5-10-1996

1996 - The First Annual Symposium of Student Scholars

KENNESAW STATE COLLEGE

School of Science and Mathematics

Undergraduate Research Symposium

May 10, 1996

Undergraduate Research Symposium

Program

10:00 a.m. SC 109	Welcome
	Dr. Herbert Davis Dean, School of Science and Mathematics
	Dr. Betty Siegel President, Kennesaw State College
10:30 - 12:00 2nd floor lobby, Science Building	Students present posters

Organizing Committee:
Dr. Patricia H. Reggio, Chair
Dr. Catherine Beise
Dr. Laura Hechtel
Dr. Virginia Rice

Special Thanks to:
Patricia Cook
Luz Hamilton
Kevin Bachtel

Kennesaw State College
School of Science and Mathematics
1996 Undergraduate Research Symposium
List of Posters

Department of Biological and Physical Sciences

Department of Chemistry

Department of Computer Science and Information Systems

Department of Mathematics

A Study of the Fecal Contamination of Lake Acworth: Determination of Sources and Methods of Detection

Christopher P. Brooks

Abstract

The use of fecal coliform bacteria concentrations is a common method of determining the amount of fecal contamination in aquatic systems, yet they do not indicate the origin of the contamination because these bacteria are found in the intestines of all warm-blooded animals. We describe two methods for distinguishing human from non-human sources of fecal coliform bacteria in a contaminated watershed. Conductivity is examined for its value in pinpointing non-point sources of contamination in the watershed. The controversial use of the ratio of fecal coliform to fecal streptococci was also re-examined. The FC/FS ratio was useful when considered relative to changes in coliform concentration, and showed that contamination in the lake originates primarily from human sources. Conductivity measurements along the length of a branch, both in stream and in visible seeps showed a positive correlation with coliform concentrations and high values were also found where sewer pipes ran near or across streambeds. Measurements of conductivity can be helpful in narrowing choices for testing fecal coliform concentrations, reducing cost and the amount of time needed in order to pinpoint these sources in the future.

DETERMINING SOURCES OF FECAL COLIFORM BACTERIA AND OTHER POLLUTANTS IN LAKE ACWORTH, GEORGIA

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MARIETTA, GA 30061

Lake Acworth is a 1.3 km^2 lake lying within a rapidly developing watershed (50.5 km^2) in suburbs north of Atlanta, Georgia. The lake has been closed to swimming since 1991 because fecal coliform bacteria concentrations exceeded state standards. Waterfowl near the swim beach were suspected as the source of contamination. As a result, a comprehensive one year study of water quality in the lake and its watershed was initiated in 1994. Fecal coliform concentration exceeded 200 colonies/100ml at all lake and tributary sites from April to August. Spatial and temporal correlations strongly indicated that bacterial contamination was from the watershed and not from waterfowl and other sources in lake or along the shoreline. A model incorporating changes in fecal coliform bacteria due to both advection and mortality of bacteria suggested that fecal coliform concentrations in the two major tributaries are high enough to contribute significantly to concentrations observed in the lake. Dramatic spatial variation in conductivity and fecal coliform in the watershed was not closely associated with septic tank areas and agricultural, suggesting that small, but numerous sewer leaks were a major source of contamination. The diffuse nature of this source of bacterial contamination has made future restoration efforts difficult.

Habitat Utilization and Distribution of Bob-White Quail.

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The Eastern bob-white quail (*Colinus virginianus virginianus)* occurs naturally throughout the Southeastern United States. The bob-white is a social bird found living in groups called "coveys" of 10 to 15 individuals. The preferred habitat of the bird is in fallow fields, at the edge of agricultural fields and forest openings. A steady decline in population has occurred over the last 100 years due to habitat loss, changes in farming practices and the use of pesticides. This study looked at where *C. virginianus* would be found in a field and if smaller groups would join together to form larger groups. Also, in a previous study some evidence indicated that the quail preferred the top of a hill instead of low areas. Our predictions were that the birds would form larger coveys and would be found on hilltops.

