms are overdue. Beginning in the Fall of 1992 Wright State will begin offering an experimental general chemistry sequence containing the core material identified by the Task Force organized on a framework of meaningful uses or occurances of chemistry. The course is backwards in that it will start with organic chemistry which is usually at the end of the year if covered at all. It is inside-out as it is organized around applications and occurances of chemistry and brings in concepts as needed instead of vice-versa. It is upside-down as topics chosen will be based on the interest or usefulness to all students instead of being a training for chemistry majors. Emphasis is on educating students in chemistry instead of only training them to do calculations.

154 HIGHLIGHTS FROM "A MATERIALS CHEMISTRY COMPANION TO GENERAL CHEMISTRY:" LECTURE DEMONSTRATIONS. Margret J. Geselbracht, Arthur B. Ellis, Department of Chemistry, University of Wisconsin-Madison, Madison, WI 53706, William R. Robinson, Department of Chemistry, Purdue University, West Lafayette, IN 47907, Martha Greenblatt, Department of Chemistry, Rutgers University, New Brunswick, NJ 08903, M. Stanley Whittingham, Department of Chemistry, SUNY at Binghamton, Binghamton, NY 13902, George C. Lisensky, Department of Chemistry, Beloit College, Beloit, WI 53511

An ad hoc committee, with support from the ACS, the Dreyfus Foundation, and the National Science Foundation, is preparing a resource text entitled, "A Materials Chemistry Companion to General Chemistry." This volume will parallel typical general chemistry texts and will provide examples from the world of materials - ceramics, polymers, semiconductors, and superconductors, for example - that illustrate the concepts traditionally taught in introductory chemistry courses. This link to our high-tech world has the potential to revitalize general chemistry courses. Selected lecture demonstrations from the "Companion" will be presented.

155 PROMOTING THE RELEVANCE & VALUE OF CHEMISTRY: THE GENERAL CHEMISTRY PROGRAM AT THE U.S. COAST GUARD ACADEMY. K. A. Redig & T.J. Haas, Superintendent (ds), U.S. Coast Guard Academy, 15 Mohegan Ave, New London, CT 06320

Our discipline is dying. Many of our students face chemistry courses with a sense of fear and foreboding, sitting in our classrooms because ours is a required course. Yet at the same time, fundamentals of chemistry have become intertwined in countless professions to say nothing of its growing importance in our everyday lives. Educators must bridge this dichotomy between attitude and importance. This paper is the case study of a systematic attempt at the U. S. Coast Guard Academy to positively change attitudes while at the same time deepening our student's understanding within the discipline of chemistry. The progress to date of this fledgling one year program has been worth the efforts. The intent of this paper is to present the framework of our program in order to spur others on to further efforts in exciting students with the relevance and importance of the discipline of chemistry.

156 **THE UNIVERITY OF MICHIGAN UNDERGRADUATE PROGRAM. WHERE DO WE STAND AFTER THREE YEARS?**

Brian P. Coppola, Department of Chemistry, The University of Michigan, Ann Arbor, Michigan, 48187.

In September, 1991, 975 of 2500 introductory chemistry students started their college chemistry with the *Structure and Reactivity* sequence. Now in its third year, The University of Michigan's curricular experiment starts students with the more qualitative models of structure and reactivity used by organic and inorganic chemists as the basis for the introductory courses. Students are immersed into the language of chemistry, reasoning by analogy, and the increasingly sophisticated models for chemical phenomena. The introductory sequence continues with a term of Inorganic Chemistry and concludes, rather than begins, with the first course based largely on quantitative methods. The laboratories associated with all of these courses have been reconstructed to emphasize independent investigation. In response to these changes, the upper level courses have been restructured as the students from the pilot class moved their way through the curriculum. The majority of the students from the pilot class will graduate in 1993, although a few graduated in 1992. Evaluating these changes has begun. A number of encouraging facts have emerged, as have a number of important lessons for departments implementing curricular changes.

157 ARE WE TEACHING THE RIGHT THINGS IN GENERAL CHEMISTRY? Julie A. Kreyenbuhl and Charles H. Atwood, Department of Chemistry, Mercer University, Macon, GA 31207.

The results of a survey of 41 prominent chemists, engineers, physicians and pharmacologists who were asked what topics in general chemistry are important for understanding the "high tech" revolution will be presented. The results are broken down into topics that are common in general chemistry curricula and the respondents' preferences for each topic. Topics that were deemed especially important and especially unimportant by the respondents will be noted. Topics which could be added to the curriculum and the respondents' preferences will be discussed. Finally differences between the preferences of chemists versus those of engineers will be highlighted.

158 REASONING SKILLS AND MISCONCEPTIONS -- A RATIONALE FOR REVAMPING CHEMISTRY INSTRUCTION. James P. Birk, John Foster, Martha J. Kurtz, and Susanne Woodward, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

A number of reasoning skills have been found to be important for success in learning and practicing chemistry. We have been testing our general chemistry students with a computerized test of several reasoning skills, including the classical Piaget chemical mixtures test, as well as tests of combinatorial reasoning, proportional reasoning, and ability to control variables. Since these reasoning skills are important for learning chemistry, it is important that we introduce material in our courses to augment these skills. Our present approach to teaching chemistry is also shown to be deficient by tests of misconceptions in simple bonding and structure topics, which have been given to a variety of students from high school through graduate school. Even though factual material is mastered, a conceptual understanding of the material shows a significant lag. Results of these various tests, and correlations with performance in chemistry exams, will be presented.

159 USING EDUCATIONAL RESEARCH FINDINGS AS A GUIDE TO CURRICULUM DEVELOPMENT. Fred Garafalo and Vin LoPresti, Departments of Chemistry and Biology, Massachusetts College of Pharmacy and Allied Health Sciences, Boston, MA 02115.

The information explosion occurring in all areas of science has impacted heavily upon college survey courses. Recent reports conclude that instructors in general chemistry need to trim content, refocus curricula, and educate students who are able to cross boundaries among scientific disciplines. Research in education suggests that such curriculum restructuring should address important findings. These findings indicate that students must be able to link new knowledge to what they already know in order to successfully grasp new concepts, and that the misconceptions students hold about natural phenomena and symbolic representations are not easily dispelled. In addition, traditional passive lecture format does not encourage students to actively engage material, and make unifying connections. This talk will focus on efforts to address these issues over the past six years in our freshman curriculum. Our approach includes integrating chemistry and biology around unifying themes, moving toward a more interactive classroom format (including the Thinking-Aloud-Pair - Problem-Solving Method), reducing content, and focusing on epistemology where possible.

160 LEARNING CYCLES IN THE HIGH SCHOOL LABORATORY. James P. Birk and Anton E. Lawson, Departments of Chemistry and Zoology, Arizona State University, Tempe, AZ 85287-1604.

A lot of evidence suggests that the commonly used lecture and lab format does not work well for teaching chemistry. We have undertaken the development of a chemistry curriculum in the form of a series of learning cycles, which provide a student-centered, laboratory-oriented classroom experience. High school chemistry teachers are participating in the development of classroom materials after initial training in the philosophy and use of learning cycles. About twenty learning cycles have been developed so far and are currently undergoing classroom testing. Additional teachers will be trained by the initial group of teachers. Results of these experiences will be recounted.

161 COOPERATIVE LEARNING IN THE LAB; AN ANSWER? JOHN G. LITTLE
St. Mary's High School, P.O. Box 7247, Stockton, California 957267-0247

Traditionally, high school chemistry labs are done by teams of two (or more) students, with the result that one student does all the work (and gets all the benefits), while the partner is left an uninvolved spectator, or at best, recorder of the experimenter's data. In an effort to involve more students in the laboratory experience, a combination of microscale procedures and cooperative learning principles is being tested. The goal is for each student to have a defined, active, hands-on role in each procedure. Microscale experiments make it economically possible to provide each student with the equipment she/he needs while minimizing the hazards associated with many of the reagents used in today's laboratory programs.

162 ONE POSSIBLE ROLE OF COMPUTERS IN THE HIGH SCHOOL CHEMISTRY CLASSROOM. J.A. Baron, La Jolla High School 750 Nautilus St. La Jolla, CA 92037-6199

Although there has been much discussion about computers in the secondary classroom, computers are used for little more than tutorial or simulation activities. This talk will discuss one teacher's effort to use the computer for the acquisition, graphing, analysis, and reporting of data. Our long range goals are to allow students to use the school software for data analysis by their home computer and modem and to network with a local industry in La Jolla, General Atomic. General Atomic has agreed to allow us to use their computer network and to use their "E mail" capabilities to allow the teachers to ask for technical assistance, computer software, equipment, materials and/or chemicals; and to allow students to get immediate professional help for science projects, experiments, or Science Olympiad.

163 ONE RESOUNDING VOTE FOR "MINDS-ON" LABORATORY EXPERIENCES WITH APPROPRIATE ASSESSMENTS. Gladysmae Good, Arlington High School, Indianapolis, IN, 46226

Computer simulations and videos have threatened the 'backbone' of the high school chemistry course. Many claim that labs are "cookbook" exercises, or that concepts learned inthe lab cannot be assessed. To answer these accusations teachers must develop new labs or rewrite the old ones to cultivate "minds-on" as well as "hands-on" activities to stimulate higher-order thinking. Then teachers can develop assessments unique to the laboratory. We will discuss several assessments: the critique of anecdotes relating to a particular lab; the challenge of a parallel laboratory activity; "pictures in the mind"; and lab practicals. You will get involved in improving a familiar experiment to include these new requirements, as well as apply appropriate assessments. We all need to get involved or we will lose an essential activity of science education.

164 BOXING THE EXAMINATION: USING SMALL-SCALE ACTIVITIES TO ASSESS CHEMICAL PROBLEM-SOLVING IN THE CLASSROOM. Wilbur Bergquist, BSCS, 830 North Tejon Street, Suite 405, Colorado Springs, CO 80903.

Assessment methods using small-scale laboratory activities have been developed which allow students to conduct experiments during the testing session. Students are required to perform a specific chemical task and then provide written protocols describing both the procedures used how they generated an answer to the problem. Scoring is based on the students' ability to utilize data collected to solve a problem. Tailoring the complexity of the task makes it possible to create a range of hands-on tasks that can help assess a student's ability to recall and apply concepts. These small-scale activities have reduced both the time and the quantities of materials needed to accomplish a given task. The necessary reagents, reaction vessels, and instructions can all be packaged into a box no longer than twelve centimeters on a side.

165 PURDUE INSTRUMENTATION VAN PROJECT: AN OUTREACH TO HIGH SCHOOLS Diane W. Burnett, Outreach Coordinator, Department of Chemistry, Purdue University, West Lafayette, IN 47907-1393.

The Purdue Instrumentation Van Project is an innovative program designed to assist high school chemistry teachers by transporting modern chemical instrumentation into their classrooms. Using the instruments first hand provides an opportunity for high school students to perform chemistry as it is done in modern research laboratories. Workshops for PIV Project teachers create a framework for updating their knowledge of analytical chemistry, writing laboratory procedures relevant to technology/society and emphasizing the use of newer teaching methodology. The response from both teachers and students has been extremely positive. This presentation will discuss the both the implementation and impact of the project.

166 THE PLACE OF LABORATORY WORK IN THE A.P. COURSE. S.R. Marsden, Harvard-Westlake School, 3700 Coldwater Canyon Ave., North Hollywood, CA 91604

Laboratory work in the A.P. course is often left to the end of the year, following the exam. An alternative approach will be presented in which the laboratory takes on the central character of the material and the traditional lecture format is all but abandoned. Typical materials used in such a course will be presented and discussed.

167 CAN WE TEACH THE FIRST LEVEL HIGH SCHOOL CHEMISTRY MERELY BY USING 'LEARNING BY DOING' METHOD? Tuula A. Asunta, Department of Teacher Education, University of Jyväskylä, Finland.

We planned chemitry course based only on practical laboratory work. The laboratory period was planned to include the basic ideas of constructivism, co-operation in the classroom and problemsolving technique. We kept constantly asking ourselves: How to make students think? How to create positive attitudes towards chemistry? We also tried to pay attention to fluent interaction between the teacher and student and analyzed the effects through the course. The evaluation of the course will be discussed.

168 HOPE COLLEGE LABORATORY EXPERIMENTS ON COMPUTER DISKS. Eugene C. Jekel, Department of Chemistry, Hope College, Holland, MI 49423.

Selected laboratory experiments that have been a part of the instructional program in the NSF-supported Summer Projects at Hope College have been edited and placed on computer disks for both MS-DOS and Macintosh systems. Most of the experiments have quantitative emphases and are designed for the second-year Advanced Placement high school chemistry course. The dissemination of these non-copyrighted computer disks will allow teachers to readily adapt, edit and print the experimental write-ups for their own instructional use without having to retype entire documents. The disks will be available at a low, not-for-profit price, based only on the expense of production and mailing. The presenter will describe the content of the compilation, make comments on key experiments and announce procedures for obtaining copies of the disks.

169 SYNTHESIS AND ANALYSIS OF A COPPER(II) AMMONIA COMPLEX SALT.

Frank S. Quiring, Box #381, North Newton, KS 67117

An experiment will be described in which the coordination compound, $Cu(NH_3)_4SO_4 \cdot H_2O$, is synthesized and then analyzed by the student. The number of moles of both ligand and metal are determined directly; the number of moles of water can be determined indirectly. Students have found laboratory work of this kind to be intrinsically interesting. Effective ways of presenting the experiment will be discussed; suggestions for making the procedures workable in short high school laboratory periods will be offered; and student data will be presented. This experiment has been a part of the Hope College NSF-supported Summer Projects for high school teachers. Handouts of the experiment will be available.

IBM Applications: I General Chemistry S. D. Gammon - Organizer, Presiding

170 LABORATORY AND SIMULATION - PARTNERS IN LEARNING, J. Crook, J. Weyh, K. Bruland, J. Peterson, G. Gerhold, D. King, Dept. of Chemistry, Western Washington University, Bellingham, WA 98225-9058

The simulation to be demonstrated is based on a general chemistry qualitative analysis experiment and is intended as an extension of actual laboratory experience. The program provides unlimited opportunity for students to explore the chemistry of 11 cations/anions and solve unknowns with exactly the same visual clues as those seen in the laboratory. It runs on any PS/2 generation computer, is completely mouse driven, and offers over 1000 possible unknowns at five levels of difficulty. In the simulation, reagents can be added to samples, samples can be heated, separations performed, and specific tests conducted for Na^+ and NO_3^-. The program then simultaneously displays real video images of authentic samples before and after the operation was performed. The displayed images are taken from a bank of nearly 250 pictures stored digitally on the hard drive. The student draws conclusions based on the images presented and proceeds with further testing until the unknown is identified.

171 MULTIMEDIA EXERCISES FOR SCIENCE LABORATORIES David M. Whisnant and Terry E. Ferguson, Wofford College, Spartanburg, SC 29303-3663

At Wofford College, we are working on computer-based multimedia exercises to help introductory chemistry and geology students study their laboratory experiments. Science laboratory experiences in introductory courses generally are strong on technique but weak in their presentation of theory. We are developing a series of multimedia lessons which encourage students to think critically about laboratory content and to gain a fuller understanding of its theoretical context. In order to help students extend their experiences beyond their laboratory observations, the exercises include realistic video images of experiments -- real-time sequences from presently available videodiscs, captured still images from videotapes we have produced, and scanned pictures. These programs are being developed using authoring software which runs under the Windows 3.0 operating system, mainly Asymetrix ToolBook 1.5 and Microsoft Visual Basic. Examples of exercises which complement our general chemistry laboratory experiments will be illustrated in this presentation.

172 SUPPLEMENTING THE CHEMISTRY LAB EXPERIENCE: USING AN IBM COMPUTER-ASSISTED INTERACTIVE VIDEODISC LABORATORY PROGRAM. Renee D. Gittler, Department of Chemistry, Penn State University, Allentown Campus, 8400 Mohr Lane, Fogelsville, PA 18051

The Allentown Campus of Penn State has no laboratories. All Chemistry laboratory courses are taught in rented facilities at the local community college. Students and faculty must travel and can only be there during scheduled course time. There is no opportunity for flexibility or creativity. The award-winning "Exploring Chemistry," an IBM interactive videodisc laboratory in General Chemistry by Loretta Jones and Stanley G. Smith of the University of Illinois, is being used to supplement and enrich the students' laboratory experience as well as reducing rental fees and supplies. The interactive disc program, which is being used for approximately forty percent of the students' laboratory experience, will be described. Course organization, student evaluation and acccomplishments will be presented.

173 TEACHING GENERAL CHEMISTRY WITH DIGITIZED VIDEO ON A CD-ROM. Stanley Smith and Loretta Jones, Department of Chemistry, University of Illinois at Urbana-Champaign, 601 S. Mathews, Urbana, IL. 61801

We developed interactive video instructional lessons for the teaching of general chemistry using a laser disc player to store and play the TV images. Alternative versions of these programs are being developed which use digitized video images stored on a CD-ROM. Instructional programs using these technologies will be compared and demonstrated.

174 PROJECT CATALYST: A PROGRESS REPORT. John W. Moore, Paul F. Schatz, Lynn R. Hunsberger, John C. Kotz, Department of Chemistry, University of Wisconsin-Madison, 1101 University Avenue, Madison, WI 53706.

Project CATALYST aims to explore the many ways in which technology (computers, videodiscs, CD-ROM, DVI, etc.) can enhance and change the chemistry curriculum. Our contention is that pervasive implementation of technology-based methods of presenting chemistry will change *what* we teach as well as changing *how* we teach. Examples will be provided of: computer-mediated laboratories, in which the computer monitors student actions and provides immediate feedback regarding quality of data; lecture materials based upon interactive videodisc, digitized images, and computer-generated animations; and hypertext/hypermedia applications designed for use in our computer room.

175

PC-BASED MATERIALS FOR FIRST-YEAR CHEMISTRY. Stephen K. Lower, Department of Chemistry, Simon Fraser University, Burnaby BC V5A 1S6, CANADA

A demonstration of some of the lessons and techniques used in a first-year course in which CAI is the major instructional tool.

176 **CHEMPROF: AN INTELLIGENT TUTOR** Arthur A. Eggert, Catherine H. Middlecamp and Anthony T. Jacob Chemistry Learning Center, University of Wisconsin-Madison, Madison, WI 53706

CHEMPROF is an intelligent tutoring system that teaches chemical literacy and problem solving to general chemistry students. it can work with students in one of three modes: assessing their skills and recommending a subsequent step, instructing them on the topic, or solving problems they or CHEMPROF supplies. In essence, students choose how to interact with CHEMPROF, and CHEMPROF adjusts its instructional flow accordingly. Thus, the primary goal of CHEMPROF is to provide individualized instruction.

CHEMPROF is currently being used by general chemistry students at the University of Wisconsin-Madison. Three content modules are available: elements and related chemical concepts, inorganic chemical nomenclature, and oxidation number assignment. Our demonstration will include how CHEMPROF can accept user inputs (chemical name or formula), screen these for legitimacy, provide a corresponding formula or name, and explain the derivation of the formula or name to the user.

177 CHEMICAL EQUILIBRIUM CALCULATIONS WITH PROGRAM E Q U I L I B. Robert D. Allendoerfer, Department of Chemistry, State University of New York at Buffalo, Buffalo, New York 14214-3094.

Program EQUILIB is an adaptation of a computer program for MS-DOS computers published by J.M. Campanario and R. Ballesteros, [JCMST 10(2), 87 (1991)] that we hope will do for quadratic equations what the electronic calculator has done for logarithm tables, *i.e.*, eliminate them from general chemistry textbooks. The Windows 3.0 version which will be demonstrated, like its DOS counterpart, can calculate the equilibrium concentrations of all the reagents in an arbitrary chemical reaction with as many as 5 species on each side of the equation without the necessity of explicitly solving any polynomial equations, using a method suggested by E. Weltin, [J. Chem. Educ. 68(6), 486 (1991)]. $aA + bB + cC + dD + eE \rightleftharpoons vV + wW + xX + yY + zZ$
The only required input data are: (1) the stoichiometric coefficients in the balanced equation, (2) the initial concentrations of the chemical species, and (3) the equilibrium constant, K_c.

178 STUDENT PLUS COMPUTER EQUALS LEARNER. John S. Martin, Edward V. Blackburn and Imre Safarik, Department of Chemistry, The University of Alberta, Edmonton AB Canada T6G 2G2.

We have written over thirty lessons on most of the topics of introductory chemistry; they run on basic PC's with ega or vga graphics. Ultimately they will make up the first computer-based textbook of chemistry.

The lessons are intended to be self-supporting; no other material (except a calculator) is needed. They are highly interactive: our ideal is to provide information to the student only in response to a perceived or diagnosed need. So, with the guidance of the computer, the student teaches him/herself.

Many lessons start with simulated experiments, so that chemical principles can be revealed in the course of analysis of the student's own data. Animations and games are also used where appropriate.

179 **ELEMENTARY DETECTIVE: AN INTERACTIVE, MS-DOS CHEMISTRY PROGRAM** David A. Kukla, North Hollywood High School, North Hollywood, CA 91606

Elementary Detective is a problem-solving program in which the student determines an element form clues about the element's chemical properties, physical properties, and uses. The student is given both verbal and graphical information. He is assigned points, and each clue costs a specified number of points. It is the the student's advantage to determine the identity of the element from the fewest number of clues. The program also analyzes the student's problem-solving path. Individual and group data can be used to determine which paths are more effective and which are less effective. Remediation, when necessary is more effective.

The program uses the MS Windows 3.0 environment. The application is a data base format and is called IMMEX. Immex was developed by Ron Stevens, Division of Microbiology and Immunology, School of Medicine, UCLA.

180 A COMPUTERIZED TEST OF REASONING SKILLS. James P. Birk, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

A number of reasoning skills have been found to be important for success in learning and practicing chemistry and other sciences. To assist in the rapid assessment of some of these reasoning skills among our students, a reasoning test has been devised for use with IBM PC compatible computers, in both QuickBASIC format for DOS and Visual BASIC format for the WINDOWS operating system. This test incorporates the classical Piaget combination of solutions (clock reaction) test, as well as tests of combinatorial reasoning, proportional reasoning, and ability to control variables. With 13 computers, it has been possible to test about 100 students per hour with this program. Results of a student's efforts are automatically recorded on disk and can be evaluated by another program. Output from this program can be incorporated into a statistical package such as SPSS for correlation with classroom performance.

181 COMPUTER-BASED LEARNING CYCLES FOR DESCRIPTIVE INORGANIC CHEMISTRY. Darcy Bardwell and James P. Birk, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

Considerable evidence suggests that discovery-based instruction is more effective than the traditional lecture format in teaching laboratory sciences. We are developing a series of discovery-based learning cycles to replace lecture in the teaching of descriptive inorganic chemistry. These learning cycles involve extensive computer interaction in the exploration phase followed by both laboratory and computer activities in the application phase. The use of computers in the learning cycles minimizes problems inherent in laboratory activities, such as cost, safety considerations, availability of materials, scope of systems that can be investigated, and time. Two existing computer programs, PIRExS and KC? Discoverer, provide a rich environment for the development of learning cycles. One example of a learning cycle is the exploration of decomposition reactions with PIRExS, followed by development of the rules governing these reactions, and finally by application of these rules to predict behavior that can be tested in the laboratory. Other examples will be discussed.

General Posters R. Erdman and B. Gonzalez - Presiding

182 Resources to Make Life Easier for Chemistry Teachers!
M.K. Turckes, Manager, Office of High School Chemistry,
American Chemcial Society, 1155 Sixteenth Street, NW
Washington, DC 20036

The American Chemical Society's Office of High School Chemistry administers many programs for high school chemistry teachers and students. Additionally, the office has several resoruces availabel to teachers. Come and hear about our new resources, such as "Safety in the Academic Laboratory"--a 35 minute videotape that discusses safety issues. Preview the new "People Who Took Chemistry--That's Who" video which discusses careers in chemistry and is intended for high school students. Other resources, such as Chem Matters magazine and Chemunity News will be reviewed. Keep in touch! Come and hear how ACS is trying to make life easier for you.

183 **CAN THE ORGANIC LAB BE COMPUTER ASSISTED?** B. N. Campbell, Chemistry Department, Potsdam College of the State University of New York, Potsdam, NY 13676

There has not been much discussion about the use of computers in the Organic Chemistry Laboratory, but there is some software that could be used. This poster will review how some software has been used or could be used to enhance the Organic Lab. Experience and concerns of the audience will be requested.

184 **HANDS-ON ACTIVITIES FROM A PRE-COLLEGE TEACHER WORKSHOP**, John P. Williams, Chemistry Department, Miami University-Hamilton, Hamilton, OH 45011, Arlyne M. Sarquis, Chemistry Department, Miami University-Middletown, Middletown, OH 45042, and Jerry L. Sarquis, Chemistry Department, Miami University, Oxford, OH 45056.

Our graduate-credit teacher workshop "Teaching Science With **TOYS**" has positively impacted grade K-12 teachers and their students from about two hundred school districts. Although workshops have had enrollments up to 72 teachers, team-taught, hands-on instruction is generally provided to smaller grade-level groups by teams of chemistry and physics faculty and peer teachers. Examples of hands-on materials used by participants at all grade levels in the workshops and then classroom-tested will be presented (such as Sumi Nagashi and the commercially-available Game Thermometer, Shrinky Dinks, and Floating Boat, and their corresponding homemade toys). Funding has been provided by the National Science Foundation, the Ohio Board of Regents, and Miami University.

185 PRACTICAL ACTIVITIES FOR THE ASSESSMENT OF STUDENTS. Maria R. Walsh, Department of Science, Pike High School, 6701 Zionsville Rd., Indianapolis, IN 46268

This presentation describes alternatives to the typical examination given at the end of a unit or chapter in a first-year high school chemistry class. Practical, hands-on activities used for evaluating the level of learning of our students are incorporated into examinations used at the end of the units on Measurements and Calculations, The Mole, and Liquids and Solids. These will be shared.

186 FABRICATION OF INEXPENSIVE ANALYTICAL LABORATORY RACKS FROM PVC PIPE. H. P. Williams, Department of Chemistry & Biochemistry, University of Southern Mississippi, Hattiesburg, MS 39406

Low cost PVC pipe was used to construct very durable storage racks for volumetric glassware. The designs shown protect calibrated glassware and allow dust free drying and safe storage locations. The ease of fabrication, durability, unique custom designs, and low cost of these are a few of the advantages offered. The techniques and tools used are simple and the cost/benefit ratio is very low.

187 EMPIRICAL AND MOLECULAR FORMULAS: A SPORTING ANALOGY

Charles M. Wynn, Department of Physical Sciences,
Eastern Connecticut State University, Willimantic, CT 06226

Prior knowledge can have a significant impact on subsequent learning. Such knowledge in the form of analogies, examples, and demonstrations can be used to connect new information with what students already know. This paper will present a useful analogy between the determination of empirical and molecular formulas and the determination of simplest and actual "game formulas" of familiar team sports. [The game formula gives the actual number of players on each team; the simplest game formula gives the lowest whole-number ratio of players on each team.]

188 **MODIFIED PSI FORMAT IN THE GENERAL CHEMISTRY COURSE THAT PROMOTES HIGHER ORDER THINKING SKILLS.** Josefina Arce, Nadia Cordero, Mariel Muir, and Rosa Betancourt, Department of Chemistry, University of Puerto Rico, Río Piedras, PR 00931

Recent trends in Chemistry teaching are geared toward developing thinking skills in the students. The great amount of material "covered" in the General Chemistry Course makes it difficult for the teacher to carry out classroom activities that stimulate students to observe, analyze, interpret data, **reach their own conclusions**, and **justify them**. The General Chemistry PSI format at UPR-RP has been modified to provide experiences that promote these skills while allowing the student to learn the course material at his/her own pace. Activities have been designed, following the constructivist approach, in which the professor exposes the students to various experiences and **guides** the discussion that leads to the "discovery" of a key concept or the solution of a problem. Emphasis is being placed in conceptual understanding and not on mathematical calculations. To reinforce this approach, audiovisual modules have been designed highlighting basic chemical concepts and the question bank has been revised accordingly to include more items that probe conceptual comprehension. Examples of the interactive demonstrations, audiovisual modules, and model questions will be presented and discussed.