The quail used were pen raised, flight conditioned birds that are bred for release in the wild. The experiment was conducted on two fields in the Allatoona Wildlife Management Area, Bartow County, GA. In each field, 4 release points were marked where 4 birds were released every week. The release points varied in topography and ground cover. The smaller field (approx. 4 hectares) had release points 75-100 meters apart, or roughly 1 flight distance. The larger field (approx. 16 hectares) had the release points 2-4 flight distances apart or 200-300 meters. Four birds were liberated at each release point in both fields each week for 4 weeks. A total of 128 quail were released. The birds were marked with paint to allow for identification per week. The day after each release, experienced gun dogs were used to locate the birds. Their number per group, location and identification of release was noted.

On the larger field, only a total of 5 live birds were found and 4 others killed by predators. No groups larger than 3 were found on the larger field. The smaller field had a total of 25 birds found alive and 6 kills were recorded. The birds of the small field had formed larger coveys, with the second week having all grouping together. Of all the birds found on both fields, only 3 were not associated with a hilltop.

It appears that the birds must be released close enough for a single flight to form a covey or they must be within calling distance. The individuals within a covey have an advantage in the protection from predation as well. As for the hilltop placement, It might be related to detecting and eluding an approaching predator, or some other factor which could be determined with more study.

DOSE-RESPONSE RELATIONSHIP BETWEEN VENTRAL-TEGMENTUM INFUSED GALANIN AND SWIM-TEST MOTOR ACTIVITY

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Using animal models, Bartafi et al. (1988) demonstrated that the neuropeptide galanin is released from ventral tegmental (VTA) terminals by burst firing of locus coeruleus (LC) neurons during stress-induced depression. It is proposed that galanin inhibits VTA-dopamine (DA) cell firing thereby mediating decreased motor activity observed in behaviorally depressed animals. Previous work in Weiss' laboratory explored effects of VTA-infused galanin on motor activity (Demetrikopoulos et al., 1995). In one experiment, Sprague-Dawley rats showed reduced ambulation and rearing during an exploratory task following VTA-galanin infusion. In a second experiment, VTA-infused galanin rats displayed more floating behavior during a swim-test than control subjects. This experiment was conducted to determine whether a dose-response relationship exists between VTA-infused galanin and swim-test motor activity. The findings replicated previous results showing increased floating behavior following VTA-galanin infusion. Further, this phenomena appears to be dose-dependent. Taken together, these studies suggest that VTA galanin mediates depressive symptomatology.

ANALYSIS OF SOLAR FLARE X-RAY EMISSIONS: DISTINGUISHING POSSIBLE ELECTRON ACCELERATION MECHANISMS

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Solar flares are explosive events in the outer atmosphere of the sun that convert magnetic energy into particle energy. Flares take place in interacting magnetic loops in which the energy conversion mechanism accelerates both protons and electrons from the top of the loop downward toward denser regions of the solar atmosphere. The mechanism(s) by which the particle acceleration occurs is not known. Two possible models have been proposed. One model suggests acceleration by directed, large scale electric fields. However, the model is only viable if the acceleration occurs in billions of oppositely directed current channels. This directed electric field model therefore requires a specific geometry. An alternative model is based on random acceleration by turbulent electric fields.

To discriminate between these models, x-ray data obtained from the Compton Gamma Ray Observatory is being analyzed. Observations are made within energy channels. Channel 1 ranges from 25-50 keV, channel 2 from 50-100 keV, and channel 3 from 100-300 keV. The data has a high time resolution of 64 ms and exhibits many bursts of emissions (referred to as spikes) superimposed on a more slowly varying background. Analysis has shown that the spikes within the time structure have an average duration of approximately .6 seconds. It is crucial to deduce whether the observed time structure is due to the acceleration mechanism(s) or to transport effects. Transport effects can arise since high energy electrons travel faster and reach the denser regions of the solar atmosphere first. Therefore they may emit x-rays at different times that lower energy electrons. One way to test for transport effects is to take the ratios of the x-ray emissions between energy channels. If the ratios between energy channels remain relatively constant, then the observed time structure is reflecting the time scales of the acceleration. Conversely, if the ratios reveal variation between channels then the time structure represents transport effects.

Analysis of several flares indicate that the ratios between energy channels are relatively constant and therefore do not illustrate the time delays expected from transport effects. These results indicate that the spikes observed are time scales of the acceleration and give some support to the model of random acceleration by turbulent electric fields.

Synthesis of Conformationally Restricted Derivatives of the Antimalarial Compound Mefloquine.

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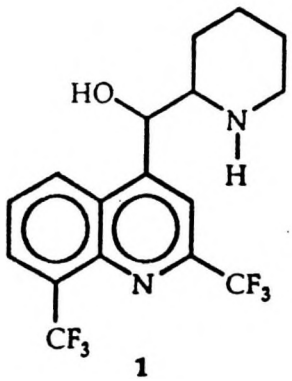
Mefloquine (**1**) is an effective methanol quinoline antimalarial compound currently used even in cases of chloroquine-resistant *plasmodium* strains. Although a pharmacophor for the quinoline-based class of antimalarial compounds has been postulated, little is known about their conformational requirements at the binding site.

We have designed a series of compounds (**2**) which incorporate conformational rigidity about the ethanol amine fragment of the molecule with little addition to the steric bulk of the overall molecule. Eight stereoisomers will be synthesized and tested for antimalarial activity. A ligand-ligand molecular modeling approach will be used to define conformational requirements for binding.

Here, we report on the progress toward the synthesis of the target compounds.



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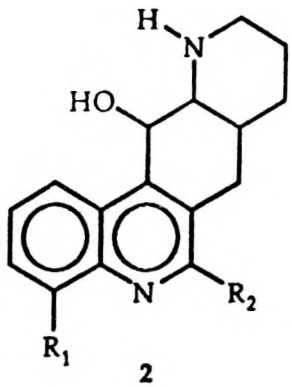

2

SIMULTANEOUS DETERMINATION OF ASPIRIN, SALICYLAMIDE, AND CAFFEINE IN A PAIN RELIEVER BY TARGET FACTOR ANALYSIS

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The much accepted method currently employed to analyze most pharmaceuticals is high-performance liquid chromatography (HPLC). One limitation of HPLC is its inability to completely resolve the analytes before they are detected. Secondly, where good resolution is achieved, acquiring a chromatogram may take as long as 15 to 40 minutes, with consequent low through-put. This study reports the use of a multicomponent analysis technique, target factor analysis (TFA), in the simultaneous determination of the concentrations of aspirin, salicylamide, and caffeine in pain relievers.

TFA attempts to solve for K in a general equation of the form $R_{n,p} = C_{n,r}.K_{r,p}$, where R is the response matrix, C is the calibration matrix, K is the response-factor matrix, and n, p, and r are the matrix dimensions. R contains a combination of the signals of the analytes, instrumental noise, and other unknown matrix effects. TFA quantifies all the significant factors in the R matrix. It then uses the concentrations of the calibration matrix as 'targets' in a step which leads to obtaining the K matrix (response factors of pure aspirin, salicylamide, and caffeine). The K matrix is then used to predict the analyte concentrations in the pain reliever. The predictive power of the K matrix depends on, among other factors, the design of the calibration matrix and the degree of overlap of the signals of the analytes.

Data for the present study were obtained by acquiring the absorbance spectra of several calibration and sample solutions via a scanning UV160 Shimadzu spectrophotometer in the range 200 to 340 nm. Data were then analyzed by in-house computer programs. For comparison, HPLC results were obtained from the chromatograms of the calibration and sample solutions. The chromatograms were obtained via a Milton Roy HPLC, equipped with a CRI C_{18} column (4 mm x 300 mm), at 225 nm detection. Both the HPLC and TFA results spanned the same range of percentages of aspirin, salicylamide, and caffeine in the pain reliever. With a well designed set of calibration solutions, TFA completely resolved the components of interest in a much shorter time-frame than the HPLC method, thus making TFA a better alternative to HPLC in the analysis of the pain relievers.

The Characterization of a Region of Steric Interference for Aminoalkylindoles at the Cannabinoid CB1 Receptor

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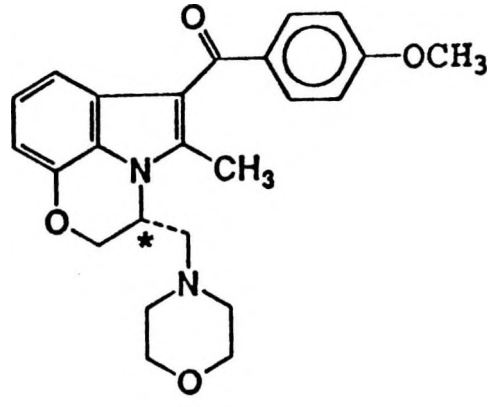
The Aminoalkylindoles (AAIs) are cannabinoid receptor ligands developed by Sterling-Winthrop. One such compound (**1**), a paramethoxy benzene analog of WIN 55212-2, has demonstrated binding affinity for the cannabinoid CB1 receptor and activity at this receptor only when in an R -(+)- configuration. It is our hypothesis that the inactivity of the S -(-)- isomer is due to a steric clash between the S -(-)- isomer and the AAI binding pocket at the CB1 receptor.