189 COOPERATIVE - SELF PACED - AND BILINGUAL GENERAL CHEMISTRY

Isabel B. Cains and Mariel M. Muir, Department of Chemistry, University of Puerto Rico, Rio Piedras, Puerto Rico 00931

General Chemistry has been taught in a bilingual mode at the University of Puerto Rico in two different formats for several years. The textbook used is written in English and the class and group work as well as testing is conducted in Spanish. Students must be fluent in both to be able to do graduate work or continue in science or medicine related fields. One of the two formats is lecture based and the other follows a self- paced system which evolved from the original Keller plan. Both systems have been retained to provide for the students different modalities of learning styles as well as for the instructors different modalities in teaching styles. Lately, cooperative group learning has been incorporated into the self - paced format to promote greater interaction and to develop and improve problem solving strategies and thinking skills. The adaptation of the cooperative group learning strategies in this course will be described.

190 **MODULAR TOPICS APPROACH TO GENERAL CHEMISTRY** Doris R. Kimbrough and Robert R. Meglen, University of Colroado at Denver, Denver, CO 80217-3364

In the Fall of 1991, the Chemistry Department at the CU-Denver began a revision of its general chemistry lecture and laboratory classes. Our approach was to rethink the manner in which general chemistry was taught where the information is presented and then applications are explained. Our approach was to use the different subdisciplines of chemistry to teach chemical principles: atmospheric chemistry to teach gas laws, or biochemistry to explain oxidation-reduction. This approach led to numerous successes as well as some mailures.

191 INFRARED SPECTRA OF PLASTIC WRAPS FOR AN INTRODUCTORY ANALYTICAL CHEMISTRY LAB. Karen A. Henderson, Physical Sciences Division, Scarborough College, University of Toronto, 1265 Military Trail, Scarborough, Ontario, Canada M1C 1A4

Students like to work on 'real' samples in analytical chemistry and today, for introductory Infrared Spectroscopy, that means high costs for cells and windows. This experiment introduces the basic concepts of the theory and works on samples with interesting spectra to interpret, while avoiding the high costs of cuvettes and windows. Samples of every brand of plastic wrap and plastic bag to be found in the supermarket are prepared in 'home-made' cardboard mounts. Spectra are collected and identified by comparison to a 'hard copy' library. If you have an FTIR with a library search facility, the computer can be asked to compare the spectrum of the 'unknown' to a prepared library and give the 'best hits'. Practice is obtained in collecting spectra, converting transmittance spectra to absorbance spectra, interpreting the spectra, where possible with reference to the monomer involved, and the use of the library search program.

Revamping General Chemistry: III Approaches J.J. Fortman - Organizer, G.M. Bodner - Presiding

192 LABORATORY-CENTERED INSTRUCTION IN CHEMISTRY: CONCEPT INTRODUCTION IN THE LABORATORY. Judith A. Strong, Moorhead State University, Moorhead, MN 56560 and Ram S. Lamba, Inter American University of Puerto Rico, Hato Rey PR 00919

The laboratory committee of the ACS Task Force on General Chemistry has agreed that laboratory-centered instruction in general chemistry is preferable to the traditional approach. Such an approach provides an understanding of basic concepts of chemistry; develops higher order thinking skills; promotes positive attitudes towards chemistry; and meets the needs of the chemical community for introductory courses. The committee is presently working on development and dissemination of materials to encourage and assist implementation of this approach. A major feature is the introduction of fundamentals through experimentation and observation prior to theoretical exposition. Past work with this approach has been done. Experiences at Moorhead State University where laboratories are taught by faculty other than lecture instructors will be described. One notable result was significant improvement in attitudes of both faculty and student participants.

193 PROMOTING STUDENT LEARNING THROUGH LABORATORY CENTERED INSTRUCTION.

Ram S. Lamba, Inter American University of Puerto Rico, P.O. Box 1293, Hato Rey, PR 00919
and Judy Strong, Moorhead State University, Moorhead, Minnesota 56560

In response to the widespread dissatisfaction with the state of undergraduate chemistry courses, the Task Force on General Chemistry of the DivCHED recommends that the laboratory experience should be given a more central role in the student's learning experiences. It also recommends that the concepts should be introduced through laboratory activities and then discussed more fully in the lecture. This investigative approach should involve the students in questioning, hypothesis formation, observation, testing and concept formation. The goal of the Task Force is to provide mechanisms to facilitate the adoption of laboratory-centered, inquiry-based instruction in introductory chemistry courses. To achieve this goal we need to develop and refine well documented, flexible laboratory-based instructional modules; develop and characterize instructional models which adapt successful laboratory-based courses to different institutional settings; and develop mechanisms for dissemination of the different instructional modules and models through workshops, conferences, and publications. Once the laboratory becomes the central focus of the course and the source of all major concepts, it is expected that the students will have better understanding and retention of the concepts of chemistry, thereby increasing positive attitudes and motivation to pursue a career in science.

194 General Chemistry from a Learning Theory Approach.

B. C. Pestel, D. K. Erwin and D. A. Lewis, Department of Chemistry, Rose-Hulman Institute of Technology, Terre Haute, IN 47803.

In our general chemistry program, content and process occupy positions of equal priority. Our goals are to help students develop learning skills, problem-solving ability, critical thinking strategies, self-confidence, and a teamwork concept all within the context of a core of essential general chemistry content. Discovery-oriented laboratories are used to initiate class discussions of the properties of chemicals and the principles that are drawn from them. Once the principles have been developed, students are given the opportunity to learn how to apply these principles through a variety of classroom group work activities. Open book examinations containing conceptual and quantitative components encourage students to learn beyond what can be memorized and to organize information. Group accountability and group assessment mechanisms reinforce the emphasis on the advantages of a team effort in learning. Specific examples will be given of classroom strategies used and problems encountered.

195 GENERAL CHEMISTRY WITH A UNIFYING PRINCIPLE.

David K. Erwin, B.C. Pestel, and D.A. Lewis, Department of Chemistry, Rose-Hulman Institute of Technology, Terre Haute, IN 47803.

College-level general chemistry courses need one unifying principle that ties together the typical considerations of chemical reactions including stoichiometry, thermochemistry, chemical equilibrium, and chemical kinetics. Otherwise, students all too often view theses topics as individual, mutually exclusive entities. In addition, some of these often require revisions as the course proceeds. A much more satisfying approach is to introduce one unifying principle which contains all of these topics and which seeks to insure consistency throughout the development of the chemical concepts. This unifying principle must be presented at the beginning of the course and continually reaffirmed. It requires that chemical equilibrium be considered before stoichiometry, thermochemistry, and kinetics. The unifying principle and course approach will be presented along with initial student data supporting its success.

196 RESTRUCTURING GENERAL CHEMISTRY AT THE UNIVERSITY OF REDLANDS,

J.L. Roberts, J.I. Selco, D.B. Wacks and W.J. Zajdel, Department of Chemistry, University of Redlands, 1200 E. Colton Ave., Redlands, CA 92373-0999

We have introduced a variety of different teaching techniques into our General Chemistry program. Some of these are: the use of computer spreadsheets in open ended lab experiments, team-teaching, choice of required textbook, weekly abstracts from science journal articles, and tutoring from upper division chemistry students on a walk-in basis. The success and effectiveness of these changes are presented.

197 THE MCP PROJECT: TEACHING INTRODUCTORY CHEMISTRY IN A CURRICULUM COORDINATED WITH MATHEMATICS AND PHYSICS,

James H. Reeves, Charles R. Ward and John H. Zimmer, Department of Chemistry, University of North Carolina at Wilmington, 601 S. College Rd., Wilmington, NC 28403

The MCP Project at UNCW is a major effort to reform the way introductory level mathematics, chemistry, and physics courses are taught. The project will address three significant national problems facing these disciplines at the undergraduate level: 1) low student retention rates, 2) limited ability of students to transfer their knowledge of calculus, chemistry, and physics among the three disciplines, and 3) lack of motivation and excitement for science and mathematics. To impact these problems, a *coordinated* program for introductory physics, chemistry, and calculus is being developed around a common set of conceptual themes, instructional formats, and cognitive and psychomotor skills. Extensive use is being made of computers as tools for data acquisition, analysis, and description with computer-aided writing tasks being an integral part of all student activities.

This talk will focus on proposed changes in the general chemistry curriculum designed to facilitate the achievement of the goals of the project. Special emphasis will be placed on the coordination of the lecture and laboratory portions of the course, and on the use of modern instructional technologies to enhance the students' experience and deepen their understanding of science and the scientific perspective.

198 "TRANSFORMATION OF INTRODUCTORY CHEMISTRY EXPERIMENTS INTO 'REAL WORLD' CONTEXTS"

R. Bayer, B. Hudson. J. Schneider, Carroll College, Waukesha, WI 53186.

The laboratory component of introductory chemistry provides a challenge to science educators. The existing experimental work meets the stringent requirements of the discipline, but often does not produce an enthusiastic response from students nor motivate them to further consideration of science. This paper describes how an existing set of experiments familiar to and preferred by individual instructors can be placed into a real-world context. Students become "chemist employees" in the laboratory of a local organization (industrial, business, consulting, regulatory, governmental, etc.) and work on these experiments reformulated as current projects of that organization's laboratory. Details have been developed to allow instructors to add introductory "scenarios" to existing laboratory work and allow the experimental work to take on new meaning.

199 THE SEQUENCE OF DESCRIPTIVE INORGANIC TOPICS IN THE GENERAL CHEMISTRY COURSE.
J. D. Hostettler, Chemistry Department, San Jose State University, San Jose, CA 95192-0101.

The prefaces of general chemistry texts often claim that the text is written to accommodate several different teaching sequences. Conventional wisdom has it that the sequence of topics really does not matter very much. On the other hand, the order of topics in texts is fairly standard, and most teachers follow the text order. If the exact sequence is not that important, why are the sequences so standardized in practice? This paper argues that the order of topics in general chemistry -- like the order of words in a sentence -- is very important. Furthermore, it is argued that topic sequence is a crucial consideration in the design of a course which attempts to integrate descriptive chemistry with principles. Several unsuccessful sequences will be briefly described and then compared with a more successful sequence which features early descriptive chemistry, extensive classification schemes, a structure/properties/uses format for materials, and an occurrence/preparation/ pollution format for reactions in various environments. Experiments and model exercises are also discussed.

200 DESIGNING LABORATORY CURRICULA FOR THE LARGE COURSE.
Patricia L. Samuel, Dept. of Chemistry, Boston University, Boston, MA 02215

During the past few years there has been much discussion, and some action, relating to the first-year college chemistry course. Both the content and format of these courses are being examined by a number of individuals and groups, and we can expect to see new and revised curricula in the near future. However, very little attention is being paid to the large course and its peculiarities, especially in regard to laboratory instruction. For example, laboratory instruction in small courses is often given by faculty members; in the large course, Teaching Assistants are most often the instructors. This fact places many constraints on curriculum design. Other constraints arise from economic considerations, availability of space, and logistics. Creating excellent laboratory curricula for the large course requires much more than interesting and intellectually challenging content; the delivery and assessment systems are crucial to successful implementation of content. A group of faculty who direct large laboratory programs at universities across the country has been formed. This paper will be a progress report of our work.

New Technology for Chemical Education R. Ulrich - Presiding

201 MAKING CAI MAKE A DIFFERENCE IN INTRODUCTORY-CHEMISTRY
Stephen K. Lower, Dept of Chemistry, Simon Fraser University, Burnaby BC V5A 1S6, Canada (lower@sfu.ca)

Computer-based lessons can profoundly change what is learned and how it is taught, but only if they are carefully integrated into a course, rather than simply used as add-ons. Some specific benefits include bringing students with diverse backgrounds up to a common level in the basics, and presenting a far more in-depth treatment of many concepts than is practical by other means. The use of lessons linked to homework problems helps deflect students from a "substitute into the formula" approach, and to develop some confidence in problem-solving, while largely eliminating the need to collect and grade them.

202 CHEMISTRY LAB AUGMENTED BY INTERACTIVE VIDEODISC. John E. Bauman, Jr., Department of Chemistry, University of Missouri, Columbia, MO 65211.

A large general chemistry course was given the opportunity of using computers and interactive videodisc programs for drill and laboratory enrichment. Students were allowed to choose their own hours on the computers, to select what lessons to cover, and to report their assessment. Others were assigned to the computers to remedy deficiencies in their background. A correlation of grades, lessons covered and time on the computers is presented.

203 **TEACHING SCIENCE IN THE ELEMENTARY SCHOOL: VIDEODISC MATERIALS FOR PRE-SERVICE TEACHERS.** Melvin D. Joesten, Department of Chemistry, Vanderbilt University, Nashville, TN 37235. Clifford Hofwolt, Department of Teaching and Learning, George Peabody College for Teachers, Vanderbilt University, Nashville, TN 37203.

Videodisc materials are an integral part of the Vanderbilt program for teacher education. This presentation will describe the development of videodisc materials and their use in both content and science methods courses. Two different types of videodiscs are used in the introductory chemistry course and excerpts from these videodiscs will be shown during the presentation. At the beginning of the lab period, students view a videodisc segment that provides prelab instruction for the experiment. At the end of the lab, pre-service teachers also view a videodisc segment of an experienced teacher using the same chemical concepts in a hands-on experiment for 5th or 6th grade students.

In the science methods course the videodisc is used with a hypercard menu that provides the student a chance to analyze teaching techniques. The videodisc materials are used in the classroom, and then students have an opportunity to view them outside the classroom.

204 **THE USE OF MICROWAVE SYSTEMS IN UNDERGRADUATE ORGANIC LABORATORIES.** Rodgers Hicks and George Majetich, Department of Chemistry, *The University of Georgia*, Athens, Georgia 30602

Many reactions performed as instructional exercises by organic chemistry students require heating for extended, usually unproductive periods of time. We have found that undergraduate students can quickly carry out a wide variety of organic reactions using a commercial microwave system, thereby increasing the time available for doing more experiments, learning purification techniques or recording spectra.

Our presentation will include an explanation of why reactions are accelerated using microwave heating, our experiences of using this technology in undergraduate teaching, and the numerous reaction types (including a four-step total synthesis) which benefit from this new technology for chemical education.

Name That Compound: Old Rules, New Methods H.A. Smith - Organizer, Presiding

205 THE BIRTH AND GROWTH OF THE BLUE BOOK OF RULES: A USER-FRIENDLY PERSPECTIVE. James G. Traynham Department of Chemistry, Louisiana State University, Baton Rouge, Louisiana 70803-1804.

The first international conference concerned with chemical nomenclature was held a century ago in Geneva. Some of the agreements reached there live on in the current rules of nomenclature of organic chemistry, but some others, including the primary one, did not last. This paper summarizes the circumstances that led to that conference, its achievements, and the extensions and revisions of its framework of resolutions during the following hundred years. During that century international agreements on the nomenclature of organic chemistry have been driven by significantly more than mere identification. This history illuminates not only how the nomenclature rules have been developed but also the striking parallel with the dynamic nature of other work in chemistry. No matter what curriculum brings students to an organic chemistry class, the students will later have to use the nomenclature taught there. Teachers aware of the history and evolution of the rules are probably more likely to advantage their students by avoiding erroneous usage and teaching of organic chemical nomenclature.

206 THE EVOLUTION OF ORGANIC NOMENCLATURE TO MEET MODERN NEEDS. Homer A. Smith Jr., Department of Chemistry, Millikin University, Decatur, Illinois 62522.

Accelerating progress in organic chemistry in modern times continues to exert pressure for new naming systems and for automated techniques for name constructio.. Following publication of the "Blue Book" in 1979, the IUPAC Commission on Nomenclature of Organic Chemistry (CNOC) has continued the development of naming systems in response to progress in organic research and in response to professional and societal needs. In addition to new naming systems for phanes and fused rings and recent publication of the delta and lambda conventions, CNOC has in press a new comprehensive Guide that will recommend modifications of the Blue Book rules that will affect every organic teacher. Just underway is a Unique Names project, which is designed to meet the specialized needs of nonchemists in such areas as emergency hazard management and foreign trade regulation. A desktop computer naming system called AUTONOM that is nearing commercial release is likely to be the forerunner of important advances in automated naming.

207 TEACHING IUPAC NOMENCLATURE IN THE TRENCHES: CAN THE COMPUTER HELP? Gary M. Lampman, Department of Chemistry, Western Washington University, Bellingham, WA 98225.

Those of us who teach organic chemistry realize the importance of nomenclature, but often do not want to spend a lot of lecture time on the subject. Programmed texts and CAI materials have been used successfully to help students. Armed with some basic IUPAC rules, students can usually master the naming of most simple compounds. The computer program which will be demonstrated covers 18 functional groups.

In the tutorial-question section the student is presented with rules and examples, followed by a question based upon the tutorial. Each part of the name is checked for accuracy and the student is given a specific analysis of all errors. Rather than re-typing the answer, a student may use the editor to correct the name or ask for help. The drill section "tests" the student. We have found that the computer is infinitely more patient than we are in teaching nomenclature. We can rely on it to teach these concepts and thus release lecture time.

208 NAME THAT COMPOUND: A WORKSHOP. James G. Traynham Department of Chemistry, Louisiana State University, Baton Rouge, Louisiana 70803-1804; Gary M. Lampman, Department of Chemistry, Western Washington University, Bellingham, Washington 98225; Homer A. Smith Jr., Department of Chemistry, Millikin University, Decatur, Illinois 62522.

This informal workshop will offer participants the opportunity to bring their nomenclature problems, questions, and comments to the panel of symposium speakers. Problems in naming specific compounds or queries about strategy in teaching elementary nomenclature may be directed to the panel. Also, the panel will welcome comments and questions about the importance of history in the teaching and learning of nomenclature.

Macintosh Applications: II General Chemistry J. Casanova, B. Luceigh - Organizers; B. Luceigh - Presiding

209 COMPUTER GENERATED ANIMATION APPLICATIONS IN BEGINNING CHEMISTRY. J. Buell, A.F. Montana, C.F. Prenzlow, P.A. Wegner, Department of Chemistry and Biochemistry, California State University, Fullerton, Fullerton, California 92634.

Dynamic instructional materials for introductory courses are being developed to enhance comprehension of the molecular processes that are central to chemistry. Students, especially those with weak chemistry backgrounds, frequently have difficulty relating macroscopic behavior with abstract concepts and models. Low cost instructional materials that demonstrate that dynamic visualization can compactly, efficiently and effectively convey important chemical information have been prepared utilizing microcomputer graphics and animation applications. A development sequence that starts with Lecture Tools for instructor use and proceeds to Lecture Amplification and Tutorial units for student use, provides the framework for this effort. Each step in the sequence incorporates and then expands upon material from the earlier steps. Examples of units will be presented that range from examination of hase changes to detailed organic mechanisms as well as the use of animation in simulating laboratory techniques.

210 COMPUTER GENERATED GRAPHICS FOR INTRODUCTORY CHEMISTRY. John I. Gelder, Nancy S. Gettys and Judd Wheeler. Department of Chemistry, Oklahoma State University, Stillwater, Oklahoma 74078

The use of interactive computer generated graphics images which are displayed in color and can be animated can help the lecturer in chemistry assist students in grasping concepts important to a good foundation in chemistry. Over the past four years a large collection of animated computer graphics have been developed for use in an honors or advanced placement high school course or a college-level introductory chemistry course. Materials in three areas have been produced: visualization of abstract microscopic phenomenon, i.e., intermolecular attractive forces and the solution process; interactive transparencies, i.e., animated examples of atomic and hybridized orbitals, molecular shapes and cubic cells; and animated problem solving examples in many representative areas. In all the materials in both color and black-and-white versions require approximately 80 megabytes of disk space. Due to the amount of storage required all of the materials will be available on CD-ROM. The animated graphics on CD-ROM are accessed using a HyperCard based index stack which affords quick location of a particular example. The color versions of the materials require a Mac II or LC platform with a minimum of 2-megabytes of RAM. The black-and-white versions require a MacPlus, SE or Classic platform with a minimum of 2-megabytes of RAM. Besides a CD-ROM drive and HyperCard 2.x, no additional hardware or software is required.

211 **THE CHEMISTRY NAVIGATOR HYPERBOOK.** John C. Kotz, John W. Moore, and Paul Schatz, Department of Chemistry, University of Wisconsin, Madison, WI 53706

We have developed a chemistry "hyperbook" called the *Chemistry Navigator* (CN), a program that runs under Hypercard 2.0 on Macintosh II computers. (A version of the project that runs under Toolbook and Windows has also been prepared for IBM-type computers.) Topics in introductc ; chemistry are organized under the following headings: (a) *Elements*, (b) *Compounds*, (c) *Reactions*, and (d) *Structures and Bonding*. Each of these sections is subdivided into linked Hypercard stacks on appropriate topics, and an illustrated glossary of terms and a history stack underlies this structure. For example, under *Elements* one section is titled *The Chemistry of the Elements*. Each element has a "card" on which there is information about the properties of the element, its common compounds and uses, and the history of its discovery. Buttons on each card also link the text to the reactions of the element on "The Periodic Table Videodisc" (Project SERAPHIM) and "The Redox Videodisc" (JCE: Software, Special Issue 1) and to other sections of the *Chemistry Navigator*. Another section of CN concerns the structures of some of the elements, of simple molecules, and of common crystals. This section gives descriptions of these structures as well as structure models accurately depicted using the shareware program "MacMolecule." This package of interlinked Hypercard stacks is intended for use as a lecture demonstration aid and for the individual student to explore the chemistry of selected elements.

212 EQUIPPING STUDENTS WITH A CHEMICAL EYE; Alton J. Banks, Tim Kerns, and Shannon Peek; Dept. of Chemistry, Box 8204, Raleigh, NC 27695-8204.
Interactive media and object-oriented programming offer a unique opportunity to assist students with a better understanding of chemical concepts - a "chemical eye". Examples of some modules will be demonstrated.

213 COMPUTER EXCITEMENT FOR GROUND STATE STUDENTS Gordon L. Galloway, Department of Chemistry, Michigan State University, East Lansing, Michigan 48824-1322

When we tell students chemistry is an interesting coherent science that they can master, they believe it is a forbidden transition. At MSU, we are changing that with software that facilitates the study of general chemistry. Our software runs on Macintosh II computers and is created with Authorware Professional™, a powerful object-oriented authoring package designed for unsophisticated programmers (like us). Currently we are using seven interactive, animated, full-color modules on topics such as nomenclature, bonding, VSEPR hybridization, and crystal structures. More are planned. Modules are introduced in lectures and are continuously available in a public microcomputer lab located in our department. This paper will report the enthusiasm with which students have received the software; the principles and philosophy that guided its creation; the problems we confronted and still face; and our view of why we need a consortial effort to create more instructional software. Examples of our work will be available for examination.

214 SYMPOSIUM: "MACINTOSH APPLICATIONS IN TEACHING CHEMISTRY" CHEMTUTOR AND CHEMTUTORPROJECT. Marian C. Hallada, Department of Chemistry, University of Michigan, Ann Arbor, MI 48109.

In this talk, the three year old ChemTutorProject will be presented and demonstrated, with data on users and their achievement gains in general chemistry at the University of Michigan. ChemTutor is a computerized study aid for beginning undergraduate chemistry students where simulated professor-student conversations are used to probe student thinking and problem solving techniques. The ChemTutorProject includes not only the set of ChemTutor lessons, but also lesson construction programs and data gathering systems, and plans for developing interactive networks to analyze and improve students' critical thinking skills.

215 VISUALIZING THE ABSTRACT IN BEGINNING CHEMISTRY ON THE MACINTOSH™ AND VIDEOTAPE. Richard A. Paselk, Mervin P. Hanson, and John B. Russell, Department of Chemistry Humboldt State University, Arcata, California 95521; Richard L. Harper, Redwood Software, Arcata, California 95521.

Focusing on theoretical and abstract concepts in beginning chemistry, we are developing a series of Macintosh™ software programs and full animation color videotapes under the heading *Visualization of the Abstract in Chemistry*. We have completed and tested B&W and color software presentations of atomic orbitals on Macintosh™ computers; a fully animated color VHS video tape of scatterplots of representative *s*, *p*, *d*, and *f* hydrogen orbitals; and a highly interactive program on drawing Lewis structures. We are now working on a program on bonding, allowing the student to manipulate atoms and molecules and to observe the bonding process, as represented by rigorously calculated models. Using these projects as examples, we will look at lecture presentation versus individual work at the computer, interface design, student monitoring, and the effectiveness of the computer in teaching chemical theory to beginning students.

216 HYPERLABS: COMPUTERIZED VENTURES IN THE GENERAL CHEMISTRY LABORATORY. Dennis Swauger, Physical Science Department, Ulster County Community College, Stone Ridge, NY 12484

Thanks in part to an NSF Instrumentation and Laboratory Improvement grant, a HyperCard-based format has been implemented as the basis for a number of general chemistry experiments at Ulster County Community College. All phases of the laboratory process are programmed or accessed through the HyperCard format: pre-lab tutorials and exercises, procedural details, data acquisition and control parameters, and the organization and analysis of experimental data. This presentation will highlight the two major considerations in the development of the HyperLab format: the student use of modern technology in introductory science courses and the pedagogical value of such an approach.

217 CURRICULUM DEVELOPMENT POSSIBILITIES IN A COMPUTER EQUIPPED FRESHMAN LABORATORY. Kenneth Emerson, John R. Amend, and Jay B. Radke, Department of Chemistry and Biochemistry, Montana State University, Bozeman, MT 59717.

This chemistry department has now had DOS based workstations in its introductory chemistry labs for non-majors for five years. We have redesigned the curriculum around the workstations and written a series of manuals to take advantage of this situation. Some of the advantages and disadvantages of computer based instruction on this scale will be discussed. Evaluation has been a major stumbling block, and our techniques are still very crude. The workstations are very powerful for undergraduate use, but freshmen are not generally equipped to appreciate, let alone make use of that power. Much more careful guidance and experiment design are needed than has traditionally been the case in these courses.

218 IBM PSL EXPERIMENTS FROM INTERDISCIPLINARY PERSPECTIVES, J.R. Zimmer, G.G. Lugo, J.H. Reeves, and C.R. Ward, UNCW, Wilmington, North Carolina 28403

IBM Personal Science Laboratory (IBM-PSL) equipment permits rapid data acquisition for a variety of chemical and physical experiments. Because of this, IBM-PSL allows a coordinated approach among mathematics, chemistry, and physics. Take, for example, a first order reaction such as the bleaching of bromocresol green. The mathematician (teaching calculus) works to model the graph of concentration versus time. The chemist wants to understand how the data is taken and to study the relation between reaction rate and concentration. Exploring IBM PSL experiments from the perspectives of different disciplines enlightens the student as to what the disciplines do. It also encourages a learning cycle approach to teaching each discipline.

219 COMPUTERIZED SIMULATIONS, DEMONSTRATIONS AND LABORATORY INTERFACE EXPERIMENTS FOR GENERAL AND PHYSICAL CHEMISTRY CLASSES. Philip I. Pavlik, Department of Chemistry, Northern Michigan University, Marquette, MI 49855.

Demonstration/discussion of computer programs listed below:
A. Lecture Demonstrations: Simulated Atomic Mass Determination Using Mass Spectrometry; A Simulation to Demonstrate the Normal Law of Error; X-Ray Crystallography; Time Dependent Wave Mechanical Phenomena; Reaction Mechanisms and Kinetic Rate Laws.
B. Laboratory Simulations and Computation Aids: Simulated Infrared Spectra of Diatomic Molecules Based on Quantum and Statistical Mechanical Computations; A Spreadsheet Data Analysis Application for an Emission Spectroscopy Experiment.
C. Laboratory Experiments Using the MSU Lab Interface: Automated Acid-Base Titration; Enthalpy Change for a Chemical Reaction; Interfacing the Lab Interface to a Spec-20 Spectrophotometer.

220 DEVELOPMENT OF SENSORS FOR COMPUTER INTERFACING. Ronald P. Furstenau, Matthew Carroll, Richard Moore, and Dwight Wood, Department of Chemistry, U.S. Air Force Academy, Colo. Spgs., CO 80840-5701

We are in the process of equipping all of our general chemistry laboratories with computer interfacing equipment originally developed at Montana State University. With support from the National Science Foundation, we will be able to provide all of our freshman class (~1400) the opportunity to participate in computer-assisted experiment design, data acquisition, and analysis. An important part of our laboratory development is to design and build a wide range of sensors which will meet the requirements of our laboratories. Low cost, rugged construction, and ease of use have been our major design requirements. We have currently designed and built solution conductivity sensors, pressure sensors, and an electronic balance using standard electrical components and other readily available parts. We will demonstrate the use of these sensors in experiments and discuss the design.

221 The IBM Digital Multimeter in Electrochemical Computer-Interfaced Experimentation. Diana Malone Dept. Of Chemistry, Clarke College, Dubuque, IA 52001

The IBM Digital Multimeter (DMM) can be interfaced to any electrochemical experiment which generates a voltage, current or resistance. The associated software plots these data in real time in relation to each other or as a function of time or keyboard input. Mathematical transformations of the data can be done in the graphics mode so that a visual analysis of the experiment is done in a fraction of the time it would take to enter the data into a graphical analysis or data reduction program.

Visual data from several types of experimentation will be presented including: Redox titrations, Precipitation Titrations, Ion Specific Electrode Concentration plots, Conductivity titrations, Constant Current Coulometry, Amperometric titrations, and data from spectrophotometric analyses.

222 AUTOMATION IN UNDERGRADUATE P. CHEM. LABS., J. Giguère, J.-R. Martin, Département de chimie, Université de Sherbrooke, Sherbrooke, Québec, Canada J1K 2R1.

In the last few years we have automated the control and data acquisition for most of the experiments in our undergraduate P. Chem. labs. The computers are interfaced to instruments, cells and detectors with A/D converters, GPIB-IEEE and serial RS-232C. Most of the control is done with the help of P.I.O.'s. The computer are IBM PC's or compatibles. Research grade data are collected with these workstations. The students analyse the data and trace graphs with programs such as Lotus 1-2-3, Quattro Pro, Excel or our own statistical packages. New methods for analysis and data reduction have been developped and will be presented. The advantages and disadvantages of the method will also be discussed.

223 LIMSPORT: SPREADSHEET DATA ACQUISITION AND LABORATORY INFORMATION MANAGEMENT FOR GENERAL CHEMISTRY.
Ed Vitz, Department of Physical Sciences,
Kutztown University, Kutztown, PA 19530.

We have developed a program called LIMSport for general chemistry laboratory instruction which is based on the Lotus 1-2-3® spreadsheet. LIMSport consists of a "master template" which adds a set of data acquisition commands to Lotus, and allows measurements from interfaced instruments to be incorporated in real time into the spreadsheet. Interfaced instruments include game card-based colorimeters, conductivity cells, Geiger counters, and thermistors with very high (.05°C) resolution as well as balances connected to the RS232 port and inexpensive (~$100) bus-mounted commercial I/O (Input/Output) boards. A very sophisticated data acquisition station, measuring about seven parameters to very high precision can be assembled for a few hundred dollars. Lotus 1-2-3 itself is available to educational institutions for under $100. Only a few common Lotus commands are needed to acquire, reduce, and graph data, and learning the use of a spreadsheet may be viewed as a desirable bonus. We have designed "experiment templates" for a set of common general chemistry experiments, but any teacher can develop these with simple Lotus skills.

224 MEASUREMENT OF PRESSURE, TEMPERATURE AND VOLUME DURING A RAPID NEAR ADIABATIC COMPRESSION OF VARIOUS GASES. Bruce E. Lee, Physics Department, Andrews University, Berrien Springs, MI 49104

The equipment to be demonstrated compresses various gases such as air, argon, or CO_2 in about 100 ms, during which time the pressure, temperature, and volume are monitored with an A to D data acquisition system operating in the three channel storage oscilloscope mode. The software package provides for callibration of the three inputs, plotting three separate graphs, plotting any two variables against each other, and integration to determine the work done on the gas during compression. With additional plotting software, the ratio of specific heats, gamma, can be determined. The computer interface used is the PASCO Series 6500 Data Monitor or the Vernier Multipurpose Lab Interface for the IBM. Interfaces for other computers are also available.

225 MAKING THE INTERFACED COMPUTER MORE THAN A TOOL. S. D. Gammon, Department of Chemistry, University of Idaho, Moscow, ID 83843

There are a host of commercial and non-commercial laboratory interfacing products on the market. The majority of these systems are designed to be extremely powerful and versatile. From experiences with university freshman, we have found that there is often little appreciation of the power and versatility of the interfaced systems. This paper will present some examples of custom computer software that is designed to collect data and guide students through experiments. It will be argued that this type of approach provides beginning chemistry students with a better introduction to computer interfaced experiments.

226 MICROSTATES: DEMONSTRATING MOLECULAR ORDER AND DISORDER. R. W. York,
Department of Chemistry, Wittenberg University, Springfield, Ohio 45501

MICROSTATES is an interactive computer program which permits the user to explore the random exchanges of energy among a small group of molecules in a crystal. It is designed to demonstrate how stable energy distributions result from random events. It shows graphically or numerically the development of a Boltzmann distribution of energies as a system of molecules comes to equilibrium. It can be used in a general way to explore issues of order and disorder in high school or general chemistry courses, or at more advanced levels to illustrate concepts of statistical thermodynamics. MICROSTATES uses only a Monte Carlo method to determine the energy distributions. Populations of energy levels are tallied after every random energy exchange and can be viewed for each individual microstate or as an average distribution over time. A detailed numerical analysis can be viewed, printed, or saved in an Ascii file for use by a spreadsheet.

227 ANIMATED ILLUSTRATIONS OF ATOMIC AND MOLECULAR PHENOMENA. R.C.
Rittenhouse, Department of Chemistry, Walla Walla College, College Place, WA 99324

Atoms and molecules, by virtue of their small size, escape methods of simple and direct observation. Thus, such entities are destined to remain obscure in the minds of many beginning science students. While not easily overcome, the obstacle of size can be reduced by the use of computer graphics as a visualization aid. Vivid images relating to atomic and molecular structure can be generated using a variety of commercial software. Dynamic events at the atomic and molecular level can be illustrated by linking together sequences of previously generated images into animation clips. There are now several commercial animation construction programs available for IBM computers which lend themselves nicely to illustration of chemical concepts. At least two of these will be discussed and demonstrated.

228 INCORPORATION OF *AB INITIO* CALCULATIONS INTO THE PHYSICAL CHEMISTRY COURSES,
Richard W. Schwenz, Department of Chemistry and Biochemistry, University of Northern Colorado, Greeley, CO [illegible] and Franklin B. Brown, Science and Mathematics Division, Tallahassee Community College, Tallahassee, FL 32304, and Supercomputer Computations Research Institute, Florida State University, Tallahassee, FL 32306-4052.

In an effort to update the physical chemistry lecture and laboratory curricula to reflect the increasing importance of computational chemistry in both the academic and industrial settings, we have incorporated microcomputer-based *ab initio* computational chemistry codes in these courses. Specifically, we have used improved versions of the MICROMOL suite of programs developed by Colwell and Handy (1). These codes allow the user to interactively construct input data sets, perform a variety of types of calculations based on the Hartree-Fock Self-Consistent Field Method, and graphically analyze the results which include molecular orbitals, electron densities, and normal mode vibrations and corresponding frequencies. Calculations can be performed on a large number of small molecules containing as many as twelve atoms. In this paper, we describe the use of these programs and methods in the context of the standard undergraduate physical chemistry course and laboratory.

1. S.M. Colwell and N.C. Handy, J. Chem. Educ. 1988, 65, 21.

229 EMPOWERING STUDENTS TO LEARN CHEMISTRY. Charles J. Bier, Life Science Division, Ferrum College, Ferrum, VA 24088

In this presentation I will share some of the ways that I use to encourage our students to understand themselves as important contributing members of a learning team that includes each member of the class and myself. More time is spent in the first class meetings for the class to get to know each other and myself than in covering a detailed outline of the syllabus. It is my job to help each student discover, develop, and share their competence in chemistry. I emphasize that they will be more successful learners if they make learning a team activity. I honor their reasons for taking the course and try to connect repeatedly our current learning task to previous experience or course work. Our students have responded well to this approach.

230 WRITING TO EMPOWER LEARNING IN CHEMISTRY. Michael J. Strauss, Barbara B. Lewis, Department of Chemistry, University of Vermont, Burlington, VT 05405-0125 and Horace Puglisi, Founders Memorial School, Essex Junction, VT 05445.

For several years in grade school and introductory college chemistry, we have been using informal-ungraded student writing to empower students to create meaning and understanding of chemical content. Student interpretations are combined with text, notes and lab work to allow personal constructions of chemical principles. The writing is not used as an evaluative tool, but as a means for helping students learn how to think about chemical content using their own language. This creates a powerful method for empowering students to achieve insights into chemical phenomena. Practical aspects, advantages and drawbacks to such pedagogy will be elaborated. Extensive use will be made of student samples (on the overhead projector) which demonstrate the value of the method.

231 STRUCTURING CHEMISTRY COURSES FOR SUCCESS, NOT STRESS. Doris I. Lewis, Department of Chemistry, Suffolk University, Boston, MA 02114.

Satisfactory completion of a chemistry course requires mastery of three different types of learning objectives: **concepts**, **facts**, and **skills**. Our successful course for non-science majors at Suffolk University provides a more positive learning environment for students by distinguishing clearly among these types of learning and providing learning experiences appropriate for mastering each. The student gains a sense of control in gaining an understanding about the learning process, as the situation is redefined from "I just can't do chemistry". Chemical **concepts** are at once the most important and in some respects the most accessible of the three forms of learning. Concepts like atomic theory provide a new way of looking at reality, exciting to students, and unforgettable once mastered. They should feature prominently in class discussion and in exams. Chemical **facts** can be useful: chemical names, for example, are essential information in the lab. Techniques for learning facts are similar to those used in language class: repetition and drill, for example. Facts should be clearly distinguished from concepts, and should not be the major focus of the course. Problem-solving **skills** are usually the major obstacle for chemistry students. Skills development requires regular practice. Skills to be acquired should be clearly identified, and ample opportunities provided, in and out of class, for skills practice. Frequently, the issue becomes defined as one of time management, far removed from the initial self-perception of being "dumb" in science. Clearly defining learning tasks results in more successful students, empowered by their increased chemical knowledge and their increased insight about learning processes.

232 RESTRUCTURING THE QUIZ SECTION IN GENERAL CHEMISTRY. Cecile N. Hurley, Department of Chemistry, University of Connecticut, U-60, Room 151, 215 Glenbrook Drive, Storrs, CT 06269-3060

In the Spring of 1991, one quiz section of general chemistry was divided into study groups that worked as teams on homework problems. The results of that pilot project prompted examination of the quiz-section format. Since the groups worked on all the homework problems together, there was no longer a need to discuss those problems at the weekly quiz section. During 1991-92, additional group-centered collaborative activity was implemented in randomly-selected experimental quiz sections. Each group worked collectively on challenging problems and conceptual questions under examination conditions: time limits and closed books. Students in the Fall experimental sections had an average course grade of B-, and rated their experience as highly positive. Three of them changed from undecided majors to chemistry majors. The average course grade in the entire general chemistry class was C-. Results from Spring, 1992, will also be reported.

233 **KEYS TO SUCCESS IN CHEMISTRY** Grover W. Everett Department of Chemistry, University of Kansas, Lawrence, KS 66045

Many freshmen entering large, public universities lack basic study skills needed to succeed in a science course such as general chemistry. Most students will develop better skills on their own, by trial and error, over a period of weeks or months, but by that time the first semester may be nearly over.

"Keys to Success in Chemistry" is a continually-evolving handout designed to help students acquire study skills essential for chemistry as soon as possible. The handout begins by listing these skills and points out that knowledge in chemistry is cumulative. This is followed by suggestions on how to read a chemistry textbook, how to organize factual information for better memory retention, how to manage time efficiently, how to understand concepts, how to take effective lecture notes, and how to review for examinations. it is believed that these suggestions, with modifications, may be applied also to other courses.

234 WORKSHOPS TO REDUCE STUDENT LAB ANXIETY. Marjorie Kandel, Department of Chemistry, SUNY at Stony Brook, Stony Brook, New York 11794-3400.

All chemistry instructors must be familiar with beginning students who are nervous about lab. Within a few class sessions, many of them are relaxed and doing well, gaining satisfaction from their accomplishments. Others are afflicted by more acute nervousness that may not self-correct until much later if at all. Our interest in helping this latter group has led us to offer "Reduce Your Lab Anxiety" workshops early each semester. By relating lab techniques to everyday skills, workshop exercises show the connection between what students already know and what they need to learn in order to solve lab problems. The informal, ungraded workshops help students achieve lab sav'y earlier than they would otherwise and, it is to be hoped, improve their grades and attitudes. This project is being supported by the National Science Foundation's Undergraduate Curriculum and Course Development Program under grant # USE-9055829.

235 UNDER OBSERVATION: THE PRE-MED ORGANIC EXPERIENCE. A.R. Morrill, Department of Chemistry, University of Minnesota, Minneapolis, MN 55455.

Pre-meds in organic chemistry suffer from unrealistic expectations both of their own and of the instructors'. These expectations are a mixture of beliefs related to career and school requirements, complicated by the educational, psychological, and ethical background of both student and instructor. A helpful remedy is to relate the educational milieu to the student background in an open way, allowing for the differences in focus of student and instructor. The TA on the "front line" can see a difference in student productivity and satisfaction with the course when this approach is used versus more traditional methods based on negative incentive such as the administration of quizzes of inappropriate difficulty. These other methods seem to accentuate the misperceptions of the student and increase dissatisfaction, decreasing productivity.

236 EASING THE TRANSITION INTO LABORATORY RESEARCH. Tami I. Spector, Department of Chemistry, University of San Francisco, San Francisco, CA 94117

Training students to use the scientific method to produce significant research results is essential to the growth of students as scientists and central to our goal as educators. This paper will outline a model for the management of undergraduate research in the context of an organic chemistry laboratory. This model is based on three factors: 1) Planning an appropriate research project for the undergraduate level with an emphasis on an exploratory approach and maximization of peer teaching; 2) Setting a realistic time-line which will result in success based on beginning a project in the junior year with clarity pertaining to goals and performance evaluation; and, 3) Easing the transition from classroom laboratory to research laboratory by using the classroom laboratory to prepare students for research, by preparing experimental protocols for the research lab, and by setting a balance between failure and success.

237 UNDERGRADUATE RESEARCH PROGRAMS IN CHEMICAL EDUCATION. Phoebe K. Dea, Department of Chemistry and Biochemistry, California State University, Los Angeles, CA 90032.

To develop the students' potential, a variety of programs are in place at Cal State L.A. for students to carry out undergraduate research. The success of these programs is based on the concept that students can be motivated toward academic success by working with faculty committed to providing students with an experience in laboratory research and with caring academic counseling. As Professor of Chemistry, I work closely with students from pre-college to graduate levels to get them excited about their research, and to instill confidence in them for the challenges awaiting them. I teach them to be critical thinkers and nurture their analytical skills. I generally work very closely with students in the beginning until they have some data before sending them to the library to read the literature. This is especially important for minority students in science. When students can relate their own research with what is published in the literature, it generates a great deal of excitement and confidence.

Another important aspect of involving students in research is the group dynamics of the research team. The laboratory provides them with a "home" within campus where students study together and tutor each other in a network. They learn to support each other and look critically at each other's work. This strengthens their scientific communication skills and enhances the exposure of students to a broader scientific base and interest.

238 INTERACTING TO FOSTER SCIENTIFIC SELF-CONFIDENCE, Kathleen E. Turner, Learning Skills Center/Chemistry, Baker Laboratory, Cornell University, Ithaca, New York 14853

Students' confidence in their scientific ability factors into their aspirations and their success. In our daily work with students, in class, in help sessions, in the laboratory, and in casual conversation, we have the opportunity to empower by the verbal and non-verbal messages we send in every interaction. Students continually send us messages about their beliefs. If we understand those messages and the underlying beliefs, we can help change faulty assumptions. For example, students who are perpetual observers: what they are telling us and how we can engage them. The image of chemistry is significantly affected by the images of chemistry professors and teachers. If we provide an updated model of chemistry instructor/scientist, we act as an example for our teaching assistants and our students, eventually improving the image of the chemistry.

Problem Solving in High School and General Chemistry: Why and How F. Cardulla - Organizer, Presiding

239 THE HABIT OF PATIENT THINKING. Conrad Stanitski, Department of Chemistry, Mount Union College, Alliance, Ohio 44601.

Learning chemistry involves many types of problem-solving activities. Those requiring quantitative understanding and mathematical skills are perhaps some of the more obvious, even routine, ones encountered. Although significant, these types are not, however, the only kinds of problem-solving activities requisite for success. Reading acuity, searching for comparisons and analogies, recognizing pivotal relationships while rejecting extraneous or superfluous material, and proposing and testing of various hypotheses also play important roles in effective problem solving.

The ability to properly assess the nature of students' difficulties with problem-solving is perhaps the first step in helping those students progress in their problem-solving skills development. Protocol analysis is one method for making such assessments. This presentation will consider various aspects of problem solving strategies, including protocol analysis, and their applications to chemistry teaching and learning.

240 PROBLEM-SOLVING DAY. George M. Bodner, Department of Chemistry, Purdue University, West Lafayette, IN 47907 and Amy J. Phelps, Department of Chemistry, University of Louisville, Louisville, KY 40292.

Science courses are dominated by a mode of instruction that traces back to medieval universities -- a series of lectures, in which scholars summarize the knowledge in their area of expertise, and the students listen. (If they come.) This approach is successful when the goal of instruction is factual knowledge, which is assimilated by rote memory. This is not the goal of instruction, however, in certain aspects of a high-school or college-level chemistry course -- particularly those parts of the course intended to help students develop problem-solving skills. For these portions of the course, alternative modes of instruction are more appropriate. This paper will describe an alternative approach to developing problem-solving skills among high-school chemistry students, which is based on research on problem-solving done at Purdue. This paper will also describe what was learned when we studied the implementation of "Problem Solving Day" in two high-school classrooms.

241 EXPANDED DIMENSIONAL ANALYSIS: UNDERSTANDING AND COMMUNICATING CHEMISTRY WITHOUT MEMORIZING FORMULAS Ronald DeLorenzo, Department of Chemistry, Middle Georgia College, Cochran, GA 31014

Expanded dimensional analysis is a common sense approach to problem solving that allows students to answer most general chemistry problems without resorting to memorized formulas. Such solutions are easily translated into written or oral statements so students can explain how they tackle problems without resorting to mechanics. The expanded dimensional analysis technique promotes student thinking and builds problem solving confidence. It is a lifelong skill that carries over into other academic areas, and it is equally effective after employment.

242 SOLVING QUALITATIVE PROBLEMS IN THE CLASSROOM, William R. Robinson, Purdue University, West Lafayette, Indiana 47907-1393

Students who understand the qualitative aspects of quantitative problems are generally more successful at solving these problems than are students without such understanding. This presentation will address techniques for developing qualitative understanding of numerical problems. These include the use of various representations of problems and steps in the problem solving process and different approaches to teaching problem solving in the classsroom.

243 WHERE GOOD STUDENTS GO WRONG DURING PROBLEM SOLVING: MATHEMATICS SKILLS AND CONCEPTS. Thomas J. Greenbowe, Department of Chemistry, Iowa State University, Ames, Iowa 50011.

A review of the research studies on chemistry problem solving indicates that, in general, high school and college students exhibit poor problem-solving skills and are not successful in solving the target problems. Having observed the majority of my high school and college students successfully solve appropriate chemistry problems, something seems out of place in these research studies on problem solving. Is it the problems? Is it the instruction? Errors committed by students on general chemistry exam problems have been tracked over a number of years. What makes the difference between success and failure on "normal" (relatively low cognitive demand) chemistry problems seems to fall on two factors: mathematics skills and chemistry concepts. Examples of students errors on exams from equilibrium, electrochemistry, and kinetics topics will be discussed. Establishing a link between the gains made as a result of students high school chemistry problem solving experience to college chemistry problem solving will be discussed.

244 DIMENSIONAL ANALYSIS: REQUIESCAT IN PACE. James H. Burness, Department of Chemistry, The Pennsylvania State University, York Campus, 1031 Edgecomb Avenue, York, PA 17403

Dimensional analysis has become a standard technique for solving chemistry problems and is discussed in high school and college courses. Most, if not all, of the current chemistry texts describe the approach (usually in the first chapter) and encourage its use for setting up and solving a variety of chemistry problems. The premise of this talk -- and a view held by a growing number of chemical educators -- is that the use of dimensional analysis actually inhibits the learning of chemical concepts, even though it might enable students to solve routine chemistry problems. In addition to examining the results of some published studies which have raised doubts about its effectiveness, this talk will examine how the emphasis on dimensional analysis has evolved over the last twenty-five years. The results of a recent study using a diagnostic quiz, which was designed to measure the effectiveness of dimensional analysis, will also be presented.

245 MAKING IT CONCRETE MAKES IT STICK. Sondra F. Wieland, Fort Mill High School, Fort Mill, South Carolina 29715 and Daniel J. Antion, University of South Carolina, Columbia, South Carolina 29208.

Many chemistry concepts are difficult for many science students to assimilate on an abstract level. Research has shown that visual and tactile experiences provide concrete pathways that facilitate learning, comprehending, and recalling of these concepts. Teaching models, games, mnemonics, and other hands-on activities will be presented. Each idea, how it can be implemented, the materials used, its effectiveness, and the appropriate place in the curriculum will be demonstrated. High school chemistry and physical science teachers will participate in some successful classroom activities.

246 A GENERIC APPROACH TO ANALYTICAL THINKING. James E. Brady, Department of Chemistry, St. John's University, Jamaica, NY 11439

In many ways, solving chemistry problems is like repairing a car or fixing a toaster. Both involve the application of the right tools at the right times. This talk describes how a "chemical toolbox" analogy can be developed that aids students in analyzing and solving chemistry problems. The method is applicable both to numerical problems as well as the use of theoretical concepts. In the process, students are encouraged to develop strategies for problem analysis that have significance beyond the bounds of chemistry.

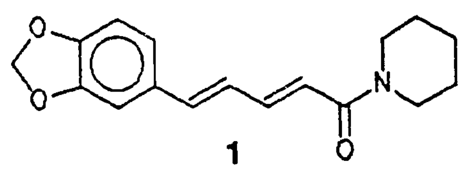
247 THE NEGLECTED STEP: HOW TO READ A PROBLEM. Francis P. MacKay, Department of Chemistry, Providence College, Providence, RI 02918.

A careful reading is a crucial step in problem solving, but it gets much less attention than other aspects of the process. Very often students' inability to do a problem can be traced back directly to a failure to read the problem properly. They miss-identify what they are looking for, overlook data, do not understand what is happening physically in the problem, or miss important cues. A handout consisting of thirteen instructions for reading a problem has been prepared. Each of the thirteen is accompanied by specific illustrations students will encounter. When and how to use the instructions are emphasized repeatedly. If a problem is read systematically, the problem solving process begins furing the reading and frequently leads directly to a solution without the crutch of model problems.

Poster Session on Microscale Chemistry S.I. Lamb - Organizer, Presiding

248 ISOLATION OF PIPERINE FROM BLACK PEPPER. William W. Epstein, David F. Netz and Jimmy L. Seidel, Departments of Chemistry, University of Utah, Salt Lake City, UT 84112 and University of Wisconsin-Oshkosh, Oshkosh, WI 54901.

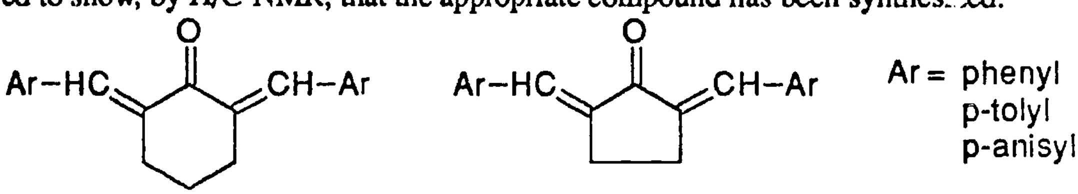
The isolation and purification of the alkaloid piperine (**1**) from black pepper is a useful introductory experiment for a first course in organic chemistry. The experimental procedure utilized to obtain **1** familiarizes students with the use of a reflux apparatus and the techniques of recrystallization, suction filtration, thin-layer chromatography, and melting point determination. Micro- or macroscale labware and techniques can be utilized when performing this experiment.



1

249 THE DIBENZALACETONE REACTION REVISITED, L. A. Hull, Department of Chemistry, Union College, Schenectady, NY 12308

One of the standard reactions used to illustrate the aldol condensation reaction is the reaction of benzaldehyde and acetone catalyzed by NaOH. This experiment is easy to perform and gives satisfying yields of a recrystallizable product. Even nicer is that it has been adapted to microscale work in a number of recent organic laboratory texts. Unfortunately the students when they do the experiment fail to see significance of the reaction and, for the most part, treat the experiment in a cook book type approach with little thought to experimental design. An effort to introduce the notion of discovery and experimental design has led me to a simple modification of the dibenzalacetone reaction. The students, working in groups of 2-4, are given a synthetic target (of the dibenzalketone type, see below), told to modify the dibenzalacetone procedure given in the lab text (propose reagents, modify amounts) and required to show, by H/C-NMR, that the appropriate compound has been synthesized.



250 Microscale Recrystallization/Melting Point and Liquid/Liquid Extraction Experiments With Unknowns Robert D. Minard and Alan J. Freyer, Chemistry Dep't., Penn State University, University Park, PA 16802

It seems peculiar that lab texts include experiments which introduce students to recrystallization by having them take pure compounds and recrystallize them to produce pure compounds. To demonstrate the technique in a more meaningful way, we have developed an integrated recrystallization/melting point experiment in which students obtain one of four possible *impure* compounds as unknowns. We have developed recipes for their successful "impurification". The m.p.'s of the unknowns are close enough so that if the students don't properly purify them and take accurate m.p.'s they will find it difficult to make the correct identification.

Williamson's *Microscale Organic Experiments* doesn't have a liquid/liquid extraction experiment in which both acidic and basic as well as neutral components are all together in the starting mixture. Admittedly, it is difficult to mix and store solid or solution mixtures containing all three. It is also difficult to find easy-to-isolate solid bases (normally anilines). After some trial and error we have found we can prepare suitable unknowns containing: 1.) benzoic or 3-toluic acid; 2.) 4'-aminoacetophenone or 3'-aminoacetophenone and; 3.) 1,4-dimethoxybenzene or 4,4'-dimethylbenzophenone.

251 PREPARATION OF β-ANGELICALACTONE: A STUDENT EXPERIMENT INVOLVING SYNTHESIS, NMR SPECTROSCOPY, MOLECULAR MODELLING AND SPECTRUM SIMULATION. Donald L. Pavia, George S. Kriz, Catherine Radzewich, and Shane D. Crowder, Department of Chemistry, Western Washington University, Bellingham, Washington 98225.

A project experiment for advanced students in organic chemistry is described. The experiment includes the isomerization of α-angelicalactone to β-angelicalactone and purification of the product by preparative gas chromatography. The product is characterized by a complete structure proof which utilizes nuclear magnetic resonance spectroscopy. The spectroscopic results are analyzed and confirmed by spectrum simulation and molecular modelling programs.

252 PREPARATION OF α-ANGELICALACTONE: A STUDENT EXPERIMENT INVOLVING SYNTHESIS, NMR SPECTROSCOPY, MOLECULAR MODELLING AND SPECTRUM SIMULATION. Donald L. Pavia, George S. Kriz, Michael E. Brown, Gary M. Knapp, and Melinda M. Seibel, Department of Chemistry, Western Washington University, Bellingham, Washington 98225.