To test this hypothesis, a conformational analysis of the R and S conformers of compound **1** was performed using the method of molecular mechanics as encoded in the MM3 program. Any conformation whose final steric energy was within 6 Kcal/mol of the global minimum energy conformer was considered an accessible conformation. The conformational analysis revealed that the position of the paramethoxy benzene group is similar in the minima generated by the active R -(+)- and inactive S -(-)-structures. In the inactive compound, however, the morpholino ring protrudes into a region of space not occupied by the morpholino ring of the active compound. The position of this ring might explain the inability of the S -(-)- isomer to bind to the receptor.

In order to further investigate steric differences between the two isomers, the Active Analog Approach was used. To this end, all accessible conformers of the R -(+)- and the S -(-)- isomers were superimposed on their indole rings. The map facility within the Chem-X molecular modeling program was then used to characterize that region of space occupied by the inactive (S-(-)) isomer of compound **1** that is not occupied by the active (R-(+)) isomer. This region is called a Receptor Essential Volume (REV) region. The resultant REV map revealed a sterically forbidden region of space near the chiral center in molecule **1** above the plane of the molecule. This REV region may correspond to a region occupied by atoms of the CB1 receptor itself. This region, then, would be a sterically forbidden region for ligands of the CB1 receptor.

[Support: CUR-AIURP Fellowship to T.R.H. from Monsanto Co; NIDA 03934 Grant to P.H.R.]



1

The Importance of C-2 Substituent Size to the Affinity of Aminoalkylindoles for the Cannabinoid CB1 Receptor

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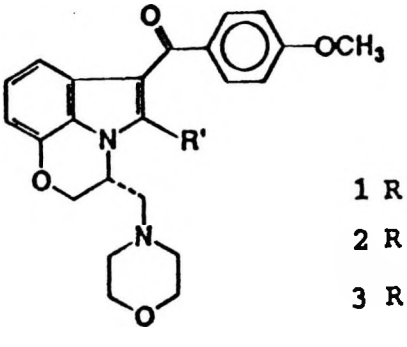
The aminoalkylindoles (AAIs) are a class of cannabinoid ligands structurally dissimilar from the other three classes of cannabinoid ligands. D'Ambra et al. [J Med Chem, 35, 124-135, 1992] found that increases in the size of the substituent at C-2 in certain AAI agonists (see drawings below) resulted in reduced affinity and efficacy for AAIs at the CB1 receptor. The IC_{50}s for [^{3}H]-WIN-55,212-2 labeled CB1 receptor binding of R/S mixtures of compounds **1**, **2**, and **3** were 249±17nM, 152±17nM, and 27% at 1µM respectively. The IC_{50}s for this same series in the mouse vas deferens assay were 44.5±9.8nM,123±13nM, and 28% @ 10µM respectively.

Our working hypothesis is that the AAIs interact with the cannabinoid CB1 receptor primarily via aromatic stacking interactions. Based on NMR and UV studies, Bell et al. [J Med Chem, 34, 1099-1110, 1991] reported that AAIs may exist in both an s-cis and an s-trans conformation. In the s-cis conformation, the indole and benzene rings form an aromatic stack. In order to evaluate if such a stacking interaction occurs in compounds *1-3*, and to ascertain any differences between 1-2 and 3, we undertook conformational analyses using the semi-empirical AM1 method.

Following geometry optimization, AM1 conformational searches were performed for all rotatable C-C and C-N bonds in compounds **1**, **2**, and **3**. Conformers were considered accessible if their heat of formation was within 6.00 kcal/mol of the global minimum. While compounds 2 and 3 were found to exist predominantly in s-cis conformations, compound 1 was found to exist in both s-cis and s-trans conformations. Superposition of the accessible conformers of **1** - **3** at their indole rings revealed that the only molecular feature that distinguished the higher affinity analogs **1** and **2** from the lower affinity analog **3** was the additional molecular volume at the C-2 position in compound **3**. It is possible that the extra molecular volume at C-2 causes compound 3 to have a poor fit at the CB1 receptor binding site. Consequently, the affinity of compound 3 for CB1 is attenuated. [SUPPORT: NIDA Grant 03934]



1 R' = H
2 R' = Me
3 R' = Et

CONTROL OF N-METHYL-D-ASPARTATE-TYPE GLUTAMATE RECEPTORS BY EXTRACELLULAR pH

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Glutamate, in addition to being an amino acid, also functions as a neurotransmitter. There are at least five different types of glutamate receptors known. The most widely studied of these is the N-Methyl-D-aspartate (NMDA) receptor family. Glutamate and its receptors are mostly found in the brain and have many functions in the developing and adult central nervous system. Activation of these receptors is thought to play roles in epilepsy, brain damage after stroke, long-term potentiation, and Parkinson's disease. The focus of this study was to examine the control of NMDA receptor function by altering extracellular pH. Alternatively spliced mRNAs were microinjected into *Xenopus laevis* oocytes. After four days NMDA receptors were expressed in the membrane of the oocytes, and oocytes were used for voltage-clamp recordings. The response of NMDA receptors to glutamate and glycine was measured as a function of pH. Four types of RNA were used. Two types had been previously shown to respond differently to pH changes. For each of these types, a mutant RNA was also examined in which an asparagine was changed to an arginine. For the wild-type NR1.1B receptor, the percent response (compared to pH 7.6, ± standard error) was 91±3%, 69.5±4.6%, 40.5±1.4% at pH 7.2, 6.8, and 6.4, respectively. The NR1(N637R).1B mutant receptors showed a 56% response at pH 6.8. These results show that the receptor function is inhibited by even a slightly acidic environment. More data needs to be collected for the mutant receptors, but when combined with data previously obtained by the same laboratory, suggests that the altered amino acid plays an important role in the control of the receptor function by pH. This is an important finding because this amino acid was previously believed to be located near the intracellular portion of the ion channel and was not expected to affect the response to pH.

ANALYSIS OF COMPOUNDS AS POTENTIAL INHIBITORS OF THE SERINE PROTEASE ALPHA-CHYMOTRYPSIN

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The serine protease family of enzymes shares many structural and functional aspects. This enzyme family is believed to be involved in the manifestation of many human physiological disorders including emphysema, arthritis, and others. The design of effective compounds to inhibit the activity of these enzymes is an area of intense interest. These inhibitors are being designed with hopes of creating drugs to treat the physiological problems associated with uncontrolled serine protease activity. Eight compounds were analyzed as potential inhibitors of serine proteases. All compounds are heterocyclic with variations in side chains. The compounds were first tested for stability in buffer at pH 7.5. The compounds were examined as inhibitors of the serine protease alpha-chymotrypsin using the substrate Suc-Ala-Ala-Pro-Phe-pNA. The analysis was done spectrophotometrically by monitoring the absorbance at 410 nm of the p-nitroaniline group released upon enzymatic hydrolysis of substrate. From data obtained by this method, Lineweaver-Burk plots were constructed to determine K_m and V_{max} for each compound tested. K_i and k_{cat} were also determined when applicable. To analyze for possible irreversible inhibition, time dependent assays were performed. Three of the compounds, the carbamoyl derivatives of N-substituted phthalimides, were not tested with enzyme because they were found to hydrolyze in buffer at pH 7.5. The 6-methyl-N-(benzyloxy) phthalimide derivative was determined not to be an inhibitor of alpha-chymotrypsin. The three alkyl-N-(sulfonyloxy) phthalimide derivatives: methyl, isopropyl, and p-toluyl, were determined to be inhibitors of the enzyme. Lineweaver-Burk analysis showed that K_m was increased and V_{max} stayed approximately the same, which indicates competitive inhibition. The K_i increased in the order: p-toluyl< isopropyl< methyl, with the K_i of the p-toluyl derivative being 37 nM and thus the most potent inactivator of the enzyme. Time-dependent inactivation studies showed that all three alkyl-N-(sulfonyloxy) phthalimide derivatives were irreversible inhibitors with complete inhibition in less than four minutes.

SPECTROSCOPIC PROPERTIES AND MOLECULAR STRUCTURE OF 1,3-DIMETHYL-2-(*SE,SE*-DIBROMOSELENO)-2(3*H*)-IMIDAZOLYLIDENE.