A project experiment for advanced students in organic chemistry is described. The experiment includes a synthesis of α-angelicalactone, starting from levulinic acid, and the product is isolated by preparative gas chromatography. The product is characterized by a complete structure proof which utilizes nuclear magnetic resonance spectroscopy. The spectroscopic results are analyzed and confirmed by spectrum simulation and molecular modelling programs.

253 PERMANGANATE OXIDATION OF TRANS-STILBENE TO BENZOIC ACID USING PHASE TRANSFER CATALYSIS: A MICROSCALE ORGANIC EXPERIMENT.

Christina Noring Hammond, Department of Chemistry, Vassar College, Poughkeepsie, NY 12601.

This experiment was developed as part of a laboratory program seeking to minimize the use of hazardous substances and reduce waste disposal costs. Utilizing permanganate ion to oxidize trans-stilbene eliminates the waste disposal handling and costs associated with chromic acid oxidations, since the manganous ion produced in the reaction can to be washed down the sink as a dilute aqueous solution. The only organic by-product is a small amount of toluene. The product, benzoic acid, can be saved for use in another experiment. Students typically obtain yields of 45-55% of very pure benzoic acid as judged by the melting point. The experiment also serves to introduce the widely applicable synthetic technique of phase transfer catalysis early in students' organic laboratory experience, as alkene chemistry is usually a first semester topic.

254 MICROSCALE REACTIONS IN SEALED TUBES. Martha J. Kurtz and James P. Birk, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

We have examined a variety of decomposition reactions carried out in a sealed tube reaction vessel. Various solids in amounts of about 0.1 g were placed in a bent glass tube, which was then evacuated with aspirator vacuum and sealed off. The tubes were evacuated since many of the reactions examined give off gases; evacuation prevented explosion. Reactions were initiated by heating with a Bunsen burner flame. This method provides a safe way to carry out reactions that produce toxic substances, such as the decomposition of metal nitrates to produce nitrogen dioxide, and the ammonium dichromate volcano reaction. The toxic substances are completely contained and ready for safe disposal. Some reactions were found to be reversible over a period of time. Results will be presented for various reactions.

255 MICROSCALE ESTERIFICATION REACTIONS OF VANILLIN: A SURPRISE PRODUCT.

Rosemary Fowler, Department of Chemistry, Cottey College, Nevada, MO 64772.

Two microscale esterification reactions of vanillin, 3-methoxy-4-hydroxybenzaldehyde, have been developed to study acidic and basic catalysis and to show that reactions do not always yield the "textbook" product. One reaction esterifies the phenolic group of vanillin using acetic anhydride with catalytic amounts of base and yields the expected product, 4-acetoxy-3-methoxybenzaldehyde. The second esterification reaction of vanillin with acetic anhydride using a catalytic amount of sulfuric acid yields a different product, 4-acetoxy-3-methoxy-1,1-diacetoxytoluene. The two products are formed in good yield and are easily purified providing enough sample for identification of the products. The structures of the two products are determined using IR and NMR and the products produced by the two mechanisms are studied.

256 **A DIFFERENT APPROACH TO MICROSCALE.** Geoff Rayner-Canham, *Chemistry Department, Sir Wilfred Grenfell College, Corner Brook, NF Canada A2H 6P9.*

The switch to microscale experimentation has become dominated by "well-plate fever" -- that is, attempts are made to perform every experiment in a well-plate. Imagine if all conventional experiments were to be performed in beakers! There are several alternative technologies, one being the microcentrifuge tube (or microtube). These are very inexpensive and extremely versatile. Uses and limitations will be described. In addition, medical suppliers provide a wealth of accessories that make the microtube particularly useful for qualitative analysis. Some of the home-made adaptations of microtubes, such as gas generators, will also be displayed.

257 MICROSCALE ORGANIC ON A SHOESTRING: AN EXPERIENCE AT WKU. John W. Reasoner and Robert F. Forsythe, Department of Chemistry, Western Kentucky University, Bowling Green, KY 42101

We wanted to investigate the possibility of teaching microscale organic at the college level without having to resort to specialized microscale equipment since none was available at the time. We also wanted to insure that the students could perform the same experiments and learn the same techniques as those with Mayo-type glassware kits.

This presentation discusses some of the problems encountered and the experiments actually performed during the first semester and a discussion of how we accomplished a semester of microscale organic chemistry without access to special microscale glassware other than Pasteur pipettes and small test tubes, flasks and beakers. Student response to and satisfaction with the shoestring approach to microscale organic lab will also be discussed.

258 SMALL SCALE, LOW-COST EXPERIMENTS - Maria Elisa M. Pestana and Mariana Pereira - Faculdade de Ciencias - Univeridade de Lisboa - C1-3-P-1700 Lisboa

A questionnaire of first-year Portuguese university students indicated that several of them never performed experimental work in chemistry in secondary schools, some of them had seen demonstrations performed by their teachers, but others had no experience in laboratory work in chemistry. This is even worse for the 8th and 9th grades. In order to change this situation it is important, as a first step, to know the real reasons why secondary school teachers do not use such an important pedagogical resource. For that purpose a study was undertaken in the Lisbon area. A questionnaire was used with teachers from well-equipped inner city schools and from new schools. The latter, which were constructed in the outskirts of the capital because of the population migration and the educational boom, are often poorly equipped. In the answers to the questionnaire, among other reasons, teachers mention, as expected, the lack of equipment. However, lack of motivation of teachers seems to be a more important factor, because we found that in well-equipped schools laboratory work is still not often undertaken in lower grades. Other aspects mentioned are the inadequacy of programs (now being restructured), lack of confidence in performing experiments, and lack of safety conditions in the labs, when they exist. However, in some badly equipped schools teachers are not constrained by the situation, and try to improvise materials. They accepted the challenge presented by the Education Division of the Portuguese Chemical Society to create a group to design and develop small-scale, low-cost experiments and materials in kits, together with experimental procedures for the new programs. The results of the questionnaire and a kit will be shown.

259 **MICROSCALE EXPERIMENTS FOR USE IN ARMCHAIR CHEMISTRY.** Lowell W. Shank, Department of Chemistry, Western Kentucky University, Bowling Green, KY 42101

Two experiments performed by students in the classroom at their seats (armchair) using microscale techniques will be described and demonstrated. The laboratory procedures including report sheets will be available.

The first is the "Examination Of Acids And Bases Using Red Cabbage Extract As The Indicator." Ten household liquids with known pHs plus three with unknown pHs are examined in a 24-well plate. The students are asked to observe and record the colors obtained when red cabbage extract is added to the standards and then to estimate the pH of the three unknowns based on the colors obtained.

The second involves the "Preparation Of Two Polymers From Household Reagents." Slime is prepared from Guar Gum, available from a health food store, and Borax. "Silly Putty" is prepared from aliphatic resin glue and liquid starch. The properties of these two polymers are then examined and compared.

260 THE DESIGN OF VERSATILE MICROSCALE DISCOVERY KITS AND IMPLEMENTATION PROCEDURES FOR WIDE-RANGE AUDIENCES. Karen E. Eichstadt and Nancy C. Grim, Department of Chemistry, Ohio University, Athens, OH 45701

The microscale approach, using drops of chemicals on acetate sheets, has numerous advantages including individualized learning activities, reduced expenses, minimized safety concerns and facilitated waste disposal. We have designed kits which are useful for a wide range of activities. Meaningful scientific experiences for nine focus groups ranging from second grade to the graduate level have been conducted. The adaptations required for target groups will be discussed. Management techniques for implementation of the experiments in laboratory, lecture hall, and remote locations will be outlined.

ChemCom in Russia - Poster Session K. Michael Shea - Organizer; D. E. Jones - Presiding

261 CHEMCOM WORKSHOP AT MOSCOW SCHOOL 455,
Abraham M. Rennert, Manchester High School, Manchester, CT 06040

Moscow School 455, a school whose upper grades specialize in chemistry, hosted a CHEMCOM workshop attended by a cross section of chemical educators of the former Soviet Union including student teachers, teachers, technical institute and pedagogical institute professors. Impressions and experiences from the workshop will be presented.

262 MOSCOW, P.S. #455 AND CHEMCOM. Gwendolyn Pollock, Glenwood High School, Chatham, IL 62629.

As a result of an invitation from the Mendeleev Institute issued at the Cortland, New York ACS/NSF ChemCom workshop in July, 1990, a serendipitous group of US ChemCom teachers were guests as presenters of the ChemCom 'style' in public schools in Moscow in November, 1991. Some of the adventures and insights are to be shared with listeners. This trip was of special international importance to the further development of relations on the professional scale of the chemists and chemistry teachers of the CIS and the US. Perhaps more importantly, a personal scale between citizens with a global sensitivity was broadened.

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CHEMCOM TOWN MEETING- RUSSIAN STYLE. Marcia C. Bonneau. Cortland Jr./Sr. High School. 8 Valley View Drive. Cortland, New York. 13045

One important goal that we wanted to achieve during our workshop in Moscow was to have our Russian colleagues participate in the town meeting activity, "Putting It All Together: Fish Kill in Riverwood - Who Pays?". With only one copy of the English version of the ChemCom text, no xerox machine, and the extraordinary efforts of two translators, we will show how we were able to give them the information they needed about Riverwood , the fish kill, the presenter groups, their roles, and the rules for conducting the town meeting. It was a historical occasion to have a democratic process being modeled in a communist government about to be toppled. With photos that show their Russian version of a town meeting, their impression as expressed on their faces, and the results of the critiques done at the end of the activity, we'll let you decide if our Russian colleagues liked the workshop.

264 CHEMCOM TEACHER TRAINING IN RUSSIA. Vincent Bono, New Dorp High School, Staten Island, NY 10306; Fitzgerald Bramwell, Department of Chemistry, Brooklyn College, CUNY, Brooklyn, NY 11210; Robert Silberman, Department of Chemistry, SUNY at Cortland, Cortland, NY 13045.

As part of a Soviet-American effort on teaching high school chemistry, we presented a 4-day ChemCom workshop to 30 Soviet teachers at School N174 in Moscow, Russia. ChemCom is the American Chemical Society high school curriculum for college-bound nonscience major students. The workshop participants were from various Soviet republics, including Kaliningrad, Byelorussia, Russia, Siberia and the Ukraine. These republics encompass an area over 9,000 miles across and are home to many different ethnic groups. The response of the workshop participants to the society-technology-science aspects of the ChemCom curriculum was a function of the needs within the immediate region served by the Soviet participant. The relative lack of basic laboratory resources within Soviet high schools made the presentation of microscale techniques critically important.The strengths and weaknesses of the adaption of microscale laboratory techniques to ChemCom highlighted many of the differences and similarities within the curricula of various Soviet republics as well as within those of the United States.

265 **CHEMCOM AT P.S.N. 109 - MOSCOW** Helen O'Keefe Natick High School, 15 West Street, Natick, MA 01760

John Kovacs, Robert Dayton and Helen O'Keefe conducted a 3 day Workshop at P.S.N. 109 in Moscow. This was a progressive school educating children of junior and senior high school age.

The director of the school explained that they have a psychologist on staff and also have a pony and 2 horses as a therapeutic offering to its students.

Chemistry teachers, principals, heads of chemistry departments as well as members of the ministries of education and Pedagogy enthusiastically performed Micro-Chem Com Labs.

One particular lab on water testing indicated qualitively the presence of calcium and chloride ions in the Moscow water.

It was a global experience linking Massachusetts and New York State with Moscow, the Ukraine, Siberia, the Urals, Latvia and Lithuania.

A wonderful teacher/teacher exchange took place.

266 CHEMCOM WORKSHOP AT SCHOOL N109, MOSCOW. R. DAYTON, RUSH-HENRIETTA HIGH SCHOOL, HENRIETTA, NY 14467.

On 10 November 1991 John Kovacs, Helen O'Keefe, and I , (accompanied by our translator), arrived at the Moscow School N109 to present a workshop on ChemCom, (Chemistry in the Community), to 24 teachers from all parts of the (then) Soviet Union. We were unsure what to expect from the group but we found a very warm welcome from the school's director and students. We also found a group of eager, friendly teachers who seemed insatiable when it came to our "lessons". We brought books and materials of ChemCom to use and leave with the teachers. I would like to share with you some of our experiences with these teachers as we worked through some of the ChemCom ideas and laboratory acitvities. These teachers were very eager to find out about our methods of teaching science and our school organization. We were also hoping to learn of the schools of Russia and the Republics. While we were with the group at School N109 we were engaged in constant discussion comparing the teaching of science in the U.S. and the Soviet Union. I hope you will be able to discuss this international experience with me.

267 **CHEMCOM - INTRODUCTION TO PS N109 MOSCOW, RUSSIA** John A. Kovacs West Seneca West High School, 3330 Seneca Street,West Seneca NY 14224

During November 1991, Robert Dayton, Helen O'Keefe and I presented a four-day workshop to selected Chemistry educators in the Soviet Union. The purpose of the workshop, held in PS N109, Moscow, was to introduce the Chemcom program, microscale techniques and collaborative strategies to Russian teachers.

268 **VIDEO OF SCHOOL #615 MOSCOW** Donald C. Stroop, Jr West Perry High School, Elliottsburg, PA 17024

This video shows laboratory facilities, equipment, workshop participants, and various classrooms. The children's chorus will also be included.

269 USING UP A METAL - A MICRO-TECHNOLOGY ACTIVITY DEMONSTRATING CORROSION-SHARED WITH RUSSIAN TEACHERS. S. Jonathan Wachko. Egan High School, Fairless Hills, Pa. 19030

In an effort to help teachers of chemistry from the former Soviet Union to bring " Chemistry in the Community" to their classrooms, this microscale activity was utilized by S. J. Wachko in Moscow. This technology orientated activity is designed not only to emphasize the Law of Conservation of Matter, but to give first hand knowledge of its applications to industry. The valuable product formed in this activity can find its use on an industrial level. It can be used as a ceramic color, an oxidant in textile dying and printing; as a pyrotechnical oxidizer; and as a fungicide and herbicide. The teachers with whom this was shared had been handicapped by a lack of chemical technology activities and equipment, but their high level of enthusiasm, native talent and hard work displayed during this activity will upgrade their teaching methods into the modern era of technological education.

270 REACTIONS AND REFLECTIONS ON INSERVICING SOVIET CHEMISTRY TEACHERS ON USING ChemCom IN SOVIET SCHOOLS C.P. Clermont. Prince Georges County Schools, Largo High School, Upper Marlboro, Maryland 20772

A five-day workshop conducted by 16 American chemistry teachers and three college professors helped introduce over 100 Soviet chemical educators to a "Science and Society" approach to teaching chemistry at the secondary school level. The workshop focused on one of the most popular curricula of this type in the U.S.. namely, ACS's ChemCom - Chemistry in the Community. This non-traditional approach to teaching chemistry, with its emphasis on learning chemistry on a need-to-know basis. received praise, respect, queries, and lively discussion from the Soviet chemistry teachers attending the ChemCom workshop in Moscow.

The Soviet teachers seemed to react to the ChemCom philosophy and its various activities as representing a clear departure from the traditional approach to teaching chemistry ubiquitous in the former Soviet Union. Their embrace of the ACS curriculum was tempered by a genuine concern of how to adapt the ChemCom concept to their culture. changing political ideology, and current economic state.

271 STRIKING IT RICH WITH CHEMISTRY - A CHEMCOM ACTIVITY SHARED WITH RUSSIAN TEACHERS. Frances P. Gray, West High School, Manchester, NH 03102

"Chemistry in the Community" or ChemCom is a curriculum that has many activities to generate student interest in both chemistry and societal issues. One of them is presented here. In this activity, students create a "gold" and a "silver" penny. This laboratory experiment has surprising results that are contrary to conventional observations. This generates interest in the chemical process. At the same time the activity shows how chemistry is involved in the transformation and use of our metallic resources. This in turn stimulates a good discussion of how substitutions may be a practical response to limitations on our supply of metals. In interactions with the Russian teachers during this activity it was found that they were reluctant to present any experiment without first explaining the chemistry. Eventually, the Russian teachers understood our approach and were enthusiastic with the methods of ChemCom.

272 CHEMCOM IN MOSCOW, D.E.Jones, Western Maryland College,and S. A. Ware, The American Chemical Society

On November 6, 1991, 23 people embarked on a trip to Moscow at the invitation of the Dr. Pavel Sarkisov, rector of The Mendeleev Institute of Chemical Technology and also Vice-President of the Mendeleev Chemical Society. The invitation resulted from his experience with the 1990 ChemCom institute at the State University of New York, Cortland. Dr. Sarkisov invited all of the teachers, the directors and others from the ACS staff to come to Moscow to teach teachers of the then USSR about ChemCom as the guests of the Mendeleev Institute. While in Moscow, about 120 teachers were exposed over five days to the philosphy of ChemCom and the use of microscale in the laboratory. We also met with and discussed an international project under the auspices of UNESCO to provide several international examples of adapting other country's experiences to the ChemCom style. Several of us visited the Shemyakin Institute of Bioorganic Chemistry, an institute owned and operated by the Russian Academy of Sciences in Moscow, as well as the Moscow State University. More detailed discussions of these visits, pictures, and memorbilia will be shown and discussed. In addition we also had the opportunity to attend an opera at the Bolshoi Theater, a ballet at the Kremlin Theater and the Moscow State Circus.

General Papers: New Courses in Chemistry J. Pribyl - Presiding

273 "FIZZ" - AN INTEGRATED CURRICULUM DESIGN PROJECT. Edward A. Mottel, Department of Chemistry, Rose-Hulman Institute of Technology, 5500 Wabash Avenue, Terre Haute, IN 47803

In the Fall of 1990, an Integrated Curriculum of Science, Engineering and Mathematics was begun at Rose-Hulman. A key aspect of the curriculum was an increased emphasis on engineering design. By organizing traditional disciplines around the major themes of rate of change, accumulation and conservation, it was intended that students break down artificial barriers between the disciplines and focus on problem formulation and solution. Of the six design projects attempted during the first year of the curriculum, "Fizz" brought together the most interdisciplinary study. The statement of the problem was "Consumers like fizz, tell me something about it". Three man teams had to state a specific goal by defining the term "Fizz", design experiments which measured "Fizz", analyze and then present their results. Studies included measurements of internal gas pressures within cans and bottles of various soft drinks, total gas released, the kinetics of decarbonation and attempts to carbonate water. The methods by which these projects were studied brought together some of the students' integrated backgrounds, including applications of Bernoulli's Principle, Henry's Law and sound amplitude spectra of various soft drinks as they lose their fizz!

274 TEACHING CHEMISTRY WITH THE NEWSPAPER. Peter M. Jeffers and Arden P. Zipp; SUNY-Cortland, Cortland, NY, 13045.

A special one-credit honors module for General Chemistry has been taught during the spring semester each of the last three years. The course was taught in a seminar format with student-selected articles from the popular press as source material, supplemented with other readings as appropriate. The topics covered include global warming, ozone depletion, applications of lasers, drug development, nuclear medicine, solar energy and water pollution.

275 SCIENCE EDUCATION REFORM: A NEW CHEMISTRY COURSE FOR PROSPECTIVE ELEMENTARY TEACHERS. Craig W. Bowen, Science Education, Room 203 Carothers Hall, Florida State University, Tallahassee, Florida, 32306

As part of a large-scale effort to reform the science education program at Florida State University, new science courses (in biology, chemistry, geology and physics) are being developed for prospective elementary teachers. During this presentation an overview will be given of how the new chemistry course was developed by a team of chemists, physicists, science educators, and others. In addition, a description of the course will be given and contrasted with the current course typically take by these prospective teachers in terms of the goals, content, learning theories, instructional practices, students, and assessment.

276 APPLICATIONS-ORIENTED GENERAL CHEMISTRY COURSE. Hans J. Mueh, Clifford M. Utermoehlen, and Ronald P. Furstenau, Department of Chemistry, U.S. Air Force Academy, Colorado Springs, CO 80840-5701

During the past year, we have implemented an applications-oriented general chemistry course into our curriculum. The course serves the majority of our freshman cadets (~900), with the cadets going into science and non-science majors. The first one-fifth of the course (Phase I) includes a variety of topics, such as photography, petroleum chemistry, and household chemistry, in which we immediately show how chemistry is relevant to the cadets' lives. In addition, we introduce many chemical concepts which we expand upon later in the course. During Phase II, the middle three-fifths of the course, we cover fundamental concepts of general chemistry, oriented whenever possible to applications. We finish the course with Phase III, which is an instructor/student option block focusing on the detailed chemical concepts involved in a particular topic, such as environmental chemistry or medicinal chemistry. This presentation will detail the structure of the course and student feedback about the course.

277 MARINE AND ISLAND ECOLOGY. Lawrence J. Stephens and William G. Lindsay, Jr. Elmira College, Elmira, NY 14901.

For the past twenty years members of the chemistry and biology faculty at Elmira College have taught a course in marine and island ecology at the Bahamian Field Station. As one of the most isolated of the Family Islands, San Salvador provides an ideal setting for field studies.

The course content emphasizes the interaction of chemical and biological factors in the ecology of the island and its surrounding coral reef community. The faculty have had to become generalists in order to cover such topics as the chemistry of carbonates and aqueous systems as well as giving lectures on such topics as: tides, waves, and ocean currents.

A major benefit for the faculty as well as the students has been the cross-disciplinary learning which has occurred. A number of continuing student-faculty projects resulted from our participation in the course including studies on the possible role of chemical factors in mangrove succession patterns.

We will emphasize our experience in the continual development of the course and the special factors involved in cross-disciplinary field courses.

278 ENVIRONMENTAL CHEMISTRY: A NEW PERSPECTIVE. Lawrence E. Welch, Department of Chemistry, Knox College, Galesburg, Illinois 61401

Fueled by increased student interest in environmental matters, Environmental Chemistry has become a growing curricular entity. A wide variety of topics are available within this heading, allowing customization to fit instructor interests and expertise. By focusing on environmental monitoring using instrumental methods, one can impart an analytical emphasis to the subject. This talk will describe the creation of an Environmental Chemistry course that is essentially a lower-level and more applied version of the traditional Instrumental Analysis course. Lecture time is split between descriptive coverage of environmental problems and the analytical methodology needed for monitoring these problems. The laboratory portion of the course features HPLC, AA, Fluorescence, and GC applied to environmental samples. Compared to an Instrumental Analysis course, less time is spent discussing instrumental operation and molecular behavior, while greater emphasis is placed on method selection and data interpretation.

279 THE EDUCATION OF AN ENGINEER FOR SCIENTIFIC LITERACY, Grace L. Swartz, Department of Chemistry, Michigan Technological University, 1400 Townsend Drive, Houghton, Michigan 49931-1295

What in the World Isn't Chemistry?

Chemists believe that chemistry is an exciting and vital science. Why? Can we capture that excitement and impart it to our students? How can we encourage the development of a scientific attitude, as well as foster an understanding of how science works and its application to everyday life? Can we meet the intriquing challenge and design a general chemistry course to: 1) educate an engineer for scientific literacy and the application of technology?; 2) motivate and challenge the student?; and 3) incorporate the flexibility to accept *his/her* level of maturity in both mathematics and the college environment? At MTU 1200 of the 1400 incoming freshman take *the* general chemistry course during their first year. Our attempt - both in classroom strategy and support function - to accomplish these goals will be discussed.

280 **BRINGING ENVIRONMENTAL PROBLEMS TO THE CLASSROOM.** Gary Mort and James H. Swinehart, Department of Chemistry University of California, Davis, CA 95616

The use of environmental problems as a focus in the teaching of chemistry gives the student a connection between chemistry and problems she/he is aware of through general publications, and trains future scientists to use sound chemical principles in the solution of environmental problems. We have used environmental problems as a focus in two chemistry classes. These classes are Concepts in Chemistry, a general education course for non-science students at all levels, and Inorganic Chemistry: Main Group Elements, a course for sophomore-senior chemistry majors. The key to this approach is that the student has a sound background in the fundamental ways of thinking used in chemistry, three dimensional structures, equilibrium, and kinetics, so that an integrated approach can be used in the solution of the problems posed. The methods used to teach the fundamental ways of thinking at the very different levels of these two courses will be described. The environmental problems used in these classes, such as the chemistry of agricultural evaporation ponds and acid rain, and the integration of these problems with the fundamental ways of thinking and factual information presented in the courses will be discussed as models of this approach.

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I. **REFORMS IN TEACHING BASIC ORGANIC CHEMISTRY EXPERIMENTS IN TEACHERS COLLEGES IN CHINA** Wang Jiang-ping Department of Chemistry, Luo Yang Teachers' College, Henan, 471022, China

II. **ON THE REFORM OF THE TEACHING OF BASIC ORGANIC CHEMISTRY AT TEACHERS' COLLEGES AND UNIVERSITIES IN CHINA** Wu Yong Vice-President and Associate Professor, Nanping Teachers' College, Nanping, Fujian 353000 P.R. of China

(Copies of papers submitted to the Program Chair by these authors are available in the conference office in Freeborn Hall.)

282 CHEMICAL TRANSFORMATIONS AS THE FOCUS OF A DISCOVERY-BASED INTRODUCTORY COURSE. Nancy L. Devino, Michael S. Holden, Robert E. Leyon, Gerald Roper, and Cindy Samet, Department of Chemistry, Dickinson College, Carlisle, PA 17013-2896.

Dickinson College will implement a discovery-based, one-semester introductory chemistry course in Fall, 1993. Laboratory and classroom work will be integrated, in order to teach students what chemists do and how they do it. The first portion of the course will be a study of chemical reactivity. The second major area will focus on atomic and molecular structure as the basis of reactivity. The course will conclude with a study of equilibrium and thermochemistry. A detailed description of the course content will be presented, with emphasis on repeating threads, such as periodicity, reactivity, and stoichiometry. Sample laboratory exercises and projects will be described in terms of their relationship to the central themes of the course. The impact of this course on the entire chemistry curriculum has been studied, and the department has determined that the traditional divisions in chemistry are not compatible with our introductory course. We have re-designed a required eight-course core curriculum which, along with two additional upper-level electives, will complete the chemistry major. A description of the standard route to completion of a chemistry major will be described, along with alternate paths for students beginning chemistry in the sophomore year, transfer students, and those who choose to study off-campus for a semester.

283 CALIFORNIA WINE HISTORY AS SEEN THROUGH VARIETAL DIVERSIFICATION

James T. Lapsley, Dept. of Viticulture and Enology, U.C. Davis, Davis Ca 95616

Wine of varying quality has been produced in California for over 200 years. California wine history can be viewed as a continuing progression towards high quality, ultimately represented in varietal wine. This paper reviews the several boom/bust cycles of wine production in California and specifically examines the introduction, acceptance and adaptation of high quality varietals in California. The effect of Prohibition on varietal selection and the important work on vareity/site interaction undertaken by U.C. Davis faculty will be emphasized. The paper ends with a discussion of Chardonnay as a case study in cultivar introduction and acceptance.

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285 GAS CHROMATOGRAPHY - OLFACTOMETRY OF WINE Terry E. Acree Food Science and Technology, Cornell University - Geneva, NYSAES Geneva, NY 14456

Gas chromatography - olfactometry (GCO) or "GC - Sniffing" as it is often called, uses the human nose as a gas chromatographic detector. The nose is more sensitive than any other detector attached to a GC. As little as 50 femtograms (10^{-15}g) of the volatile important wine odorant, β-damascenone, has been detected by GCO. Furthermore, there is evidence that potent odor-active chemicals present at even lower levels in wines (attogram, 10^{-18}g) can be detected in natural products using GCO.

Odor-active chemicals often have distinctive odor qualities that GCO analysis can utilize in combination with their retention properties to provide compelling verification of a proposed chemical structure. This is because no two odor-active chemicals have the same GC retention properties and the same odor quality. In this presentation GCO will be described using examples of it's application to wine chemistry.

286 **AN ACADEMICIAN IN THE VINEYARD** Lanny Replogle Fenestra Vineyards, Napa CA

287 **CHEMICAL ENOLOGY TRAINING AT UC DAVIS** Andrew L. Waterhouse Department of Viticulture and Enology, University of California, Davis CA 95616

Winemaking involves many chemical processes, and it is essential that practicing enologists be able to understand certain chemical concepts. In particular, they must understand the redox chemistry behind SO_2, acidity, and the principles related to the chemical analyses carried out in wineries. Training at UC Davis demonstrates the chemical principles in the context of the "Wine and Must Analysis" class. Major changes are underway in the methodologies used at wineries and the class is under current review for content and presentation.

Integrating Computational Chemistry Into the Curriculum A. J. Lata, J. Casanova - Organizers, Presiding

288 Warren J. Hehre, Tammy Chao, Scott Fielder, PREDICTING SELECTIVITY IN ORGANIC REACTIONS, Univ. of California, Irvine, CA 92717; and Wavefunction, Inc. 18401 Von Karman #210, Irvine, CA 92715

Electronic structure methods are not only able to account for selectivity in organic reactions, but may also provide qualitative rationale for the observed preferences. Two very different classes of methods are discussed. Transition state models relate kinetic product distributions to the relative activation energies of pathways leading to these different products. These are applied to the description of regio- and stereochemistry in Diels-Alder cycloadditions, and are used to interpret the origin of noted preferences. Electrostatic and orbital models examine the reactants well in advance of the transition state in order to anticipate their selectivity. Illustrations are provided for each. Applications illustrated here are to the description of stereochemistry of nucleophilic additions to carbonyl compounds, and to the regio- and stereochemistry of free radical additions to chiral olefins.

289 TEACHING PHYSICAL CHEMISTRY WITH THEORIST. Gary L. Breneman and O. Jerry Parker, Department of Chemistry/Biochemistry, Eastern Washington University, Cheney, WA 99004.

Theorist, a symbolic algebra and graphing package for Macintosh computers, has some very useful features for teaching Physical Chemistry. Some of these features include color graphing of one and two variable functions in Cartesian or spherical coordinates; calculating single, double, and triple integrals; calculating derivatives; and finding roots of functions. Applications of these features applied to several physical chemistry topics will be discussed including temperature dependence of enthalpy; equilibria problems including titration curves; one, two and three dimensional quantum mechanical systems; and molecular velocity distributions. How Theorist has been included in the curriculum and comparisons with other mathematics packages will be included.

290 TEACHING THE ELECTRONIC STRUCTURE OF ATOMS AND MOLECULES TO INTRODUCTORY CHEMISTRY STUDENTS. Gwen P. Shusterman, Department of Chemistry, Portland State University, Portland, Oregon, 97207

Current introductory chemistry textbooks, and the courses based on them, are dismal failures when it comes to teaching the essential concepts of electronic structure. This failure has two sources: the lack of good models for depicting electronic structure, and undue emphasis on difficult and paradoxical bonding theories. The first problem can be overcome using recently developed computer modeling software such as SPARTAN. SPARTAN runs on inexpensive computer workstations and is flexible and user-friendly. A solution to the second problem is to change the focus from wavefunctions and bonding theories to two more fundamental properties of electronic structure: the molecule's electron distribution and electrostatic potential. Computer-generated models describing such elementary principles as electronegativity, covalent vs. ionic bonding, multiple bonding, and electron delocalization will be described.

291 VISUALIZATIONS IN TEACHING CHEMISTRY. Nora Sabelli, Igor Livshits, National Center for Supercomputing Applications, University of Illinois, Urbana-Champaign, Illinois 61820

Our work aims to enhance the chemistry curriculum by enabling students to manipulate visual representations of abstract concepts, explore these concepts, and thus, bring the studying of chemistry to the doing of chemistry. Routine numerical investigation of possible solutions is a crucial development of science in the last decade. Such research is possible because of the development of interactive (i.e., real-time and individually controlled) visualizations that place modeling and simulation results in the context of the chemist's intuitive working models.

The project consists of specific user-friendly modules based on a combination of local and remote simulations. We will select, train and support fifteen to thirty teachers over the country in their use of interactive simulations and visualizations to supplement, enhance, and complement laboratory experimentation and classroom discussion within the existing chemistry curriculum. The results will contribute to a restructuring of the curriculum to keep pace with new conceptual advances in the field.

Our hardware includes a connection to Internet, Macintosh II systems, and Sun and Cray computers.

292 A Visual Interpretation of Chemical Structure, Properties and Reactivity,

George D. Purvis, III, CAChe Scientific, Inc., Beaverton, Oregon, 97077.

Today, colorful computer-generated molecular graphics often splash the covers and pages of journals and periodicals. Commercial systems make this generation quick and easy, even in 3D stereo. The challenge is to use these images coherently to interpret and teach chemistry. Wouldn't it be nice to check on a spectra and see the orbitals responsible for the absorption? In this talk, three chemical problems, one related to molecular structure, one related to chemical properties and one to reactivity, will be interpreted visually.

293 QUANTUM MECHANICS WITH MATHCAD 3.0. F. Rioux, Department of Chemistry, Saint John's University, Collegeville, MN 56321

Mathsoft has recently released Mathcad 3.0 which runs under Windows 3.0. The live document interface and the graphical environment of this version of Mathcad combine to yield a powerful mathematics program that can be used for a large number of applications in the traditional physical chemistry course. This poster presentation will demonstrate the following applications of Mathcad in the area of quantum mechanics: routine problem solving and units management; linear, non-linear and polynomial regression analysis; finding roots for transcendental equations; numerical solutions for Schrödinger's equation; the linear variation method; a molecular orbital calculation on the hydrogen molecule ion; a self-consistent field calculation on the helium atom; and an NMR simulation.

294 SHAPES OF ATOMIC and HYBRID ORBITALS. **O. Jerry Parker** and Gary L. Breneman, Department of Chemistry & Biochemistry, Eastern Washington University, Cheney, WA 99004

Macintosh computers provide a convenient means of presenting graphical interpretations of atomic and hybrid orbitals. A Basic program called ATOMORB has been used to plot electron probability density contours for atomic and hybrid orbitals. Hydrogen-like wavefunctions that include both the radial and angular parts of the wavefunction can be plotted as a surface using the Born interpretation. This surface represents a slice through the three dimensional space occupied by the nucleus and its associated electrons. Orbital contour diagrams are produced using character graphics. From the orbital contour diagrams, the shapes of the contour lines can be easily recognized and the level of electron density between orbitals can be compared. ATOMORB allows the user to experiment with atomic and hybrid orbitals that are not usually treated in many general chemistry texts.

295 MATHEMATICS AND COMPUTATION IN THE CHEMISTRY CURRICULUM.

Allan L. Smith, Chemistry Department, Drexel University, Philadelphia, PA 19104

In the present cycle of self-examination among chemical educators, it is important to reassess the role of mathematics and computation in our undergraduate curriculum. This is particularly true in light of the significant nationwide efforts in higher education to reform both the introductory calculus offering and the first course in computing. From my perspective as a participant in an interdisciplinary team which has revised the entire curriculum for a group of entering engineering students at Drexel (the Enhanced Educational Experience for Engineers), as well as a participant in the CHEMED-L on-line chemistry education discussion list, I will discuss the present mathematical content of introductory chemistry courses, survey the mathematics required in upper level chemistry courses, and make recommendations on the use of mathematical software by undergraduate students of chemistry.

New Initiatives in Organic Chemistry S. Levine - Organizer, Presiding

296 **RELEVANCY IN ORGANIC CHEMISTRY**

James K. Whitesell and Marye Anne Fox, Department of Chemistry, The University of Texas at Austin, Austin, TX 78712

Many important changes in how Organic Chemistry is taught have occurred in the last twenty years. These include not only how the material is organized (e.g., functional group versus reaction type) but also which specific material is included. A prevalent theme among many texts, and presumably therefore in courses, is relevancy where specific material is added with the aim of eliciting student interest. Such topics often follow biologically related themes as, for example, biosynthesis and gene expression. Unfortunately, in the majority of cases such added material is just that and the background information required for an clear understanding is missing. For example, little information is generally provided on the nature of the hydrogen bond, especially as it relates to biological systems, yet this background is essential for a clear understanding of the chemical principle behind translation of the genetic code through base pairing.

In the past, organic chemists have decided what material within the subject was of direct interest to them, and then additional, material relevant to the audience was added. Rather, decisions should be made on what information a science student should be provided from the field. Thus, premedical students should have a firm understanding of the molecular basis upon which modern pharmaceutical science is based: nutrition students should have the necessary level of understanding of organic chemistry principles that the chemical function of co-factors (i.e., vitamins) will become clear. Many topics must be added, but correspondingly, many must also be deleted.

297 BRIDGING THE GENERAL CHEMISTRY AND ORGANIC CHEMISTRY COURSES.

F. A. Carey, Department of Chemistry, University of Virginia, Charlottesville, VA 22903.

A number of suggestions designed to bring about better continuity between the introductory courses in general chemistry and organic chemistry will be offered. Included among the topics to be addressed will be:

(*a*) **Classification of reaction types**. While acid-base reactions and oxidation-reduction receive coverage in both general chemistry and organic chemistry, certain organic chemistry terms relating to reaction types (substitution, addition, elimination) are not commonly used in general chemistry but should be.

(*b*) **Mechanistic terminology and curved-arrow notation**. Conventional organic terminology (nucleophile and electrophile, heterolytic and homolytic, for example) could be introduced in general chemistry. The students would develop a better qualitative feel for acid-base chemistry and for proton transfer as a process by tracking electron movement using the curved arrows employed by organic chemists.

(*c*) **SI units**. Organic chemists need to recognize that their students have never been exposed to anything other than SI units and are more comfortable with kJ/mol than kcal/mol.

298 TEACHING PROBLEM-SOLVING IN ORGANIC CHEMISTRY. L. G. Wade, Jr., Department of Chemistry, Whitman College, Walla Walla, WA 99362.

Organic chemistry instructors in the 1990's will continue to decide which new reactions, theories, and analytical techniques should be added to the introductory course, and which old topics must be shortened or omitted. Pedagogy will improve, and problem-solving is an area that should receive special attention. Many students understand the basic concepts of organic chemistry, but they cannot see how to approach and solve problems such as multistep syntheses and mechanisms. These types of problems are different from those encountered in general chemistry. Flexibility and imagination are required, and students cannot learn formulas that always lead to solutions.

Experienced chemists approach synthesis and mechanism problems systematically, using methods that have become intuitive with practice. We have developed and summarized methods students can use to analyze and take apart organic synthesis and mechanism problems using simplified versions of the mental processes organic chemists instinctively use. These methods do not lead directly to solutions, but they provide a framework to isolate the important aspects of each problem. Such a systematic approach is particularly useful on exams to help students organize their thoughts and get past the initial terror they feel when confronted by an unfamiliar problem.

299 PUTTING THE HORSE BEFORE THE CART: USING THE PRINCIPLES OF STRUCTURE AND REACTIVITY FOR INTRODUCTORY CHEMISTRY COURSES. Brian P. Coppola, Department of Chemistry, The University of Michigan, Ann Arbor, Michigan, 48187.

What constitutes an introduction to chemistry? Now in its third year, The University of Michigan's curricular experiment starts students with the more qualitative models of structure and reactivity used by organic and inorganic chemists as basis for the introductory courses. Students are immersed into the language of chemistry, reasoning by analogy, and the increasingly sophisticated models for chemical phenomena. Organic chemistry has provided the ideal vehicle for the first two courses, which are titled *Structure and Reactivity*. The evaluation of these changes has begun, and a number of encouraging facts have emerged. The courses have also gained a reputation for encouraging broad notions about scientific practice and developing learning skills.

300 Organic Chemistry--Then and Now. Richard F. Daley, Department of Chemistry, Walla Walla College, College Place, Washington 99324.

Over the past 50 years or so, the field of organic chemistry has undergone rapid change. These changes have forced practicing organic chemists to shift their model of organic chemistry. This paradigm shift has caused a move away from the organization of the chemistry of organic molecules based the oxidation state of the functional group under investigation towards an organization based on common mechanistic pathways. Unfortunately, this change in models has not found its way into mainline introductory organic texts. Included will be examples of how this paradigm shift affects the teaching of organic chemistry.

301 **WILL THE ORGANIC LABORATORY SURVIVE THE DECADE?** Ralph J. Fessenden
Department of Chemistry, University of Montana, Missoula, MT 59812

The sophomore organic laboratory is very expensive. It takes a significant amount of students' time and preparation. Its cost for chemicals, waste disposal, and equipment rises each year. Its health considerations for faculty, staff and students cannot be ignored.

Is the purpose of the laboratory to train students in manipulative skills or to demonstrate the principles of chemistry? Cannot both of these be taught more efficiently and at lower cost using computers and videos. Cannot interactive computer systems be substituted for hands-on laboratory experience?

Is the laboratory as we currently teach it worth the cost? Can we defend it in the face of rising criticism and demand for its resources? Should we compromise and offer a laboratory for only chemistry majors? Should we resist any change from the current system of laboratory instruction? What will happen to our departments and profession if change is forced upon us? In the next decade, most of us will be required to answer such questions. How should we respond?

302 ORGANIC CHEMISTRY EDUCATION IN THE 1990s. A. David Baker and Robert Engel, Department of Chemistry and Biochemistry, Queens College of the City University of New York, Flushing, NY 11367.

As the discipline of organic chemistry grows and evolves, the approaches to its teaching must similarly grow and evolve. Of particular significance for the future educational activities of the discipline are: the rapidly increasing body of factual knowledge which must be mastered, or at least dealt with by the student; the role of computers, particularly microcomputers, in the handling of data and its evaluation; evolution of the concerns of the chemical (organic) laboratory regarding both new techniques and concerns. In these regards we see future education to be particularly involved with the understanding of the nature of chemical reactions rather than the memorization of specific reactions, that the student will be prepared to find and devise new reactions with a greater emphasis than previously. Computers are seen as being of particular value for the organizing of reaction data and its correlation, as well as for the understanding of stereochemistry. Finally, the laboratory will take on increased importance as students learn to accommodate their efforts, in university and employment, to concerns of other aspects of our society.

General Papers: Finding and Retaining Future Scientists R. Goode - Presiding

303 CHEMISTRY FOR THE GIFTED STUDENT AT PIKE HIGH SCHOOL--YEAR ONE. Maria R. Walsh, Department of Science, Pike High School, 6701 Zionsville Road, Indianapolis, IN 46268

In the school year 1991-92, the first group of Metropolitan School District of Pike Township students identified as gifted moved into the sophomore year at Pike High School and the first-year chemistry course. This presentation will describe the philosophy of our course, the development of the curriculum for this first year, and the successes and failures for this first year of chemistry for the gifted student at our school.

304 **THE U.S. NATIONAL CHEMISTRY OLYMPIAD** M.K. Turckes Manager, Office of High School Chemistry, ACS, 1155 Sixteenth Street, NW, Washington, DC 20036

The American Chemical Society (ACS) will sponsor the U.S. National Chemistry Olympiad (USNCO) for the tenth year (1992-1993) and served as host for the 24th International Chemistry Olympiad (IChO) during July, 1992. The competition seeks to encourage students to achieve excellence in chemistry and recognize outstanding chemistry students and their teachers.

The competition begins in March with a qualifying round administered by the ACS local section. Each section is permitted to nominate anywhere from 5-15 students to take a national examination held each April. Twenty high school students are invited to attend a 10-day study camp where they attend lectures and perform laboratory experiments. At the end of the camp, four students are chosen to represent the United States and compete against teams from over 30 other delegations in the IChO in July.

The session will allow teachers to view the 1991 and 1992 national examinations and to discuss specific approaches that could be used to prepare students for future competitions. Statistics from the study camp will be shared, concerning the type of student that attends the camp. A description of the study camp and the mentor selection process will be discussed.

305 **TEACHING CHEMISTRY TO LEP (LIMITED ENGLISH PROFICIENCY) STUDENTS** Diane McGann Science Department, Santa Ana High School, 520 W. Walnut St. Santa Ana, CA 92701

In the 1990-91 school year Santa Ana High School had a 99% minority enrollment of which 94% were Hispanic/Latino students. Although these students qualified for Chemistry 1-2 (the traditional high school first year course) based on of their math background, they had limited English proficiency (LEP). To accommodate these rapidly increasing numbers of LEP students, I have devised an innovative method of teaching chemistry. This revamping of chemistry has proven effective. It has increased minority enrollment and completion of the course by one-third.

The implementation of this program embraces visual and tactile techniques for instructing bilingual students. The course also emphasizes student participation in laboratory activities, pre- and post- lab reviews and teacher demonstrations. The periodic table is used to integrate and organize chemical topics covered in this program.

306 PROJECT SEED; HOW TO PRODUCE "THE EXPERIENCE THAT CAN CHANGE A LIFE". Gladysmae C. Good. 5419 N. Arlington, Indianapolis, In 46226

Wouldn't it be great if all interested high school students had the opportunity to spend their summers doing chemical research? ACS has devised a program for disadvantaged students and provided funds for stipends. All it takes is local implementation! Indiana Section started its program in 1973. We have improved, mostly, by trial and error. We also run a parallel but integrated program for those not so disadvantaged. Now, we would like to pass on our success stories (and blunders) to you so you, too, can have a successful SEED program. Wouldn't you like to know how to: find disadvantaged but qualified students, recruit preceptors, solicit funds, provide guidance, and assess the results? Included will be slides, sample applications and the 1992 video used to do all the above.

307 REACHING THE TALENTED PRE-COLLEGE STUDENTS AND TEACHERS THROUGH THE MILLSAPS COLLEGE SUMMER RESEARCH INSTITUTE IN CHEMISTRY AND BIOLOGY. Johnnie-Marie Whitfield, Chemistry Department, Millsaps College, Jackson, MS 39210.

The fourth successful year of this three phase Summer Research Institute (SRI) has just been completed. The four week, eight hour a day commuter program has reached over 36 secondary teachers and 130 students from 45 different schools. In Phase I, the teachers and Millsaps faculty work together in an intense program that explores the experiments and equipment that will be utilized again when the high school students join the SRI in Phase II. Phase II is a highly structured two weeks with activities in chemistry, biology, library research, and computers. Phase III includes field trips to local labs for applications of similar instruments and tests. On the capstone Calebration Day, students give presentations on their group research projects and meet other former SRI participants who are invited back for the festivities. Funding for the SRI is gratefully acknowledged from the Howard Hughes Medical Institute.

308 STUDENT SUPPORT FOR AND THE RETENTION OF MINORITY STUDENTS IN CHEMISTRY.
H. B. Silber, Department of Chemistry, San Jose State University, San Jose, CA 95192.

Even as overall enrollments in science level-off or decrease, the numbers of minority students enrolled in chemistry and science courses at our Institution are increasing. However, in any multi-purpose general chemistry class, the numbers of declared chemistry majors is small, and even smaller for under-represented minority students. It is critical to not only increase the numbers of under-represented minority students, but even more importantly we must retain those we admit. It is important to place the better teachers into these courses, because students respond to the quality of teaching and can become chemistry majors. One way to encourage students into a chemical career is to engage them in research, even as freshman. This becomes even more important for minority students. We have been successful, partially by being involved with programs for high school students, such as the ACS Project Seed, as well by encouraging minority high school teachers by programs, such as the Research Corp. High School-College Interface Grants, which is not a minority program. We will discuss the strategies that have been successful in retaining, encouraging and training these students. In our group we have attracted minority students by supporting both minority and majority students by grants available to all students, such as ACS PRF Grants and Welch Grants. We will also discuss funding and recruitment of minority students via the NIH Minority Access to Research Careers (MARC) Grant, NIH Minority Biomedical Research Support (MBRS) Grant, and funds from the NSF and the Department of Energy.

309 EXPERIENCING THE LIFE OF A COLLEGE PROFESSOR AS A FORD FELLOW WHILE ENRICHING AND EXPANDING THE IMPACT OF THE FACULTY MENTOR: THE MILLSAPS COLLEGE FORD FELLOWSHIP PROGRAM.
Brian G. Barnett & Johnnie-Marie Whitfield, Chemistry Dept., Millsaps College, Jackson, MS 39210.

This college-wide program seeks to attract top-flight students into college teaching careers through an undergraduate apprenticeship in both teaching and research. Currently three of thirteen competitive Ford Fellowships for 1991-1992 juniors and seniors have been awarded in chemistry. These Ford Fellows are not merely undergraduate versions of graduate teaching assistants. The program is also distinct from the Millsaps Honors Program. Ford Fellow Barnett and Faculty Mentor Whitfield will focus their joint presentation on the impact of the current Ford Fellows in chemistry as well as their two year ongoing project in restructuring the general chemistry laboratory course.

310 **RETAINING UNDERGRADUATES INTERESTED IN CHEMICAL SCIENCE. A RESEARCH-ORIENTED SECTION FOR FIRST-YEAR STUDENTS**

Brian P. Coppola, Department of Chemistry, The University of Michigan, Ann Arbor, Michigan, 48187.

The first year chemistry course for many undergraduates at The University of Michigan is the organic chemistry based course titled *Structure and Reactivity*. During the first term, students are given the option of selecting themselves into a special section of the second term of the course. The only criterion for enrollment is a potential desire to pursue a career in the chemical sciences. A total of 92/700 students enrolled for the 1991-92 offering. With this group, there is an opportunity to explore issues of experimental design and practical laboratory skills. Examinations are more interpretive than in the parent course, and present primary data in the way a chemist would read it. These students have a separate, semester-long laboratory research project that offers the possibility for individual experimentation. Weekly literature assignments give the students experience in information retreival and scientific writing. Written, in-class feedback assignments give the instructor greater access to student misconceptions. The history of the self-selected, research-oriented section indicates that this is a good way to retain students who express an early interest in the sciences.

An Evening of Light Entertainment J. J. Fortman - Presenter

311 DAZZLING DEMOS AND VIDEOTAPED CHEMICAL BLOOPERS. John J. Fortman, Dept. of Chemistry, Wright State University, Dayton, OH 45435.

The evening will be spent viewing my version of "America's Funniest Home Videos." Through the years I have collected and edited many misadventures which Rubin Battino and I experienced in doing demonstration shows which were videotaped live. Difficulties encountered in the studio preparation of our three hour set of videotaped demonstrations were also saved. These will make up one half hour of these showings. Gil Haight has given me permission to show portions of his "Haightful Perils of Teaching" which are spectacular in spite of technical problems. A videotape of Hubert Alyea's doing his "Old Nassau" demonstration will be shown, as will some tapes of others such as Bassam Shakhashiri and Ron Perkins caught in live demonstrations which presented problems. Contributions of Lee Marek and Cliff Schrader are included in the collection. Attendees who have videos of spectacular demos or embarassing disasters are invited to contact me and bring your tapes. Additions will be made as time allows.

Implementing the 'World of Chemistry': A Symposium Dedicated to the Memory of Isidore Adler and Marjorie Gardner (sponsored by $2YC_3$) M Schumm - Organizer, Presiding

312 **THE MANY DIFFERENT FACETS OF *THE WORLD OF CHEMISTRY*,** Nava Ben-Zvi, the Hebrew University of Jerusalem and University of Maryland, College Park

It is possible to turn on a television in the U.S., Canada, Israel, Italy, Japan, and many other locations around the globe and watch *The World of Chemistry*, created at the University of Maryland at College Park and produced by the Educational Film Center. This telecourse, primarily aimed at college-level liberal arts students, has been used in a variety of arenas: as a full telecourse, as a course in conventional classrooms, as supplementary materials in high schools and colleges, as a central focus in teachers' workshops (in-service and pre-service), and as training materials in the work place in the chemical industry. Derivatives works consist of: a version for high schools, *Issues in Chemistry*-- a one-hour videotape and videodisc for high school and junior high school, and a series of videodiscs available as special issues of the Journal of Chemical Education. Teachers around the U.S. and around the world are tailoring *The World of Chemistry* to their special needs through the creation of laboratory manuals and other written materials.

313 **WORLD OF CHEMISTRY FOR HIGH SCHOOLS** Patricia J. Smith, Air Academy High School, United States Air Force Academy, Colorado 80840

With a grant from the National Science foundation, *The World of Chemistry* videocourse was adapted for use at the high-school level. This version retains the unique characteristics of the parent series: emphasis on real world chemistry, demonstrations, and graphics. However, at the secondary school level the videos are intended to be a curricular supplement rather than its nucleus. The guiding principle was "videos should be an integral part of the curriculum rather than a post script." With this in mind each fifteen minute tape is accompanied by more than twenty pages of teacher suggestions and student activities developed by six high school teachers working on the project. This presentation will focus on the tape, "Chemical Bonding" which demonstrates a unique approach to this topic for secondary schools.

314 **THE IAC PROGRAM AND "THE WORLD OF CHEMISTRY"** R.J. Rusay Department of Chemistry, Diablo Valley College, Pleasant Hill, California 94523

IAC's project director, Marjorie Gardner, stated that the program's goal was "to make chemistry more appealing for an even larger audience of students and to offer students a very solid experience in up-to-date chemistry." The original, multifaceted program was widely accepted. It offered many instructional advantages in activity-based experiential learning. Marjorie had been preparing a new, updated edition. The project is continuing in her name with a student-centered aim, which incorporates relevant and contemporary issues. The updated program is being drafted to allow the teacher flexibility in course emphasis through selection of various topics and personal addition of experiments and other information. It will provide an easy-to-use guide in applying segments of *The World of Chemistry* as a key learning resource. It will rely on *The World of Chemistry* in printed and electronic excerpts to stress the relevance and importance of the chemical concepts established in the IAC program.

315 THE WORLD OF CHEMISTRY AT AMARILLO COLLEGE, A.G. FOSTER, Department of Physical Sciences, Amarillo College, Amarillo, Texas 79178

In the Fall 1990, Amarillo College broadcast The World of Chemistry series on the College TV station, KACV. The course was offered as the equivalent of Chemistry 3213, taken by Associate Degree Nursing students. The instructor met with the students 5 times for on-campus discussions of approximately 2.5 hours each. Students were required to turn in homework assignments and take tests in the testing center. Of the 24 students who enrolled, 22 completed the course for a grade. The students rated the videos as very good to excellent.

In the Fall of '91 the course was offered as Chemistry 3003. It was felt that the course was not the equivalent of Chemistry 3213 in teaching computational skills and writing formulas and equations. The course did not go. Plans are to reoffer the course as Chemistry 3113. This is a one semester general, organic, and biochemistry course for Dental Hygiene students and non-science majors.

316 AN HONORS COURSE FOR THE NON-SCIENCE MAJOR. John E. Bauman, Jr., Department of Chemistry, University of Missouri, Columbia, MO 65211.

A special section of a general honors discussion course was taught for 20 upper class non-science majors. The videotapes and text for World of Chemistry were used as the basis for the course. Exams, papers, special projects and oral presentations comprised the semester long course for three credits. Student backgrounds, interests and career goals were shown to contribute much to their overall interest in the material. A compari on of this course with the typical survey course is shown. Student suggestions for subsequent offerings are listed.

General Papers: History in the Chemistry Curriculum G. Rayner-Canham - Presiding

317 THE DETERMINATION OF THE CONTENTS OF A VIAL FROM THE CIVIL WAR: GENERAL CHEMISTRY AT WORK. Scott R. Goode, Department of Chemistry, University of South Carolina, Columbia, SC 29208.

Students often feel that chemical analyses are performed nearly exclusively by instruments and that methods like those of the qualitative analysis scheme taught in General Chemistry are obsolete and unused by "real" chemists. But little could be farther from the truth.

Recently, several small glass vials were found by historians at the site of a civil war explosion. The contents, a water-clear, viscous fluid, were transferred to a screw-top container and the identity of the sample was determined by applying a few (relatively simple) tests. The presence and absence of a precipitate, and the formation of colored species, rather than some complex instrumental test, were central to the process. Precipitation reactions, titrations, and solubility rules were used; the chemistry is understandable and the thought-process is clear, even at the freshman chemistry level.

Real-world examples like these place chemistry in a context that is often unfamiliar to the student--solving problems in the real world.

318 "AND I QUOTE....". Dennis Swauger, Physical Science Department, Ulster County Community College, Stone Ridge, NY 12484.

One of the most important things that a classroom lecturer must do is to "engage" the class. Once this is accomplished students will have a greater tendency to participate in the discussion at hand and will get much more out of the lecture. A method that I have found works to engage a class is to start the class with a quote, germane to the day's topic, selected from a number of different sources: famous scientists, philosophers, poets, writers, etc. This presentation will focus on sources of such quotes and particular quotes that I have found to be the most useful.