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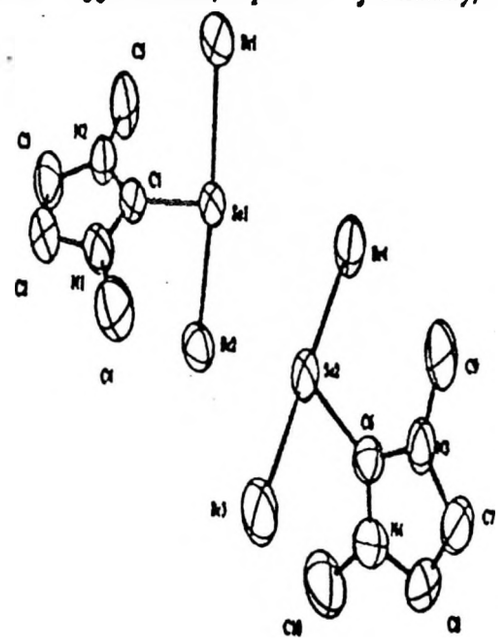

Oxidative addition of Br_2 to 1,3-dimethyl-2(3H)-imidazoleselone results in a compound that can be viewed as a Se(II) bromide complex with a stabilized imidazolylidene ring as verified by X-ray crystallography. The structure consists of dimeric pairs containing nearly linear Br-Se-Br units bonded through carbon to planar imidazolylidene rings at torsion angles of 91.4° for N1-C1-Se1-Br1 and 76.8° for N3-C6-Se2-Br3. Significant intermolecular contacts between dimeric units are seen through short Se⁻Se contacts [3.494(1) Å] and Se1⁻Br4 bridging [3.509(1) Å]. Solution state Raman data show the characteristic peaks for a linear Br-Se-Br moiety with a strong polarized peak at 158 cm^{-1} and a weak shoulder at 181 cm^{-1} corresponding to the symmetric and asymmetric Br-Se-Br stretching modes respectively. In the absence of X-ray data, correlation of structure to vibrational data provides further support for structural speculations in other compounds with the linear $SeBr_2$ grouping. Crystal structure data for $C_5H_8N_2Br_2Se$. Cell parameters: space group $P2_1/c$, a = 7.997(2) Å, b = 14.632(5) Å, c = 16.711(4) Å, β = 95.40°, Z = 8, V = 1946(1) $Å^3$, R = 0.045.

WEB PAGE DESIGN AND IMPLEMENTATION

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HTML (Hypertext Markup Language) is a method of representing the appearance and content of a document using a standard ASCII text file. HTML consists of reserved markup tags, mixed with plain text to make up a document. A HTML document is what makes up a Web page. The Web has become a major part of the world of growing technology. Web pages have become an important way for organizations and individuals to represent themselves in a way that is accessible throughout the World. It is important when developing a HTML document to use proper syntax when defining tags and attributes. It is easy to create a Web page very quickly. However, it is just as easy to create a badly organized one. Web pages must be updated regularly to ensure the continued functionality/validity of the information contained therein. Rules for creating good HTML documents must be observed. The rules for HTML document syntax are not as extensive as computer programming languages, but the success of any Web page can depend on the following:

1) Proper use of HTML tags, attributes, links, and graphics.
2) Regular maintenance of the Web page.
3) Continuous testing of the page to insure that links, graphics and other elements work properly.

HTML has grown extensively since its beginning and will continue to grow. It is important for the authors of Web documents to continuously educate themselves about the new HTML elements that are being added to the standard (currently HTML 3). This on-going project has focused on researching HTML design principles and on the development of standard templates for departments and faculty which adhere to these guidelines for good HTML design. The resulting HTML pages offer departments and faculty a common approach to providing information to current and potential students, to research colleagues, and to a wide variety of other constituents, in a format that is useful, attractive, accessible, and easily maintainable.