319 ON THE SHOULDERS OF GIANTS. Richard S. Treptow, Department of Chemistry and Physics, Chicago State University, Chicago, IL 60628

Isaac Newton acknowledged his indebtedness to the countless scientists who preceded him by declaring that he had "stood on the shoulders of giants." We teachers should do the same. I will discuss the unique role the history of chemistry can make in teaching and also demonstrate a technique for introducing it into the classroom.

The history of chemistry teaches important lessons not easily learned in other ways. Students need to know that 1) chemistry is the result of human effort, 2) scientists are sometimes wrong, 3) discovery of the unknown is exciting, and, most importantly, 4) there is a place for them in chemistry.

To encourage teachers to introduce the history of science, I have published the audiovisual game "Giants of Science." It consists of 35-mm slides depicting famous scientists and their discoveries. We will play the chemistry version of the game and discuss its learning objectives.

320 50 YEARS OF ORGANIC CHEMISTRY TEXTS-WHAT'S NEW? G.Brieger Department of Chemistry, Oakland University, Rochester,Michigan 48309-4401

A crisis point has been reached in the size and content of organic chemistry texts. Clearly there is no more room for new subject material without a significant winnowing of existing content. There is also a question concerning the appropriateness of the present coverage in light of the fact that very few of the approximately 120,000 annual readers will become chemists, let alone organic chemists. The question of content will be addressed by comparing five leading contemporary texts with each other and with two leading texts published approximately 50 years ago. Desiderata for future texts will also be presented.

321 WORKSHOPS IN THE HISTORY OF CHEMISTRY. Lawrence B. Friedman, Beckman Center for the History of Chemistry, University of Pennsylvania, Philadelphia, PA 19104-6228

The Beckman Center for the History of Chemistry has designed a workshop in the History of Chemistry for high school teachers and, in July 1991, conducted a one-week pilot of this workshop. We attempted to design an intellectually challenging program which would provide experiences for high school chemistry teachers that could be translated directly into more stimulating and effective teaching and more effective learning. The program consisted of formal classroom lectures on topics in the history of chemistry (selected by teachers in a preliminary survey) and discussion sessions in which applications of the lecture material to the high school classroom were developed. In addition, each teacher was asked to develop an individual project, specifically for classroom use, and these projects were reviewed in a concluding group discussion on the last day of the workshop.

Examples of teacher's projects will be presented, results of a post-workshop evaluation will be reviewed, and plans for expanded versions of the workshop will be discussed.

322 WORKSHOP IN THE HISTORY OF CHEMISTRY - TEACHERS' PERSPECTIVE.
Lee R. Marek, Naperville North High School, Illinois; John L. Ihde, Wausau West High School, Wisconsin; David Trapp, Sequim High School, Sequim, Washington.

Teacher participants from the Beckman Center's pilot workshop in the History of Chemistry have developed curricular activities which focus on historical aspects of chemistry. These activities include "classical" lecture demonstrations, bringing historical chemistry characters to life through role-playing and enactment, and the development of a hypermedia presentation on the periodic chart. These activities will be described in detail, and plans for additional "historical" curricular activities also will be discussed.

General Papers: Programs and Workshops for Middle and Elementary School Teachers

P. Carlock - Presiding

323

A LABORATORY EXPERIENCE FOR MIDDLE SCHOOL TEACHER/STUDENT TEAMS.
G. R. K. Khalsa, Department of Chemistry, Thiel College, Greenville, PA 16125.

Activities and strategies employed in a five morning workshop for fifth through eighth grade teacher/student teams will be described. In this program, fourteen teachers worked one-on-one with targeted students in performing forty inquiry-based chemistry activities. Students involved were preferentially female, minority, and/or socially or economically disadvantaged. Feedback and evaluation from the teachers will be discussed, particularly with regards to their perceptions about usefulness of the performed activities in the classroom and impact on the participating students. This workshop is one component of a Dwight D. Eisenhower Mathematics and Science Education Act Title II supported project.

324 PROJECT INTERACTION: AN EFFECTIVE MODEL FOR THE CONTINUING EDUCATION OF HIGH SCHOOL CHEMISTRY TEACHERS.
Daniel J. Antion, University of South Carolina, Columbia, South Carolina 29208 and Sondra F. Wieland, Fort Mill High School, Fort Mill, South Carolina, 29715.

Project Interaction is an intensive five-week continuing education institute for South Carolina High School Chemistry Teachers that employs a unique Learning-Teaching Cycle to improve knowledge and understanding of chemical principles. The Learning-Teaching Cycle lowers fear barriers to teaching difficult chemical principles, raises confidence levels, and enhances teaching effectiveness. Project Interaction can be applied as a model for local staff development as well as a model for professional growth and leadership development for chemistry or other science teachers. Details of the NSF co-sponsored project will be discussed and results of teacher performance and progress will be presented.

325 **TEACHING SCIENCE WITH TOYS--A HANDS-ON WORKSHOP FOR PRE-COLLEGE TEACHERS,**
I. L. Sarquis, Chemistry Department, Miami University, Oxford, OH 45056, A. M. Sarquis, Chemistry Department, Miami University-Middletown, Middletown, OH 45042, and J. P. Williams, Chemistry Department, Miami University-Hamilton, Hamilton, OH 45011.

"Teaching Science With TOYS" is a graduate-credit teacher in-service workshop designed to show K-12 teachers how toys can be used in science instruction. Our most successful format includes once-a-month Friday-Saturday meetings on campus during the academic year. The workshops have included from 48 to 72 teachers subdivided into grade-level groups of 16-22. The workshop is team-taught by chemistry and physics faculty at Miami University. The instructional team also includes peer teachers who have been participants in previous TOYS workshops. Between sessions, participants classroom-test the hands-on activities and provide a critique. They also develop a final project that will be presented to their peers at the final meeting. Workshop participants, who are generally part of a team of several teachers from different grades in a district, also develop an intra-district inservice program for their district. Workshop mechanics, materials, and evaluation will be presented. Funding has been provided by the National Science Foundation, the Ohio Board of Regents, Miami University, and the Cincinnati Section ACS.

327 HANDS-ON SCIENCE WORKSHOPS FOR ELEMENTARY TEACHERS.
Al A. Hazari, Arlene A. Garrison, and Sarah M. Dugger, Department of Chemistry, University of Tennessee, Knoxville, TN 37996.

Workshops on "hands-on" activities were conducted for 20 fifth grade teachers with the assistance of a grant from the Tennessee Higher Education Commission with Title II, Dwight D. Eisenhower funds. In these Spring and Summer 1992 workshops, teachers from Knox County and adjacent counties performed several "hands-on" activities and learned the essential science background material. Each teacher received a set of student-tested acience activities and was encouraged to plan for "hands-on" science classes in 1992-93 school year.

327 CHEM FEST: A COMBINATION WORKSHOP FOR ELEMENTARY TEACHERS AND STUDENTS.
Dr. Darrell Watson, Chemistry Department, University of Mary Hardin-Baylor, P.O. Box 8013 UMHB Station, Belton, TX 76513.

CHEM FEST was a part of a continuing effort of the Chemistry Department of the University of Mary Hardin-Baylor to help enhance the image of chemistry in the local community and to increase the excitement and competence levels of pre-college students in chemistry. The two components of this summer program were: 1.) teacher workshop and 2.) student activity sessions. Local teachers of grades 4-6 were selected to attend a seven day teacher workshop where they conducted exciting "hands on" chemistry activities. The scientific background and chemical concepts illustrated by the activities were discussed. The second component of the program, the student activities sessions, served two purposes. The teacher participants were given the opportunity to conduct these activities with elementary students and observe their response to these activities before they are introduced into their classroom. Secondly the elementary students selected for the workshop had the opportunity to conduct "hands-on" chemistry investigations exploring: the properties of metals, acids and bases, crystalization energy changes and polymers. Students were encouraged to continue these investigations at home with their parents. Details of selection criteria for participants, activities conducted and evaluation results will be discussed.

328 A "HANDS-ON, MINDS-ON" SCIENCE WORKSHOP FOR K-8 TEACHERS. Martha Couretas, Waverly High School, Lansing, MI 48917, John Funkhouser, Chemistry Department, Michigan State University, East Lansing, MI 48824, Annis Hapkiewicz, Okemos High School, Okemos, MI 48864, Sheldon Knoespel, Chemistry Department, Michigan State University, East Lansing, MI 48824

After presenting a number of "hands-on, minds-on" science workshops for K-8 teachers, it is evident that there is a ubiquitous need for this type of approach in order to allow the teacher to comfortably and confidently promulgate physical science in the classroom. We exemplify integration of chemistry with all subject areas, and make chemistry relevant, fun, inexpensive and safe. Evaluations and impact, material replenishment as well as the linkage of conceptualization with experiential methodology will also be discussed.

329 A CONSTRUCTIVIST APPROACH TO GRADE SCHOOL SCIENCE IN VERMONT. Michael J. Strauss, Barbara B. Lewis, Russell Agne and Horace Puglisi, Departments of Chemistry and Education, University of Vermont, Burlington, VT 05405-0125.

Vermont elementary school teachers from around the state are now participating in an NSF funded initiative to introduce chemistry, geology and physics into grades K-6 using a 'constructivist' approach to teaching and learning science. This approach focuses on how models are developed, how scientists reason and how knowledge is constructed. It encourages teachers to view science as an evolutionary, developmental process that matches the learners conceptual level. Three groups of 17 teachers are rotating through an intensive summer institute sequence of chemistry, geology and physics, which introduces content using co-operative groups, writing-to-learn, chalk talks, lab work, experiments, demonstrations, journals and other constructivist pedagogy. During the school year the college faculty in each of the science disciplines are traveling throughout the state to present demonstrations and workshops for children, bring materials to the schools and to evaluate the progress of both students and teachers as the program evolves. The curriculum, techniques and pedagogy will be presented and the relationship to other Vermont science initiatives will be discussed.

Macintosh Applications: III General Chemistry (cont.) J. Casanova, B. Luceigh - Organizers; B. Luceigh - Presiding

330 COMPUTER INTERFACED EXPERIMENTS IN GENERAL CHEMISTRY. James R. Hutchison, Department of Chemistry, Alma College, Alma, MI 48801

Macintosh computers are used in our General Chemistry laboratory as data acquisition devices interfaced to a variety of sensors and instruments. Data acquisition is controlled by programs written in LabVIEW software. The interface uses National Instrument I/O boards and locally designed and constructed electronic components. The first interface is a temperature probe which is used in calorimetry and freezing point depression experiments. The second interface creates a computer-controlled titrator used to investigate the behavior of weak acids and bases. The third interface is to a Novaspec II spectrophotometer, a low-cost, single-beam instrument, creating a Macintosh-driven, scanning visible spectrophotometer which is used throughout the course on a routine basis.

331 THE MACINTOSH IN GENERAL CHEMISTRY Steven E. Hannum, Department of Chemistry, George Fox College, Newberg, OR 97132

In the Fall of 1991 as part of the "Computers across the Curriculum" program each freshman at George Fox College received a Macintosh Classic™ computer. The software included a word processor, a spreadsheet and a draw program. This paper will report some of the first year's experiences of integrating the use of the computer into a general chemistry class.

332 COMPUTER ASSISTED LAB INSTRUMENT OPERATION AND PRINCIPLES EXPLANATION (CALIOPE)
Robert D. Minard Chemistry Dep't., Penn State University, University Park, PA 16802

CALIOPE is a Macintosh-*LabVIEW 2*™ based system that combines guidance in the operation of sophisticated instruments and data acquisition/display. It is designed to allow hundreds of sophomore level organic chemistry lab students to carry out analysis of synthetic products on a "walk-up" basis without constant supervision. The first CALIOPE was created for gas chromatography and uses*LabVIEW 2* to create an animated interface that: 1) identifies the major parts of the GC (injector, column oven, detector, etc.); 2) guides the students through the set-up of the temperature program and signal attenuation controls based on an experiment number entered by the student; 3) demonstrates how to use a microliter syringe and inject a sample; 4) acquires and displays the gas chromatogram in one window and 5) presents a graphic explanation of the principles by which a gas chromatograph works in another window.

333 MACINTOSH BASED LESSONS FOR FIRST-YEAR CHEMISTRY
Stephen K. Lower, Dept of Chemistry, Simon Fraser University, Burnaby BC V5A 1S6, Canada (lower@sfu.ca)

Two groups of lessons will be demonstrated: Properties of Gases (11 lessons covering ideal gases, real gases, and elementary kinetic-molecular theory), and Chemical Bonding (18 lessons covering fundamental concepts, polar covalence, VSEPR theory, hybrid orbitals, and simple molecular orbital treatment of diatomic molecules and transition metal ions, metals and semiconductors.) These lessons concentrate on concept development and are intended for an introductory-level course in which CAI serves as a major instructional tool.

334 MULTIMEDIA AND MENTAL MODELS IN CHEMISTRY. Joel Russell, Chemistry Department, Oakland University, Rochester, MI 48063, Robert B. Kozma, Tricia Jones and Joann Wykoff, 1302 School of Education, University of Michigan, Ann Arbor, MI 48109, and Christine Russell, Chemistry Department, College of DuPage, Glen Ellyn, IL 60137.

This presentation will demonstrate a multimedia software environment designed to address student conceptual difficulties in chemistry. The software, entitled 4M:Chem, provides users with an interactive environment within which chemical phenomena are represented in multiple, dynamic ways on the same screen. For example, in one window the user might see a video of the experiment as it would appear on the lab bench; another window might show a molecular-level animation of the reaction; a third window might show a dynamic line graph of changes in concentrations of reagents over time. A user can manipulate certain variables (e.g., increase temperature) and see the changes propagate across the multiple representations. We will provide the theoretical rationale for the design and present initial field tests results.

335 SEEING THROUGH CHEMISTRY; Paul G. Rasmussen, Charles Dershimer, Peter Wurman, Michael Nowak, Chris Buswinka; Department of Chemistry and Office of Instructional Technology, University of Michigan, Ann Arbor MI 48109,

Seeing Through Chemistry is a multi-media package implemented on the Macintosh computer that is designed to help students learn general chemistry concepts. The package incorporates video from video disk, still and animated images, along with short-answer questions to help students develop integrated understanding of basic chemical concepts through inquiry and observation. The video is made Macintosh compatible by use of the Raster-Ops video board. *Seeing Through Chemistry* features a unique user interface which encourages active exploration by allowing the user to tailor the way information is presented to his/her own preferences. The package will be displayed in a live demonstration.

336 **MACINTOSH WITH AND WITHOUT INTERFACE WITH VIDEODISC PLAYER FOR USE IN CHEMISTRY PRE-LAB, HOMEWORK AND LECTURE DEMONSTRATION** S.K. Airee
The University of Tennessee at Martin, Martin Tennessee 38238

Course Builder software from TeleRobotics International, Inc. was utilized to generate interactive materials for students to use at free standing Macs or the ones accessed by a server. A laserdisc player interfaced with a Mac was also made available to generate sequences of frames from JChemEd Periodic Table videodisc or from one of the ACS Doing Chemistry videodiscs. Students signed onto a Mac were asked a series of questions related to the material shown form the videodisc or based on the material covered in the lecture or the laboratory. At the end of the ten question set, students print out a report that lists the student's name, percent score and the time used. Only if they scored 80% or more were they given credit or allowed to work in the laboratory. For demonstrations to classes or large groups, a Color Space module from Mass Microsystems was used to show the videodisc image or the Macgraphic on one or more of the TV monitors. Developed materials are free standing and do not require the user to thave the TRI software.

337 VISUAL PATTERNS FOR STOICHIOMETRY.

H. P. Williams, Department of Chemistry & Biochemistry, University of Southern Mississippi, Hattiesburg, MS 39406

Stoichiometric calculations are encountered in Introductory Chemistry and scattered throughout the entire first year of General Chemistry. Each of these varied problems are often seen as separate isolated obstacles with no clear connection for too many students. The method of constructing an equivalent mole mattrix offers an easily remembered visual array for organizing information in such a way as to integrate the solution of all types of stoichiometric problems. This approach offers a visual, easily comprehended and concrete method enabling students to solve any stoichiometric problem.

338 OXIDATION NUMBERS. A. Duttaahmed, Department of Science and Technology, Bucks County Community College, Newtown, PA 18940

A new definition of oxidation number and its determination in different units of matter will be discussed. The distinctive feature of the author's approach is to use electronegativity and molecular structure instead of current approach of postulates and exceptions. Limitations of prevailing methods will be discussed. A procedure for balancing oxidation reduction equations will also be discussed.

339 FOCUSING STUDENTS ON MOLECULAR ACTION THROUGH ACTIVE LEARNING. Francis P. MacKay, Department of Chemistry, Providence College, Providence, RI 02918.

Virtually any active learning technique can be effectively adapted to the chemistry classroom and they can be effective in making students realize that they cannot understand chemistry without understanding molecular interactions. The problem initiated class which is begun with a brief experiment, demonstration, or presentation of data with a perplexing result is an excellent way to gain a class' attention and focus them on molecular interactions. Having a pair of students dissolve a salt, one exothermic and one endothermic, can lead to an illucidation of the steps involved in dissolution and their energies, the structure of salts and water and entropy. Role playing in which students act out molecular behaviors is an effective way to get students to "see" molecules. Difficult concepts such as the difference between real and ideal volume, collision theory, and limiting reagent can be illustrated by students acting as molecules. They enjoy it and it can lead to quite stimulating discussions.

340 ELECTRON WAVES, AN ALTERNATIVE TO THE RESONANCE AND MOLECULAR ORBITAL MODELS OF DELOCALIZATION.

Francis M. Klein, Creighton University, Omaha, NE 68178-0104

The resonance approach, long used to describe delocalized systems and predict electron distribution within them, is often misinterpreted by students. Of equal or greater importance, many identify the method with the phenomenon, and thus never reach an understanding of the phenomenon itself. The molecular orbital description of these systems can give students a better model of delocalization. However, except in the most elementary cases, students in the first organic course have great difficulty predicting MO's.

The author has devised an alternate approach to delocalized systems which combines the simplicity of the resonance model and the "correctness" of molecular orbitals. Using this approach, students can predict electron and charge distribution in any conjugated system without MO or resonance. This paper will describe this model, called the wave approace, and discuss some of its merits and limitations.

341 WHAT NO ORBITALS! A NEW APPROACH TO THE TEACHING OF BONDING IN GENERAL CHEMISTRY

R.J. Gillespie, Dept. of Chemistry, McMaster University, Hamilton, Ontario, Canada, L8S 4M1.

Difficulties, such as the concept of hybridization, that arise in the conventional orbital approach to bonding can be avoided by using the concept of valence shell electron pair domains. The electrons in the valence shell of an atom in a molecule occupy space in pairs in accordance with the Pauli principle. The space occupied by an electron pair is called its domain. By considering the distribution of electrons in single bond, double bond, triple bond and lone pair domains this approach leads naturally from Lewis structures to the VSEPR model and to an understanding of bonding independent of the orbital model. The relationship of the domain and orbital models of the chemical bond to the concept of a chemical bond as revealed by the total electron density will be discussed.

342 **A VALUABLE TOOL FOR DELIVERING SPEECHES AND LECTURES: THEMATIC MAPS.**

E. A. Castro INIFTA, División Química Teórica, Suc.4 - C.C.16, La Plata 1900 Argentina

Thematic maps are proposed on the basis of two previous related devices to present a given subject matter: Concept Maps and Mind Maps. Some drawbacks related to these two constructs are taken into consideration to surmount them and new elements are introduced into Thematic Maps to improve the efficiency of this new tool. A comparative illustrative example is given in order to make clear the main features associated with each of these maps.

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THERMODYNAMICS AND ELECTROCHEMISTRY IN GENERAL CHEMISTRY. A. Duttaahmed, Department of Science & Technology, Bucks County Community College, Newtown, PA 18940.

Problems of teaching thermodynamics and electrochemistry in freshman general chemistry will be discussed. Author's experience of applying the basic concept of energy-work-change sequence to develop a theory of chemical transformation, conceptual and quantitative, will be outlined. The emphasis is on understanding the basic principles of thermodynamics rather than extensive vocabulary. Electrochemistry is developed using the free energy concepts and quantitative relationships. A systematic approach is taken to develop electrolysis instead of the common approach of case studies. Selective examples and comparison with few popular textbooks will be discussed.

Plenary Address

344 **C_{60}, THE CELESTIAL SPHERE WHICH FELL TO EARTH** Harold Kroto School of Chemistry and Molecular Sciences, University of Sussex, Brighton, BN1 9QJ UK

Almost exactly five years after C_{60} Buckminsterfullerene was discovered serendipitously during a series of graphite laser vaporization experiments designed to simulate the chemistry in a red giant carbon star, the molecule has been isolated in macroscopic amounts. This breakthrough has triggered an explosion of research into its chemical and physical properties. The molecule has already exhibited a wide range of novel phenomena which promise exciting applications, in particular it undergoes a wide range of novel idiosyncratic synthetic reactions.

345 **EPR STUDIES OF METAL-CONTAINING FULLERENES** Donald S. Bethune, Costantino S. Yannoni, Mark Hoinkis, Mattanjah de Vries, Jesse R. Salem, Robert D. Johnson IBM Research Division Almaden Research Center, 650 Harry Rd, San Jose CA 95120-6099 and Mark S. Crowder IBM Adstar, 5600 Cottle Rd, San Jose, CA 95193

We will report on the arc-production and spectroscopic characterization of fullerene-encapsulated metal atoms and metal -atom clusters. In particular, both solution and solid-state electron paramagnetic resonance (EPR) spectra of $La@C_{82}$, $Y@C_{82}$ and $Sc_3@C_{82}$ have been obtained. Additional species containing rare-earth atoms and clusters have been produced. The results suggest, for example, that the three scandium atoms in $Sc_3@C_{82}$ form a molecule in the shape of an equilateral triangle - as was previously suggested for Sc_3 molecules isolated in a cryogenic rare-gas matrix. The spectra of the $M@C_{82}$ species (M=La, Y, Sc) exhibit small hyperfine couplings and g-values close to 2, suggesting that they can be described as +3 metal cations within -3 fullerene radical anion cages. $Sc_2@C_{2n}$ species - the most abundant metallofullerenes in the scandium-fullerene mass spectrum - are EPR-silent even though Sc_2 is EPR-active in a rare-gas matrix at 4.2K. A broader implication of this work is that production of macroscopic quantities of metal-containing fullerenes may make possible the fabrication of exotic new structures with regular arrays of metal atoms or clusters isolated in fullerene molecules, resulting in new types of host/guest nanostructured materials.

346 ALKALI DOPED C_{60} - STRUCTURE AND SUPERCONDUCTIVITY: Richard B. Kaner, John B. Wiley, Edward G. Gillan, Shiou-Mei Huang, Kyu Min, Robert Whetten, and Karoly Holczer, Depts. of Chemistry and Physics and Solid State Science Center, University of California, Los Angeles, California 90024-1569, USA.

Fullerene carbon cages continue to produce a wide variety of new and exciting chemistry. Our recent research efforts have concentrated on the synthesis and characterization of metal fullerides. Potassium and rubidium doped C_{60} (Face-centered cubic M_3C_{60}) exhibit superconducting transition temperatures of 19.3 K and 29.6 K, respectively. Experiments with C_{60} and Na, K, and Rb show that although sodium fulleride has an FCC lattice, both it and sodium-containing mixed-metal compounds are not superconducting. X-ray powder diffraction and magnetic susceptibilty data will be presented on all these systems. A series of lanthanide endohedral compounds have been produced from arc-burning of filled graphite rods, and these will also be discussed.

347 RAMAN STUDIES ON C_{60} AT HIGH PRESSURES AND LOW TEMPERATURES, S. H. Tolbert, A. P. Alivisatos, H. E. Lorenzana, M. B. Kruger, and R. Jeanloz, Department of Chemistry, University of California, Berkeley, CA 94720.

C_{60} crystals are a form of pure carbon that is metastable with respect to graphite at room temperature and pressure. We have performed studies on C_{60} as a function of pressure and temperature to see what happens when the distance between C atoms on different molecules becomes comparable to the distance between C atoms within one C_{60}.

348 PROBING FULLERENE STRUCTURE AND DYNAMICS USING NUCLEAR MAGNETIC RESONANCE Robert D. Johnson, Donald S. Bethune, and Costantino Y. Yannoni IBM Research Division, Almaden Research Center 650 Harry Road, San Jose, CA 95120-6099

NMR spectroscopy can probe diverse aspects of the structure and dynamics of fullerenes. The single line NMR spectrum of C_{60} supports its predicted icosahedral symmetry and pentagon/hexagon structure. The NMR spectrum of solid C_{60} at ambient also consists of a narrow single line, demonstrating that the molecules rapidly reorient within the crystal lattice. Cooling solid C_{60} slows the molecular orientation rate, giving a powder pattern due to chemical shift anisotropy (CSA) from which CSA tensor elements can be deduced. Measurement of the internuclear dipole-dipole coupling in the solid at 77K gave the first measurements of the two bond lengths in C_{60}. The INADEQUATE 2D NMR experiment on C^{13}-enriched C_{70} with its five types of carbons, allows the carbon bond connectivity of the molecule to be traced, giving an unequivocal experimental assignment of the spectrum, and provides a measurement of the spin coupling constants. NMR provides a quantitative probe of the molecular rotational dynamics in solid C_{60}. By studying the dependence of the magnetic relaxation rate ($1/T_1$) on the magnetic field, the molecular reorientational correlation time, τ, can be determined. At 283K, $\tau = 9.1$ ps, only 3 times longer than the τ calculated for free rotation, and shorter than the value measured for C_{60} in solution. Below 260K a second phase with a much longer reorientation time is observed, consistent with recent reports of an orientational phase transition in solid C_{60}. In both phases τ shows Arrhenius behavior, with apparent activation energies of 1.4 and 4.2 kcal/mol for the high temperature (rotator) and low temperature (ratchet) phases, respectively.

349 **BEYOND C60: THE HIGHER FULLERENES** Robert L. Whetten Department of Chemistry, University of California, Los Angeles, CA 90024-1569

Bringing Women into Chemistry J. Chase - Organizer, Presiding

350 WOMEN IN SCIENCE: WHERE DO WE GO FROM HERE? Jane Butler Kahle, Miami University, 418 McGuffey Hall, Oxford, OH 45056

National data indicate that the gains that women have made in the last two decades, concerning their entrance and retention into the scientific and technological pipeline, are eroding. The numbers of women entering certain fields (notably engineering and computer science) leveled in 1984 and have begun to decline. Furthermore, in fields that women have entered in high numbers (biology and psychology) a solid, but unacknowledged, glass ceiling affects their ability as a group to contribute to their fullest extent. The percentage of women who are under- or unemployed in technical fields has remained at a level consistently higher than the percentage for men. These findings are in spite of two decades of intervention programs, designed to increase the numbers of girls and women studying for careers in mathematics, science, and engineering. A synthesis of theoretical research and practical interventions shows that the situation is different for women in mathematics than it is in science and that those differences have resulted in more progress in mathematics than in science. Solutions, based on the progress women have made in mathematics, will be proposed for science.

351 ENCOURAGING YOUNG WOMEN TO STUDY CHEMISTRY, R. I. Perkins, Greenwich High School, Greenwich, CT 06830.

"The object ... is to present the simpler fundamental concepts of the Science of Chemistry in a form which will appeal to boys..." A. C. Gilbert, ca. 1940. Fifty years later there is still a male bias in precollege chemistry instruction -- each year the twenty national winners of the ACS National Chemistry Examination are predominately male. Contrary to this bias, Greenwich High School has a history of encouraging young women to study chemistry. Two of our female chemistry students have been chosen to participate in the National Chemistry Olympiad Study Camp in Colorado -- one becoming the first female selected and the other the first female selected to continue in the International Olympiad competition. Most of the 1,600 elementary school science lessons in our outreach program have been taught by female AP Chemistry students.