PLANNING, DESIGN, AND IMPLEMENTATION OF THE VIRTUAL OFFICE: A CASE STUDY OF AN ORGANIZATION DISPLACED BY THE 1996 OLYMPICS

Paula Skinner, Toni Jenkins, Barbara Bassett, Jennifer Calbert, Sean Gibbs, Matt Hunt, Mitsuko Ishizaki, Michael Johnson, Bruce McMillan, Amy Milford, Kent McLaughlin, Natalie Robertson, Kevin Schneider, Jimmy Trammell, Clarence Yong, Catherine Beise
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Telework (working at home using information technologies and networks) offers opportunities to save time and money for both employers and employees. However, obstacles to successful telework include resistance to change, lack of adequate technology in the home, and social isolation. ARLGT is an organization which leases office space at Georgia Tech. During the Olympics, employees do not want to have to commute downtown, park, nor have to get through extensive layers of security every day during the Olympics.

An analysis of the current organizational and technical environment, and application of a feasibility framework described in the research literature indicates that this organization fits a number of the requirements for successful telework. The employees are highly educated professionals who are measured by their outputs and have a high-tech orientation and culture which would require minimal technical training for working with sophisticated technologies such as ISDN, video conferencing, and groupware. Employee surveys suggest a positive attitude toward telework. Recommendations to the organization to increase their probability of success include installation of ISDN in the homes of teleworkers, development of an organizational policy for telework modeled after government guidelines, and addressing administrative and social needs by identifying a temporary site for face-to-face meetings. Suggested evaluation methods include post-telework employee attitudes and quantitative measures of travel time, travel cost, and work-hours for individual employees.

GROUPWARE: DETERMINING AND ACQUIRING AN APPROPRIATE TOOL FOR STUDENT TEAM COLLABORATION

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Groupware provides the means for effective and timely communication under many different environments and situations. Whether permitting anonymous brainstorming, video teleconferencing, or graphical data sharing, groupware takes full advantage of the communications technology available today.

Through a comprehensive search of various groupware tools, we provide an extensive list of tools including the following information on each:

- advantages,
- disadvantages,
- system requirements,
- best-suited purpose,
- costs, and
- feasibility of implementation on a college campus.

The most appropriate tool for use in education must permit information sharing, graphical data sharing, synchronous communication, and information storage. Brainstorming, voting, and composing features enhance such a tool. The system must provide the above features for students located over a wide area. Therefore, a tool that takes advantage of the Internet is desirable.

After selecting the most appropriate and feasible tool, we implement a prototype for viewing and testing purposes. The prototype allows faculty and students to use the tool and determine if it meets their needs.

Using such a tool on a college campus where teamwork serves as a growing requirement enables students to meet without physically gathering. Students no longer need to struggle to arrange convenient times. Also, this tool could allow for cross-campus groups. Teams created from students located around the world could work together. The right tool benefits everyone.

WHAT'S SO STABLE ABOUT A GRAPH?

Lectra Lawhorne and Virginia A. Rice
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Kennesaw GA 30144 USA

Is it possible to create invulnerable graphs with respect to edge deletion? Yes, when the inclusive edge connectivity parameter defines the vulnerability locally and globally. There are several types of edges with regard to edge deletion and s-stable edges create several infinite classes of stable graphs. Stable graphs are illustrated using three methods derived from properties contained in previously discovered stable graphs. Using these three methods, it is possible to generate stable graphs with high connectivity properties; it is also possible to generate stable graphs on any number of vertices greater than 10 except 14. Previous results and the theorems that correspond with the three methods are also displayed. Several open problems are given for further study.

MINING FOR GOLD: INVESTIGATIONS AND APPLICATIONS OF THE FIBONACCI NUMBERS

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Deborah Bielak
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"Someone placed a pair of rabbits in a certain place, enclosed on all sides by a wall, to find out how many pairs will be born in the course of a year, it being assumed that every month a apir of rabbits produces another pair, and that the rabbits begin to bear young two months after their own birth." -Leonardo Fibonacci

This initially obscure but now infamous "Rabbit problem" posed centuries ago by Leonardo of Pisa, better known as Fibonacci, has generated a highly researched sequence, the Fibonacci numbers: 1,1,2,3,5,8,13,21,... This is known as a recursive series since each term is the sum of the two preceding terms. The sequence is known as the Fibonacci sequence and the numbers produced are known as the Fibonacci numbers.

First, we investigated some mathematical properties of the sequence: looking at recursive identities and finding formulas by observing patterns; proving the formulas through proof by induction or matrices and their determinants; and obtaining a "closed" formula for generating any desired term of the sequence called Binet's Formula. Finally, we explored applications of the Fibonacci numbers as they arose in art, music and nature such as famous paintings, certain Gregorian chants and the genealogical tree of the male bee.