352 **PIONEER WOMEN IN NUCLEAR SCIENCE.** Geoff Rayner-Canham and Marelene Rayner-Canham, *Chemistry Department, Sir Wilfred Grenfell College, Corner Brook, NF Canada A2H 6P9.*

During the first two decades of this century, a significant proportion of the researchers in nuclear science were women. Yet this fact is totally unknown! We have traced the lives of fifteen of the overlooked women. Why was this such an attractive field of research for them? We will look at some possible reasons to account for this, including the supportive role of the supervisors and the social network that developed between many of the women. The existence of these potential role models should be much more widely known.

353 SCIENCE AND HUMOR: WHAT IS THE MESSAGE? R. W. Kleinman & L. K. Lee, Department of Chemistry, Lock Haven University, Lock Haven, PA 17745

A lighthearted look at the scientist. Cartoons and anecdotes will be used to examine the interactions between women and men in science. We will discuss various interpretations of each situation in order to ultimately ask: "where is the fine line between satire and prejudice?"

354 BRINGING WOMEN INTO CHEMISTRY AND ENCOURAGING THEM TO STAY, Kathleen E. Turner, Learning Skills Center/Chemistry, Baker Laboratory, Cornell University, Ithaca, New York 14853

To insure the success of programs aimed at recruiting women for chemistry we must work to stem their movement to other fields throughout their university career. At Cornell, a supplemental course designed to improve performance in introductory chemistry, is run in parallel with the parent course. Women students, many of whom are uncertain of their scientific abilities yet earn high grades, including A and A+, are our most enthusiastic participants. A supportive environment provides help with chemistry, mentoring and a center of activity within the chemistry department. Our experiences and insights into improving the classroom climate for women students will be discussed. For example, the training of the tutors who staff the office hours factors into our success with students. The success ranges from women, ready to change fields, who decide to continue in science to women who ultimately raise their scientific aspirations.

355 WOMEN IN SCIENCE AND ENGINEERING: A NEED FOR ACTION Jody Chase and Joseph G. Danek, Division of Human Resource Development, National Science Foundation, 1800 G St., N.W., Washington, D.C. 20550

Although the number of women who earn baccalaureate degrees is increasing, the increase is occurring only in psychology and sociology. In all other areas of science and engineering the number of B.S. degrees awarded to women is decreasing. Moreover, women pursue graduate degrees in smaller proportions than their male counterparts, and do not advance as rapidly in their academic careers as do their male colleagues. Women will constitute a large percentage fo the net new workers as we approach the end of the century, and the skill levels required of these new workers will rely heavily on mathematics, science and logic. A change in the science and technology environment is necessary if we are to attract talented women to science, and intervention strategies can be devised to enhance the success of women in scientific careers. NSF-funded programs are addressing a variety of these issues, and educators across the country have a part to play.

Curriculum Reform in the High School G. E. Miller - Organizer, Presiding

356 WHERE ARE WE GOING NATIONALLY? Elizabeth K. Stage, National Research Council--HA450, 2001 Wisconsin Ave NW, Washington, DC 20418

The National Research Council (NRC) is coordinating the development of a comprehensive set of national standard for K-12 science education, addressing curriculum, teaching, and assessment. This presentation will describe the way in which the NRC effort will build on existing work and will incorporate the input and critique of all stakeholders. In particular, the role of ACS members, both chemists and chemistry teachers, and opportunities for continued involvement in the process will be discussed. The standards working groups, which are meeting this summer, face several challenging questions, such as the importance of the disciplines, the level of literacy that is reasonable for all students, and the treatment of technology. Preliminary thinking about these and other issues will be shared.

357 **PROJECT 2061** Gary Oden, Science Resource Teacher, San Diego City Schools, San Diego, CA 92103

Project 2061 is an ambitious program of the American Association for the Advancement of Science (AAAS) designed to create a new science experience in schools and a greater public science literacy for the next generation of Americans. The foundation has been laid in a visionary statement produced by several distinguished panels of scientists and published as *Science for All Americans*. the current development phase is creating curriculum models based on that vision. This model will shortly be being tested and implemented in schools around the nation.

This presentation will review the goals and objectives of *Science for All Americans*, provide an update on current work status, and discuss the implications for high school science teaching in the next decade, as envisioned by Project 2061.

358 CONCEPTS OF CURRICULUM: WHAT ARE WE TRYING TO CHANGE? Craig W. Bowen, Science Education, Room 203 Carothers Hall, Florida State University, Tallahassee, Florida, 32306

The purpose of this talk is to discuss the idea of curriculum and alternative ways of conceiving this concept. Curriculum is an important concept to think about because it will help us to think about reform. For instance, what do we mean when we say we want to change "the curriculum?" First, a model of curriculum is formulated that synthesizes some aspects of the curriculum concept as described in the *Journal of Chemical Education*. Second, an overview is given of a conception of curriculum that is based on cultural interaction and interpretation within educational settings. That is, curriculum is not found in textbooks or syllabi, but is something that arises through social interactions of the participants such as the students and instructor. Finally, this second conceptualization of curriculum is used to analyze the first model in an attempt to bring to light some issues that might help us to think about curriculum reform.

359 PACESETTER: A COLLEGE BOARD INITIATIVE IN SCIENCE. Hessy L. Taft, Educational Testing Service, Rosedale Road 25-E, Princeton, NJ 08541.

Pacesetter is the new College Board initiative to develop syllabi, assessment instruments, and teacher development materials with the goal of improving instruction and student learning. This effort is being carried out in collaboration with the appropriate subject matter professional associations. In the case of science, this collaboration is with NSTA. Pacesetter in Science is seeking to describe what would be the last high school course in Scope, Sequence, and Coordination program of NSTA. The conceptual framework of Pacesetter is being developed by a Task Force comprised of specialists in biology, chemistry, physics, and earth science. Pacesetter in Science is planning an interdisciplinary approach in which chemistry will play an integral role. The Task Force is giving consideration to unifying themes such as evolution, structure of matter, equilibrium, energy, and fundamental forces. Up-dated status of progress made by the project will be reported.

360 TEACHERS BELIEFS AND CLASSROOM INTERACTIONS: LESSONS FROM HIGH SCHOOL CHEMISTRY. Amy J. Phelps, Department of Chemistry, University of Louisville, Louisville, KY 40292.

Teachers are an often ignored component in the battle to reform science education at the precollege level. This practice has proven ineffective in bringing about any lasting change in classrooms. This study focuses on the relationship between chemistry teachers' beliefs and what goes on in their classrooms. The two teachers had very similar goals for teaching high school chemistry and they used the same adopted curriculum materials, but the classroom interactions were vastly different. These differences had their basis in the two teachers' different beliefs about how students learn, what can be done to enhance student learning, and what constitutes a good background in science. These findings have implications for the current national search for a curriculum that will improve precollege science teaching and learning. They also inform the efforts of those who would try to reform undergraduate education at the college level.

361 COLLEGE FACULTY CAN INFLUENCE HIGH SCHOOL CHEMICAL EDUCATION -- A DECADE OF ACCOMPLISHMENT IN MISSISSIPPI. John H. Bedenbaugh and Angela O. Bedenbaugh, Department of Chemistry and Biochemistry, Box 8466, University of Southern Mississippi, Hattiesburg, MS 39406-8466

Ten years ago the Education Committee of the Mississippi Section of the American Chemical Society began implementing a long-range plan to improve the teaching of high school chemistry in Mississippi. This committee, comprised of concerned college and university faculty members, has over the years: (1) prepared and widely distributed two resource books, Handbook For High School Chemistry Teachers and Teaching First Year Chemistry, (2) conducted a three-year, statewide teacher enhancement workshop program for crossover chemistry teachers, and (3) established a statewide system of regional associations of chemistry teachers. Our presentation will feature activities of the regional associations and the Education Committee's plans to offer through these groups in-service instruction in chemistry on a continuing basis to high school chemistry teachers throughout Mississippi.

Financial support from the Directorate for Education and Human Resources of the National Science Foundation has made possible these activities of the Education Committee.

362 THE GOLDEN STATE EXAMINATION IN CHEMISTRY
George E. Miller, Department of Chemistry, U.C. Irvine, CA 92717

Golden State Examinations in Chemistry (and Biology) provide an opportunity for California High School students to challenge themselves against criteria established by high school teachers and college teachers. For the first time, on a wide scale, multiple measures of assessment are used to judge a student's performance level. The current examination includes multiple choice questions, constructed response (open-ended) questions, and a performance task. Pilots are to be held in 1992-93 for use of a portfolio of year long items as an additional component of the exam. One important feature of the entire process is the high degree of collegial involvement among high school chemistry teachers, college and university faculty in designing and implementing the entire examination system.

Implementing the 'World of Chemistry': A Symposium Dedicated to the Memory of Isidore Adler and Marjorie Gardner (sponsored by $2YC_3$) M Schumm - Organizer, Presiding (cont)

363 MOTIFS IN THE WORLD OF CHEMISTRY. Roald Hoffmann, Department of Chemistry, Cornell University, Baker Laboratory, Ithaca, NY 14853-1301.

The production of a telecourse covering all of chemistry was an inherently sequential and fragmenting task. But there are common threads and themes running through all the programs. Some of these motifs were designed, some emerged naturally. An account of the themes to be found in "The World of Chemistry" will be given, and perhaps a preview of a plan for a new prime-time PBS series, "The Molecular World".

364 USING *WORLD OF CHEMISTRY* TO ADDRESS NAIVE MODELS IN CHEMISTRY D.L. Frank Department of Chemistry, California State University, Fresno, Fresno, CA 93740

Research in cognitive science has come to challenge the conceptual model that views students as "blank slates". Rather, many findings indicate that both weak and strong learners come to their science classes with extensive theories on the workings of the natural world. One strategy for effective teaching recognizes that these naive models must be confronted: prior knowledge affects learning because learners try to interpret new material in relation to an already established paradigm.

In our introductory chemistry course we use a variety of techniques and demonstrations to help students make explicit their naive models. Upon reflection and discussion, usually a need for new knowledge then emerges in a problem-solving context. The **World of Chemistry** can function both as a database of demonstrations and conceptual models which can facilitate this process.

365 THE PERSISTENCE OF PRINT: VERBAL-VISUAL INTEGRATION IN EDUCATIONAL TELEVISION Robert Kaper, Independent Producer, Mechanicsville, MD 20659

Marshall McLuhan observed that the content of any medium is always another medium. Much of educational television's content is printed information from a textbook. But there is an enormous difference between the dense, time-independent verbalizations in books and the non-verbal, time-critical visualizations in television. The natural inclination when converting text to video is to maintain print's structure and format: a disproportionate amount of effort spent on verbal narrative with images selected as an afterthought to illustrate words. The result can be a program that conflicts with the fundamental physiology of vision and fails to hold the audience's attention. This presentation will explain the strategies employed on the World of Chemistry and other educational productions to overcome this tendency and produce programs that are both informative and visually compelling.

366 A NEW DIMENSION FOR EVALUATION OF A VIDEO SERIES Minna Hilton-Kramer, 268 Sunset Key, Secaucus, NJ 07094

The real question about any science video or motion picture is whether it works as entertainment or as an instructional tool, or both? Educational research and statistical analyses best deal with this question. What may be more significant in the long run is whether it work as a product of the motion picture medium (MPM)? Does it utse the unique characteristics of that medium so that it justifies the time and money invested? Does it use the "language" of motion pictures, such as the vocabulary, grammar and syntax of MPM, and more particularly the vernacular of the science film which could be viewed separately from the content materials? If not, perhaps there are other media more suitable for that particular message, i.e., a book. With an innovative system for noting the structure of the MPM, we enter into another dimension of inquiry as to whether any particular video works or not. Bronowski's series "Ascent of Man" could be the standard used to compare the use of the "language" of the MPM in the World of Chemistry. This notational system of analysis of the MPM could help reduce both time and money costs for future production of science films.

367 PRODUCTION AND UTILIZATION OF VIDEO IN GENERAL CHEMISTRY II: THE PHASE CHANGES OF CARBON DIOXIDE.

Karen E. Eichstadt, Andrew P. Lokie, Jr., Lisa Slates, and Scott A. Hatfield, Ohio University, Athens, OH 45701.

Techniques and tips for the production of useful videos for lecture enhancement will be discussed. A short video, "Phase Changes of Carbon Dioxide" will be presented to illustrate the blend of microscale laboratory technique, video production and computer animation on an interesting three phase system. The project represents a joint effort of the Department of Chemistry and the Instructional Media Services.

368 USING FT-IR IN A DISCOVERY-BASED APPROACH TO SOPHOMORE ORGANIC CHEMISTRY.

William D. Totherow, Department of Chemistry, Rivier College, 420 South Main Street, Nashua, New Hampshire 03060-5086.

It's no secret that many students enrolled in sophomore organic chemistry find the subject difficult and abstract. The terminology, structural language, and volume of information can create a sense of helplessness and panic. A student from another institution described his experience in organic as "trying to drink from Niagara Falls." Serving up mountains of information to be digested and regurgitated doesn't work. The frustration which students and teachers of organic chemistry face each year will change only by adopting a fundamentally different approach. For organic chemistry to have meaning, students must be allowed to directly experience structure and its consequences. Ft-ir, now cost effective for most institutions, is a technology which offers the opportunity to bring needed fundamental changes in how we teach organic chemistry. Our experience at Rivier College is that students who use Ft-ir in a problem-solving environment quickly make the link between theory and experiment. Structures come alive and the language and concepts of organic chemistry evolve naturally. This experience is challenging and exciting for both teacher and students, and offers the opportunity to instill in students the fascination we feel for the structures and chemistry of carbon compounds.

369 **SELF INSTRUCTIONAL INTERACTIVE COMPUTER PROGRAMS: A TEACHING AND LEARNING TOOL FOR FACULTY DEVELOPMENT**

Ram S. Lamba and Ramón A. De La Cuétara, Inter American University of Puerto Rico, P.O. Box 1293, Hato Rey, PR 00919

The goal of this project is to provide a non-traditional approach to chemistry laboratory instruction through the design of experiments using self-instructional interactive computer programs and the construction and use of locally produced low cost equipment. In order to achieve this goal we propose to train the faculty and students with the tools that can be used to apply the computer in learning about designing instruments and conducting basic laboratory experiments,and in the process provide an effective, but lower cost, approach to science education.

In the first phase of the project ten faculty members from Puerto Rico and the U.S. Virgin Islands participated in a workshop. The participants constructed pH meters, conductometers and computer interfaces, and used a Laboratory Exercise Development System to prepare microcomputer based laboratory modules. Each participant was given a microcomputer to take back to their institution to develop a computer based exercise as part of the next phase.

The presentation will describe the laboratory development system which is capable of integrating 1) text written with any word processor, 2) graphics created with a drawing program, or "clip-art" using the popular "PCX" format, 3) instrumentation connected through a low cost interface, 4) interactive drill and exercise examinations, and 5) other computer programs.

370 REACTIONS UNDER A MICROSCOPE - A STUDENT EXPLORATION. D.J. Clevette

Doane College, Crete, NE 68333

A series of chemical reactions were videotaped with an Olympus BHC microscope with trinocular head attached to a color TV camera with a C mount (magnification power from 60x to 1600x). Students enrolled in General Chemistry were allowed the option to explore this project, thereby replacing some of the scheduled lab experiments. Reactions were selected from a suggested list of mostly redox and precipitation reactions. Students systematically varied reaction conditions (e.g. concentration, magnification, type of solid) in order to optimize viewing conditions. An edited version of the videotape will be presented along with discussion about its future use in the classroom.

371 CHEMICAL LITERACY THROUGH SCIENCE FICTION FILMS: A NEW APPROACH TO AN OLD PROBLEM. S. Schreiner and J. Borgwald, Department of Chemistry, Randolph-Macon College, Ashland, VA 23005.

While Science seems to have failed in the real world (pollution, nuclear accidents, decline in science education), it offers hope in the form of science fiction films. The popularity of this genre of film attests to that. We have tapped the attraction of this form of entertainment by using science fiction films as an educational tool in a new lecture/laboratory course designed for non-science majors. The course's nature and success will be discussed with emphasis on chemical principles as they relate to the screened films.

372 USING ROCKETS TO TEACH THERMOCHEMISTRY. Ronald P. Furstenau, Department of Chemistry, U.S. Air Force Academy, Colo. Spgs., CO 80840-5701

For the past several years, we have developed our entire presentation of thermochemistry and thermodynamics in our general chemistry course around the design of a rocket. The rocket is an aspect of science and engineering which interests all of our students. As we develop this block of material, our cadets see that chemistry provides the key toward making the rocket work. Fundamental concepts such as Hess' Law, Gibbs Free Energy, and chemical equilibrium are all developed. Engineering considerations, such as fuel density, viscosity, and vapor pressure of fuels are also discussed. The block culminates with the "Rocket Problem", in which students use Hess' Law and the concept of heat capacity to determine the combustion chamber temperature of a rocket, which is the key variable of rocket engine design. This presentation will detail the material presented in this block and how it differs from the conventional approach to teaching thermochemistry.

373 Chemical Topology: The Ins and Outs of Bonding, Dennis K. Mitchell, Dept. of Chemistry, Los Angeles City College, 855 N. Vermont Ave., Los Angeles, CA 90029

Topology concerns the general shape of objects, but allows the objects to be distorted in any way as long as nothing is broken. A molecule can be considered topologically as a series of points (the atoms) and lines (the bonds), but remains topologically the same, regardless of any distortion. Recently, many topologically interesting molecules such as chemical knots, chiral catenanes, and Moebius strips have been synthesized. This presentation will show how this topic can be introduced into your classes by giving a brief presentation of topological principles and then using models to demonstrate these molecule's unique topology. The relevance of this topic in organic and biochemistry will be discussed in terms of natural and synthetic topologically interesting molecules and how these concepts expand structural notions such as chirality.

General Papers: Writing in the Curriculum H. Beall - Presiding

374 UNDERSTANDING CHEMISTRY THROUGH WRITING. Barbara D. Mowery, Department of Chemistry, Thomas Nelson Community College, P.O. Box 9407, Hampton, Virginia 23670, and Leonard C. Klein, New Horizons Governor's School, 520 Butler Farm Road, Hampton, Virginia 23666.

In an effort to meet the diverse needs of students in the two-semester non-majors course, a series of four writing projects has been implemented. The projects address a broad range of topics in order to expose the students to a wide variety of source materials and to critical thinking skills. Each project will be discussed, along with suggestions for adapting it to other courses. In addition, other course activities designed to teach skills necessary for these projects will be discussed.

375 WRITING TO LEARN: CHEMISTRY - AT CLARION UNIVERSITY. Paul E. Beck, Department of Chemistry, Clarion University of PA, Clarion, PA 16214

The concept of "Writing Across the Curriculum" or more succinctly, "Writing to Learn" has been on the national scene for sometime. Recently, it has been introduced in an integrated manner into courses at Clarion University. In this paper, I will discuss my experiences in the use of the concept in three levels of chemistry: Basic Physical Science-Chemistry, a general education course for non-science students; General Chemistry Laboratory, a course which is taken by science majors; and Organic Chemistry, a required course for chemistry majors and pre-professional students. The types of writing activities, which will be described are: short in-class impromptu free writings; journals, formal required researched papers, notebooks, and laboratory reports. Assignment design, assessment of student writing, student reaction, examples of student writing, and some successes and failures will be presented.

376 ESSAY WRITING IN GENERAL CHEMISTRY

Herbert Beall, ...rtment of Chemistry, Worcester Polytechnic Institute, Worcester, MA 01609.

Assignments of reading the literature of chemistry and writing essays about chemistry related to this literature can add a dimension to the general chemistry class. These assignments can also help dispel negative student perceptions about chemistry. These perceptions include the notions that chemistry is neither interesting nor important and that it is a mass of facts arranged in sequence in a text book rather than an active human endeavor and a way of thinking about nature. General chemistry students at WPI have been given four short literature readings and graded essay writing assignments per semester. The rationale for these assignments includes developing the students' ability to read scientific literature, giving them practice in scientific communication, and showing how the various topics in chemistry are integrated. The nature of the reading and writing assignments and the results of this program including student performance and reactions will be discussed.

377 WRITING TO IMPROVE PROBLEM SOLVING.

Francis P. MacKay, Department of Chemistry, Providence College, Providence, RI 02918.

Most freshmen arrive at college as totally undisciplined thinkers. They are unable to frame an argument logically and unable to systematically analyze a problem. Having to write one's idea does apply a discipline that can be used to improve students' analytical and problem solving skills. When students are required to think their way through problems by writing, they cannot rely on mimicking model problems. At the beginning of each semester students are given a handbook in which selected problems are worked out in detail emphasizing thought processes and generalized problem solving techniques. Students are required to maintain a problem solving notebook in whcih assigned problems must be worked out with the same detail. In class, students do problem solving free writes in whcih they must continuously write their thoughts as they solve a problem. The necessity to write does stimulate them to think of the various problem solving techniques they have learned. It also gives the teacher an insight into how students actually do problems and the impediments to their success.

378 INNOVATIVE WRITING TO FACILITATE LEARNING.

Gladysmae C. Good, Arlington High School, 5419 N. Arlington, Indianapolis, IN 40226

We hear the phrase "writing to learn" as a viable technique involving laboratory reports, essay questions, term papers. Students come to us with many talents. Why don't we use these talents to make learning exciting and more lasting ? In my class we hold oebates when the topic is controversial, learning to use sources of information and present opinions logically. We write and produce plays on chemical events and lives of chemists, videotaping our performances. We set those long lists to be learned to familiar tunes. We produce an element newscast. We have trials involving environmental issues. Some students write poems and short stories. The images of these events last long after other facts are forgotten.

379 AN INDIVIDUALIZED WEEKLY WRITING ASSIGNMENT FOR A LIBERAL ARTS CHEMISTRY COURSE. Marcia F. Bailey, Department of Chemistry, Central Michigan University, Mt. Pleasant, MI 48859

Individualized weekly 150-300 word writing (typed!) assignments were given as part of a Fall 1991 student-centered Liberal Arts Chemistry Course at CMU entitled "Chemistry and Society". The text used was World of Chemistry by Joesten, et.al., 1991. Students were asked to summarize the information presented in 1/2 to 2 text pages of their choice in an "assigned chapter" for the week. Six of these "assigned chapters" for written summaries were never otherwise covered in the course while the concepts in eight of these "assigned chapters" were discussed and tested later in the course. This approach allowed the student to explore independently their interests and knowledge in 14 areas of chemistry. A cover sheet was provided to focus student learning and facilitate evaluation. Details of the above as well as student response to these assignments will be presented.

380 USING THE LITERATURE TO CREATE A POSITIVE IMAGE OF CHEMISTRY FOR NON-MAJORS. T.A. Salerno, Department of Chemistry, Mankato State University, Mankato, MN 56002.

Reading and writing exercises have been used to teach students the relevance of chemistry and biochemistry. The target audience has been pre-nursing students in the introductory sequence of chemistry courses. One type of exercise has been the assignment of paper reviews using scientific news articles which focus on relevant life problems; i.e., the removal of environmental pollutants, the understanding and treatment of disease, the synthesis of new medical devices. In another type of exercise, students were assigned a term project in which they were required to create a positive image for Chemistry by reviewing some commercially available organic product or process. This seems to be the most succesful of the approaches because it requires students to develop some library research skills, it enables them to study a topic which interests them, and it encourages creativity in their presentations of their topics to their peers.

Macintosh Programs IV: Specific Applications J. Casanova and B. Luceigh - Organizers
J. Casanova - Presiding

381 CRYSTALLOGRAPHIC COURSEWARE. M. E. Kastner, Department of Chemistry, Bucknell University, Lewisburg, PA 17837

Crystallographic CourseWare are HyperCard stacks under development as an introduction to single-crystal X-ray diffraction. Topics which will be demonstrate include a discussion of how to grow single crystals, a "tour" of a diffractometer, plane group and space group symmetry elements, a guide to reading The International Tables for Crystallography, Volume A. and the interpretation of precession photographs.

The author gratefully acknowledges support for this project from the Physical Chemistry Project of the Mid-Atlantic Consortium of Pew Charitable Trusts (release time), the National Science Foundation grant ILI-891058 (diffractometer) and grant CIS-8650293 (precession camera) and Bucknell University.

382 EXPLORING CHEMICAL KINETICS USING INTERACTIVE COMPUTER ANIMATION SEQUENCES. Mark D. Lynch and Thomas J. Greenbowe, Department of Chemistry, Iowa State University of Science and Technology, Ames, IA 50011.

Students in general chemistry have difficulty understanding various aspects of chemical kinetics. A program has been developed that allows students to explore the relationships between, concentration of reagents, temperature, time to complete the reaction, and the initial rate of reactions. MacroMind Director® is used for the animation. The program is written in LINGO®, an interactive programming tool. The program works with the Macintosh IIxx micro-computer family using a minimum of 8 M of RAM. Students select from the bench-top area any combination of the following to do a kinetics experiment: an assortment of reagents at different concentrations, a timer, a temperature controller, and an "initial rate analyzer". Students track the variables and collect data. Students can do several method of initial rates experiments to determine the rate law, concentration vs. time experiments to determine if the reaction is first-order, second-order or zero-order. Immediate feedback with respect to the student's responses is provided. Conceptual questions and standard problems are included in the end-of-the-lesson quiz. Results of the pilot study involving general chemistry students who have used the program will be available.

383 EXPLORING ELECTROCHEMICAL CELLS USING INTERACTIVE COMPUTER ANIMATION SEQUENCES. Michele McPhillen and Thomas J. Greenbowe, Department of Chemistry, Iowa State University of Science and Technology, Ames, IA 50011.

Students in general chemistry have difficulty understanding various aspects of electrochemical cells. A program has been developed that allows students to build and to measure the emf of twenty different electrochemical cells. MacroMind Director® is used for the animation. The program is written in LINGO®, an interactive programming tool. The program works with the Macintosh IIxx micro-computer family using a minimum of 8 M of RAM. Students select from the bench-top area any combination of the following to build an electrochemical cell: a standard hydrogen electrode, a salt-bridge, wires, a voltmeter, assorted metal electrodes, and ten aqueous metal nitrate solutions. Before measuring the emf of the cell, students must identify the cathode, anode, direction of migration of ions, the direction of movement of electrons, and the half-reactions. Students use a standard reduction potential table to predict the emf of the cell. After the components of the cell have been identified and the emf predicted, the students can measure the emf of their cell. Immediate feedback with respect to the student's responses is provided. Conceptual questions and standard problems are included in the end-of-the-lesson quiz. Results of the pilot study involving general chemistry students who have used the program will be available.

384 FROST DIAGRAMS -- A TOOL FOR PREDICTING REDOX REACTIONS. James P. Birk and Heidi Hocker, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

Frost diagrams, plots of free energy against oxidation state, are useful tools for the prediction of oxidation-reduction reactions. The diagram for a single element can be used to predict disproportionation reactions of unstable oxidation states as well as reactions between different oxidation states of that element. However, the diagrams are more difficult to use when reactions between two different elements are to be predicted, because two diagrams must be overlaid as movable transparencies. FROST DIAGRAMS is a Hypercard stack that provides an easily used format for making redox reaction predictions for one or two elements by comparing slopes of the lines connecting two oxidation states. Comparisons are simplified by overlaying the Frost diagrams for two elements on a new card using Paint tools, with the second diagram being transparent and movable. The two diagrams can be aligned in any way desired, so any two half-reactions can be compared.

385 DYNAMIC SIMULATION OF THE SODIUM-WATER REACTION. James P. Birk and Joseph Zitar, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

A Hypercard stack has been created to illustrate the various processes occurring during the reaction between water and an active metal such as sodium. The simulation shows motion of the water molecules, absorption of water molecules on the metal surface, electron transfer to form metal ions, hydroxide ions, and hydrogen atoms, dimerization of hydrogen atoms, desorption of hydrogen molecules, and movement of hydroxide and hydrated metal ions away from the metal surface. Simulations such as this can help students understand observable macroscopic reactions at an atomic level.

386 COORDINATION COMPOUNDS -- A SET OF HYPERCARD STACKS. James P. Birk and John Foster, Department of Chemistry, Arizona State University, Tempe, AZ 85287-1604.

Coordination Compounds is a set of Hypercard stacks that allow users to explore the structures of four- and six-coordinate compounds and ions. The compounds included in the program illustrate the possible types of structural isomerism found with these coordination numbers. The user can select the compound from a list or allow random selection by the program. During operation of the program, the user is presented with two views of the structure of a compound. One view is fixed and the other can be rotated around the principle axes. The user is asked to decide whether the two views represent the same compound or different isomers. By rotating the movable structure, the user can obtain identical orientations, if they are possible. Upon deciding that the two structures are identical or are isomers, the user can attempt to name the compound, or select a new compound to examine.

IBM Programs III: Specific Applications S. Gammon - Organizer, Presiding

387 COMPUTER GRAPHICS DISPLAY OF MOLECULAR ORBITAL SURFACES. R. H. Batt, Department of Chemistry, Kenyon College, Gambier, Ohio 43022.

Scientific Visualization is the use of computer graphics to assist in understanding the copious numerical output from computer calculations in fields such as astrophysics, climate modeling, molecular modeling and computational physics and chemistry. This presentation will describe a package of interactive DOS-based programs for the visualization of molecular orbitals computed at the Huckel and Extended Huckel levels of theory. The MOs are displayed in perspective projections as "wire mesh" contour surfaces with hidden lines removed. Examples will be given of how this software may be used to help students understand aspects of molecular orbital theory and its applications.

388 INSTRUCTOR AUTHORED COURSEWARE: GRAPHICS BASED INTERACTIVE ORGANIC CHEMISTRY TUTORIALS. Leroy C. Butler, Department of Chemistry, Norwich University, Northfield, VT 05663.

The chemistry instructor with reasonable programming expertise is in the position to develop courseware specifically tailored to meet the needs of his or her students. This presentation describes the author's experience in developing tutorial courseware for the undergraduate organic chemistry student.

This courseware employs graphic routines that support the drawing and reactions of organic molecules. Molecular animations are included that simulate a wide variety of reaction mechanisms. The graphic routines are imbedded in algorithms that allow the student to explore several types of organic reactions in a random or user selected mode. Since the carbon atoms of molecules are implemented as nodes on a linked list, all molecular events can be handled in dynamic mode. Several of the reaction types, e.g., aromatic substitution, employ expert systems that permit reaction variables to be easily implemented.

The flexibility of the programs permit me to produce tutorial modules in a reasonable time frame in response to student suggestions.

389 CHARGE BEHAVIOR OF AMINO ACIDS AND POLYPEPTIDES. Salvatore F. Russo, Chem. Dept., Western Washington University, Bellingham, WA 98225

The charge of an amino acid or polypeptide determines how these substances behave in the biochemically important separation techniques of electrophoresis and ion exchange chromatography. The goal of this computer-assisted instructional program is to provide a tutorial on the charge behavior of amino acids and polypeptides as a function of pH. The student should be able to predict the predominant form of an amino acid or polypeptide at a chosen pH given the appropriate pK values and assuming that the dissociations occur independently of one another.

Electrophoretic behavior depends on both net charge and frictional coefficient. Drill and practice is provided for predicting the electrophoretic behavior of selected amino acids and mixtures of proteins.

Ion exchange chromatography is dependent primarily on the net charge of the sample constituents. Drill and practice is provided for predicting the elution behavior of certain amino acids from a cation exchange resin. In addition, the separation of proteins on cation or anion exchange resins can be predicted from a knowledge of pI (isoelectric point) values.

390 COMPUTER BASED INSTRUCTION: PERICYCLIC REACTIONS. Albert W.M. Lee, Department of Chemistry, 224 Waterloo Road, Hong Kong.

Two programs for teaching electrocyclic and sigmatropic reactions based on the frontier molecular orbital (FMO) theory are described. Three-dimensional graphics and animation are used to illustrate the orbital interactions and stereochemistry.

For the electrocyclic reactions, the software shows the ring closure pericyclic processes of conjugated polyenes of both the 4n and the (4n + 2) system. Some terms like HOMO and LUMO are first defined and the two rotational modes (conrotatory and disrotatory) are illustrated by animation. In each polyene system, the users can view the experimental facts and carry out a FMO analysis of either the thermal (ground state) or the photo (excited state) reaction.

For the sigmatropic reactions, the [1, j] and [i, j] migration are examined according to the FMO theory. The terms like supra, antara, retention and inversion are defined and illustrated with graphic and animation. The HOMO/LUMO interactive and their respective symmetry property decide whether the reaction is allowed or forbidden.

391 **THE USE OF SYMBOLIC AND NUMERIC PROCESSORS IN CHEMICAL EDUCATION**
W.F. Coleman Department of Chemistry, Wellesley College, Wellesely MA

The combination of symbolic logic and numeric processors enables students to explore aspects of chemistry that previously required too much time to be spent on the math (arithmetic) and too little on understanding the chemistry, or that were left out of the curriculum completely. The symbolic processors DERIVE and MathCad (Maple symbolic processor) will be demonstrated together with the numeric features of MathCad and the curve-fitting program MINSQ. Among the examples to be shown are the analysis of rotation-vibration spectra and extensions of the Huckel MO model.

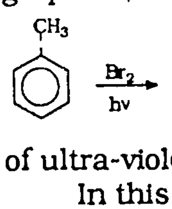
392 EFFICIENT ENGLISH FOR CHEMISTS AND CHEMICAL ENGINEERS
Orville L. Chapman and Arlene A. Russell, Dept. of Chemistry and Biochemistry, UCLA, 405 Hilgard Ave., Los Angeles, CA 90077

Efficient English, a new computer program, teaches chemists, engineers, and students to write precise, unambiguous technical documents. The program, which runs on IBM computers, contains a grammar review and features practice in analyzing and revising sentences, paragraphs, and documents. Efficient English provides exercises that offer levels of help and encourage experimentation. The program addresses sixteen pervasive problems found in technical prose and shows how to eliminate these problems.Outlines and organization are stressed. Good organization comes from proper placement of emphasis and logical development. Two styles, Spartan™ and Rococo, give the student a sense of style and encourage the use of different styles for different purposes. Composition covers sentences, paragraphs, reports, abstracts, and letters. Students learn a formal, quantitative style analysis that enables them to assess their own style and that of other authors. Efficient English focuses on clear thinking, and precise unambiguous writing. Clear writing demonstrates clear thinking.

393 INCORPORATING STRUCTURAL FORMULAS INTO CHEMISTRY DOCUMENTS.
R. K. Kirkley, Department of Chemistry, San Jacinto College, Pasadena, Texas 77501-2007.

Including chemical structures in documents such as organic chemistry exams has traditionally been a tedious task that required the author to manually draw in the formulas, arrows, and other symbols.

With the advent of *Microsoft Windows*, word processors capable of including graphics, such as *Word for Windows* and *WordPerfect for Windows*, and the chemical



drawing program *ChemWindow*, from SoftShell International, users of MS-DOS based computers have available the tools to easily incorporate chemical formulas and equations into documents. For example, the drawings necessary to illustrate the bromination of toluene in the presence of ultra-violet light have been easily made and incorporated into this paragraph.

In this presentation, actual use of these programs will be displayed, samples of printed output will be shown, and demonstration versions of the drawing program will be provided.

394 A COMPUTERIZED, BAR-CODED STUDENT RECORD KEEPING SYSTEM. Tom Ladell and Tom O'Connor, Department of Chemistry, University of Wisconsin-Madison, 1101 University Avenue, Madison, WI 53706.

We have developed and used for the past two years in the general chemistry and organic chemistry teaching labs (~3,000 students/year) a computerized student record keeping system. We have constructed a database of equipment and of the ID's of students enrolled in the course. The system allows us to check out materials for only those students registered for a course and then to keep records for each student of breakage, equipment check out, locker assignments, dollar amount owed for equipment, keys, etc. The system has been linked to the campus-wide system so that we have access to student addresses as well as ID numbers, thus we are able to issue bills nearly automatically for any charges at the end of the semester. The system also provides an automatic inventory of student drawer items. The system operates by using bar codes for the stock numbers for items checked out and returned, matching them to a bar code for each student's ID. The database was been constructed using FoxBase and has been upgraded to FoxPro 1.02, using either an IBM PS/2 Model 55SX or an IBM PC with a color monitor. There has been favorable student response to the speed at which items may be checked out.

395 A DIGITIZED VIDEO DATABASE OF CHEMICAL DEMONSTRATIONS S. Conley, S Mills, R. Wilson Department of Chemistry, University of Illinois at Urbana-Champaign, 601 S. Mathews, Urbana, IL 61801

We are using the IBM video digitizing adaptor and AVC authoring software to create a visual database of chemical demonstrations. The database serves as a resource for lecturers unfamiliar with demonstrations, a training tool for people who prepare demonstrations and an electronic enhancement used in conjunction with live demonstrations in the classroom. The image database has proven to be a marvelous tool for organizing and presenting the variety of information required to select, prepare, and perform successful classroom demonstrations. the design of the database along with hardware and software considerations will be presented.

Author Index

Workshops

Sunday August 2, 1992

8:30 a.m.--**Teaching Thinking** Learn strategies to teach your students how to think. Take home the necessary materials to put these strategies in the classroom Donald Woods Feature Editor, "Problem Solving Corner" *Journal of College Science Teaching* Chemical Engineering, McMaster University, Hamilton, Ont., Canada ($19) *(#1) (MUII)*

9:00 a.m.--**For the Love of Chemistry: Demonstrations, Discussions and Recipes** Perform, observe, discuss, and take part in more than 40 experiments that are designed to interest, motivate, and question your high school or freshman students. Irwin Talesnick, Faculty of Education, Queen's University, Kingston, Ont., Canada *safety glasses* ($59) *(#3) (Chem 194)*

9:00 a.m.--**Microscale Laboratory for Inorganic and Advanced General Chemistry** The rationale for "smaller is better" applies in areas other than organic chemistry. Mono M. Singh, Department of Chemistry, Merrimack College, North Andover, MA 01845 *safety glasses (#4) (Chem 11)*

1:00 p.m.--**Chemistry in Context** The new ACS college-level course that uses an issue-based approach to teach chemistry. (Often referred to as the college-level ChemCom) A. Truman Schwartz, Macalaster College, 1600 Grand Avenue, Saint Paul, MN 55105 ($10) *(#2) (Chem 172)*

1:00 p.m.--**Microscale Laboratory for Inorganic and Advanced General Chemistry** (repeat) The rationale for "smaller is better" applies in areas other than organic chemistry. Mono M. Singh, Department of Chemistry, Merrimack College, N. Andover, MA 01845 *safety glasses (#5) (Chem 11)*

Monday, August 3, 1992

8:00 a.m.--**Laboratory Safety Workshop**. An intensive review of lab safety fundamentals assisting teachers to develop or improve laboratory safety school programs. James A. Kaufman, Curry College, Milton, MA 02186 ($60) *(#6) (MUII)*

8:00 a.m.--**Introduction to Microscale Experiments** Learn how to begin a high school microscale laboratory program John Mauch, Pasco High School, Pasco,Washington 99301 ($50) *safety glasses (#8) (Chem 11)*

9:00 a.m.--**Transform Your Experiments into Real Word Contexts** Put reasonable scenarios around your labs to make them interesting and relevant to your students. Richard Bayer and Bud Hudson, Carroll College, Waukesha WI 53186, Jane Schneider, Brookfield Academy, Brookfield, WI 53005 *(#7) (Chem 161)*

10:00 a.m.--**Computer-Interfaced Chemistry Experiments** Learn to make computers an integral component of your chemistry laboratory. Donald L. Volz, Mannheim American High School, APO New York 09086, and Dan Holmquist, Frankfurt American High School, APO New York 09710 ($5) *safety glasses (#9) (Chem 25)*

1:00 p.m.--**Laboratory Safety Workshop.** (repeat) An intensive review of lab safety fundamentals assisting teachers in developing or improving laboratory safety programs for their schools. James A. Kaufman, Curry College, Milton, MA 02186 ($60) *(#10) (MU II)*

1:00 p.m.--**Microscale Organic Experiments** Gain hands-on experience in the techniques and experiments of this revolutionary approach to laboratory. Kenneth Williamson, Mount Holyoke College, S. Hadley, MA 01075 *safety glasses (#12) (Chem 71)*

1:30 p.m.--**GEMS: Great Explorations in Math and Science** A hands-on curriculum series developed from a science-museum perspective at the Lawrence Hall of Science. Jackie Barber, Director of Chemical Education, Lawrence Hall of Science, Berkeley, CA 94720 ($15) *(#11) (Chem 172)*

2:00 p.m.--**Chemistry in the Toy Store: An Activity for Kids** Glop, monster flesh, foam, slime - always a delightful experience. David A. Katz, Community College of Philadelphia, Philadelphia PA 19130 ($10) *Participants must wear safety goggles; children under 8 years must be accompanied by an adult. Parents of older children also welcome. (#13) (Chem 17)*

2:00 p.m.--**Fun with Polymers: A Workshop for Children** Make slime, play with balloons, kinesthetically model polymers. Marie C. Sherman, Ursiline Academy St Louis, MO 63122 ($10) *Participants must wear safety goggles; children under 8 years must be accompanied by an adult. Parents of older children also welcome. (#14) (Chem 11)*

Tuesday, August 3

9:30 a.m.--**Getting Active Participation in Your Classroom** Do students sleep in your lectures? Are they interested in what you are saying? Are they involved? Learn strategies and methods to develop in-class student interaction in classesas large as 300. Jeff Pribyl, Mankato State University, Mankato, MN 56002 and Patricia Metz, Texas Tech University, Lubbock, TX 79409 *(#15) (Chem 172)*

9:30 a.m.--**New Inorganic Materials** Experiments from each of the participants in the parallel symposium. Herbert Kaesz, UCLA, Los Angeles, CA 90024 *safety glasses. Attendance at Monday symposium helpful.(#16) (Chem 17)*

1:00 p.m.--**New Methods for Testing and Evaluation** States are increasing their scrutiny of traditional evaluation methods. Teachers want more insight into student.difficulties and misconceptions. Computers allow new approaches to testing and assessing student learning. Lucy Pryde, ACS Div CHED Examinations Institute, Oklahoma State University, Stillwater, OK 74078 *(#17) (MU II)*

1:00 p.m.--**Chemical Hygiene Plans** Federal regulations require every school to have a plan on file to deal with handling and disposal of chemicals, with implementation of right-to-know legislation, and with accident response procedure. Does your school? If so, who wrote it? Is it workable? Leave this workshop with a sensible plan for you and your school. Russell Phifer, Environmental Assets, Inc., West Chester PA ($50) *(#18) (Chem 172)*

1:00 p.m. **DNA Experiments for Chemistry Students** Students are interested in the chemistry of life processes. These experiments allow high school and lower division students to experience the dynamic field of molecular biology while still in introductory Chemistry. Toby Horn, Thomas Jefferson High School for Science and Technology Alexandria VA 22312 ($20) *safety glasses (#19) (Chem 17)*

ChemSource Find out about the best ideas, demonstrations, classroom activities, laboratory experiments, and teaching techniques that experienced teachers have found really work. Divided into 6 2-hour sessions. Attend as many or as few as you wish. David W. Brooks, Center for Curriculm and Instruction, University of Nebraska, Lincoln, NE 68588-0355 and John I. Gelder, Oklahoma State University, Stillwater, OK 74078 *Attendance at Monday symposium on ChemSource helpful.*

1:00 p.m.--**ChemSource I Using SourceBook from ChemSource** *(#17) (Hutchison 14)*

3:00 p.m.--**New Methods for Testing and Evaluation** (repeat) States are increasing their scrutiny of traditional evaluation methods. Teachers want more insight into student.difficulties and misconceptions. Computers allow new approaches to testing and assessing student learning. Lucy Pryde, ACS Div CHED Examinations Institute, Oklahoma State Univ., Stillwater, OK 74078 *(#21) (MU II)*

3:00 p.m.--**ChemSource II Using Source-Book from ChemSource** (repeat) *(#22) (Hutchison 14)*

New Listing: The following workshop was not listed in the pre-registration materials. No registration required.
3:30 p.m.--**Make the Chemistry Connection** The best way to engage your students in chemistry is to show them how chemistry connects directly to their lives. *ChemCom: Chemistry in the Community* by the American Chemical Society does just that! Learn to combine the core concepts of chemistry with a unique societal approach helps students connect with chemistry. Barbara Sitzman, Chatsworth High School, Chatsworth, CA *(#40) (Chem 166)*

Wednesday, August 4

8:00 a.m.--**Chemical Hygiene Plans** (repeat) Federal regulations require every school to have a plan on file to deal with handling and disposal of chemicals, with implementation of right-to-know legislation, and with accident response procedure. Does your school? If so, who wrote it? Is it workable? Leave this workshop with a sensible plan for you and your school. Russell Phifer, Environmental Assets, Inc., W.Chester PA ($50) *(#23) (Chem 172)*

8:00 a.m.--**Advanced Microscale Techniques** Focuses on upper-level high school and 1st year college chemistry laboratories John Mauch, Pasco High School, Pasco,Washington 99301 ($50.00) *safety glasses. Some previous experience with microscale techniques helphul. (#25) (Chem 11)*

8:00 a.m.--**A Tie-Dye Workshop** Useful for any class; frequently used to wrap-up the Petroleum unit in ChemCom course Elnore Grow, Horizon High School, Brighton, CO 80601 ($8) *safety glasses (#26) (Chem 17)*

9:30 a.m.--**Writing in the Chemistry Classroom** Enhance your students' learning, their interest in Chemistry, and their communication skills by teaching them to write about chemistry in the classroom. Practice strategies to teach with this approach. Herbert Beall, Worcester Polytechnic, Worcester, MA 01609 *(#24) (MU II)*

10:00 a.m.--**A Tie-Dye Workshop** (repeat) Useful for any class; frequently used to wrap-up the Petroleum unit in ChemCom course Elnore Grow, Horizon High School, Brighton, CO 80601 ($8) *safety glasses (#27) (Chem 17)*

1:00 p.m.--**Polymers in Chemistry Experiments and Demonstrations** A variety of polymers are used to illustrate physical properties, bonding phenomena. Recycling codes are explained Instructions for experiments and a take-home kit provided to participants. Marie C. Sherman, Ursiline Academy St Louis, MO 63122 *safety glasses (#28) (Chem 11)*

2:30 p.m.--**Polymers in Chemistry Experiments and Demonstrations** (repeat) A variety of polymers are used to illustrate physical properties, bonding phenomena. Recycling codes are explained Instructions for experiments and a take-home kit provided to participants. Marie C. Sherman, Ursiline Academy St Louis, MO 63122 *safety glasses (#29) (Chem 11)*

1:00 p.m. **Introduction to 2-Dimensional NMR and Magnetic Resonance Imaging** Visit the UC Davis Regional Nuclear Magnetic Resonance Facility and learn why modern NMR is the most important tool the chemist has for structure elucidation and why MRI greatly expands the arsenal of diagnostic tools for the physician. Maureen Scharburg, Department of Chemistry, San Jose State University, San Jose, CA 95192 and Gerd LaMar, Director Nuclear Magnetic Resonance Facility, UC Davis, Davis, CA 95616 *(#30) (Building 1D, Health Science Complex - Take campus shuttle from Silo, meet in front of building)*

1:00 p.m.--**ChemSource III Using Lesson Planning Tools** *(#31) (Hutchison 14)*

3:00 p.m.--**ChemSource IV Using LabHelper** *(#342 (Hutchison 14)*

4:15 p.m.--**A Wine-Tasting Workshop** Organized by 2YC3 - The Committee on Chemistry in the Two-Year Colleges ($10) *No one under 21 allowed in area; identification required. Ticket required. (#33) (Freeborn Patio)*

Thursday, August 6

10:00 a.m.--**Chemistry in the Toy Store: Teachers' Version** Learn how to use familiar toys to teach chemistry while providing interest and excitement in your course. David A. Katz, Community College of Philadelphia, Philadelphia PA 19130 ($25) *safety goggles (#34) (Chem 11)*

9:30 a.m.--**For the Love of Chemistry: Demonstrations, Discussions and Recipes** (repeat) Perform, observe, discuss, and take part in more than 40 experiments that are designed to interest, motivate, and question your high school or freshman students. Irwin Talesnick, Faculty of Education, Duncan MacArthur Hall, Queen's University, Kingston, Ontario, Canada *safety glasses* ($55) *(#35) (Chem 172)*

1:00 p.m.--**New Allotropes of Carbon: C_{60} and Beyond** Learn how to make, purify, and characterize the fullerenes. Robert L. Whetten, Department of Chemistry, UCLA, Los Angeles, CA 90024 *safety glasses (#36) (Chem 166)*

1:00 p.m.--**NSF Grant Writing Workshop** A participatory workshop intended to aid the inexperienced proposal writer by examining the "nuts and Bolts" of proposal preparation and review process. Curtis T. Sears and John J. Clevenger, NSF Division of Undergraduate Science, Engineering and Mathematics Education *(#39) (MU ill*

1:00 p.m.--**ChemSource V QuickTime for Chemistry Teachers** *(#37) (Hutchison 14)*

3:00 p.m.--**ChemSource VI Tools for Supervising/Cooperating Teachers** *(#38) (Hutchison 14)*

New Listings: The following two workshops were not listed in the pre-registration materials. Sign up for these workshops during the conference at the HyperChem exhibit booth in Freeborn Hall.

1:00 p.m.--**HyperChem**. Learn how easy it is to turn a desktop computer into a sophisticated 3D molecular modeling and analysis system. *(#41) (TB 114)*

2:00 p.m.--**HyperChem**. (repeat) Learn how easy it is to turn a desktop computer into a sophisticated 3D molecular modeling and analysis system. *(#42) (TB 114)*

Birds-of-a-Feather Sessions

These informal birds-of-a-feather sessions provide an opportunity for those people interested in a common topic to meet others with similar interests and to explore and share ideas on the topics. Typically these sessions last about an hour; bring your lunch if it is a noon session. Any other *ad hoc* sessions will be announced in the daily newsletter. Stop by the conference office in Freeborn Hall to notify the newsletter staff.

Sunday August, 1992

4:30 p.m.--I. **ChemSource Committee** Mary Virginia Orna, Department of Chemistry,College of New Rochelle, New Rochelle, NY 10801 *(Chem 172)*

Monday August 3, 1992

12:30 p.m.--II. **General Chemistry Coordinators** What do you do? What do others do? What should you be doing? Join your peers over lunch to discuss this neglected position. Tom Greenbowe, Department of Chemistry,Iowa State University, Ames, Iowa, 50011 *(Chem 159)*

12:30 p.m.--III. **Chemistry Van Projects** A new form of outreach. Not a road show, but serious curriculum brought to the student. Learn what can be done and how you might be able to benefit from it. Diane Burnett, Outreach Coordinator, Department of Chemistry, Purdue University, West Lafayette, IN 47907-1393 *(Chem 171)*

1:30.p.m.--IV. **Developments in Technology Education Training** Technician education is entering a period of flux with greater potential for radical change than ever before. This session will be open for an exchange of ideas about chemistry-based technician education, with emphasis on tech prep "science technology" specialty courses for high school, developing industry standards for "CPI Technical Workers", training options for technicians outside the traditional A.A.S. degree framework, faculty training and retraining, and other topics raised by participants. Kenneth Chapman Education Division, American Chemical Society, 1155 16th Street, N.W., Washington, DC 20036 *(Chem 161)*

3:30 p.m.--V. **Division of Chemical Education Executive Committee** The committee will discuss the topic of continuing education credit for participants at meetings. Open meeting. Lucy Pryde, ACS Div CHED Examinations Institute, Oklahoma State University, Stillwater, OK 74078 *(Chem 159)*

4:00 p.m.--VI. **Committee on Computers in Chemical Education** The Committee solicits ideas and activities that will advance the use of computers in learning and teaching chemistry, and ways in which the Committee can better serve the chemistry education community. Alfred J. Lata, Department of Chemistry University of Kansas, Lawrence, Kansas, 60045 and Donald Rosenthal Department of Chemistry, Clarkson University, Potsdam, NY 13676 *(TB 114)*

4:30 p.m.--VII. **Student Affiliates:Activating New Chapters; Maintaining Existing Chapters**, Linda Ross, American Chemical Society, 1155 16th Street, N.W., Washington, DC 20036 *(Chem 172)*

Tuesday August 4, 1992

12:00 p.m.--VIII. **Chemistry Students and Study Abroad** Morton Z. Hoffman Department of Chemistry, Boston University, Boston, MA 02215 *(Chem 166)*

12:00 p.m.--IX. **Culturally Relevant Chemistry for the Hispanic Student** Frank Gomez, Department of Chemistry, Harvard University, Cambridge MA 02138 and Ram S. Lamba, Department of Chemistry, Inter American University of Puerto Rico, P.O. Box 1293, Hato, Rey, PR 00919 *(Chem 161)*

12:15 p.m.--X. **Assessing Chemistry-Readiness** What knowledge, skills, and abilities do students need to succeed in high school chemistry? in general chemistry? Hessy L.Taft, Educational Testing Service, Rosedale Road 25-E, Princeton, NJ 08541 *(Chem 166)*

4:30 p.m.--XI. **Institutional Support for Conference Attendance: Finding New Methods** Institutional support for faculty to attend professional meetings is limited in amount and sometimes limited to those faculty who present papers. Also, the number of papers presented at professional meetings is rising faster than attendance. Are these two factors related? Are these the faculty who should be supported? Is the quality of the papers presented affected by the conditional support? Is there a better way to invest these funds? Is there anything we can do as individuals or as a group to direct the support in that better way? Nancy J.S. Peters, Long Island University, South Hampton Campus, South Hampton NY 11968 *(Chem 161)*

4:30 p.m.--XII. **NSF Proposal Assistance** Learn ways to write more successful proposals for the NSF programs: *Materials Development, Informal Science Education, and Assessment of Student Learning* Frank X. Sutman and Harry Hajian, DMDRI, Suite 635 Directorate for Education and Human Resources, National Science Foundation, 1800 G. Street Washington, DC 20550 *(Chem 159)*

Wednesday August 5, 1992

12:00 p.m.--XIII. **Chemistry in Eastern Europe and Russia: Chronicling A Generation** (a slide show) Robert Silberman, State University of New York, Cortland NY 13045 *(Memorial Union II)*

12:00 p.m.--XIV. *Exploring Chemistry"* **Implementation** Users of the *Comprehensive Chemistry Curriculum*, *Exploring Chemistry, Introduction to General Chemistry,* or other inclusive introductory chemistry software or interactive video course ware are invited to share information. We will discuss topics such as implementation, new laboratory designs, and impacts of extensive interactive instruction on the curriculum and on students. Loretta Jones School of Chemical Sciences, University of Illinois at Urbana-Champaign, Champaign IL 61801 *(Chem 176)*

12:00 p.m.--XV. **The 13th Biennial Conference on Chemical Education** Individuals interested in coordinating symposia or workshops or simply helping put together the next Biennial Conference are encouraged to attend this session or contact the General Chair or Program Chair. Margaret E. Kastner, General Chair, 13th BCCE, Department of Chemistry, Bucknell University, Lewisburg PA 17837 and Patricia L. Samuel, Program Chair, Department of Chemistry, Boston University, Boston MA 02215 *(Chem 166)*

12:00 p.m.--XVI. **International Collaborations** Meet educators from other countries who are interested in common problems in chemical education and begin to develop international projects with them. Ernesto A. Castro INIFTA, División Química Teórica, Suc.4 - C.C.16, La Plata 1900 Argentina *(Chem 161)*

3:30 p.m.--XVII. **Lab Curricula for Large Settings** Do you direct undergraduate courses with several hundred students? In this very practical session we will discuss curricula and management strategies for large laboratories. Come and share your ideas and experiences of things that work and problems yet to be solved with other colleagues in the trenches. Patricia L. Samuel Department of Chemistry, Boston University, Boston MA 02215 *(Chem 172)*

8:45 p.m. (following "Dazzling Demos and Video Bloopers in Chemistry")--XVIII. **Division of High School Chemistry Committee** Find out what this committee is doing or planning to do for high school teachers. The committee solicits your ideas on what else you would like the committee to do for you. All high school teachers are specifically invited. Diane Burnett, Outreach Coordinator, Department of Chemistry, Purdue University, West Lafayette, IN 47907-1393 *(Chem 172)*