POSTER PRESENTATION ABSTRACTS

Preface

A total of 37 topics have been accepted for poster presentation. These posters demonstrate the growing prominence of research and development activities within Kentucky. The Commonwealth's academic community continues to build science infrastructure and to increase the number of researchers performing quality R&D.

The Kentucky EPSCoR Program is committed to enhancing the research and intellectual capacity of its universities by building and coordinating strategic investments in human capital and physical infrastructures. Since initiation, the Kentucky EPSCoR Program has been the channel through which over $313 million in R&D funding has been secured for the Commonwealth's universities.

Agencies providing EPSCoR or EPSCoR-type awards include:

- National Science Foundation
- National Institutes of Health
- National Aeronautics and Space Administration
- Department of Energy
- Department of Defense
- Environmental Protection Agency
- Department of Agriculture

For further information on the Kentucky EPSCoR Program, please see our website (www.kyepscor.org) .

Funded by: DOD

Poster # 1

Overview of the CyberDefense Lab at Western Kentucky University

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Western Kentucky University (WKU) has developed a Cyber Defense Lab (WKUCDL) located at the WKU Center for Research and Development. WKUCDL consists of 32 Windows PCs, 8 network devices (including smart switches and routers/firewalls), and two network process analysis computers which are used for packet capture and their subsequent analysis. The PCs can be reconfigured to any network configuration within 48 hours. This allows the creation of nearly any network scenario albeit on a small scale. The analytical computers run a variety of programs—from WiresharkTM to specialized analytical software developed by WKUCDL. WKUCDL researchers are developing a variety of network traffic tools. One of these tools that we are developing uses wavelets to filter out the general network noise. Anomalous traffic and network intrusion detection algorithms are rigorously tested and receiver-operator characteristic (ROC) curves are generated to measure the effectiveness of the algorithm.

Full Funding Acknowledgement:

Funded by: DOD

Poster # 2

Context-Dependent Fusion of Multi-Algorithm Systems for Detecting Explosive Objects

Hichem Frigui, Multimedia Research Lab, CECS, University of Louisville

Detection and removal of land mines is a serious problem affecting civilians and soldiers worldwide. In addition to land mines, buried Improvised Explosive Devices (IEDs) also pose threats in a variety of environments. Buried mines can be used as triggers to so-called ”daisy chains” of IEDs. The goal of this research proposal is to devise, analyze, and demonstrate new concepts and computational algorithms for building multi-algorithm systems for detecting explosive objects. The envisioned application scenarios involve single or multiple sensor systems that acquire data over regions of space that may contain explosive objects and make autonomous decisions concerning the existence of buried explosive objects.

Algorithm performances for buried mine and IED detection are strongly dependent upon a variety of factors that are not well understood. The factors appear to be somewhat correlated with geographical and environmental conditions but not strongly so. The challenges are to come up with algorithms that can identify the different contexts, and that can take advantage of the stronger sensors/algorithms for a given context without suffering from the effects of weaker sensors/algorithms in the same context. The context identification and characterization would allow the algorithm to perform detection quickly and accurately in the presence of rapidly changing geographical and environmental conditions.

This project involves multi-disciplinary interactions between government, industry, and academics. In particular, our basic research is coordinated with our applied research with the U.S. Army Countermine Division into detecting buried explosive devices to obtain access to new data sets and to ensure that we are working on problems of interest. We also collaborate closely with engineers and scientists at NIITEK, Inc. and BAE Systems to gather data sets, field test newly developed algorithms in real environments, and transfer technology from lab to industry.

Full Funding Acknowledgement:
This work was supported in part by an ONR award number N00014-05-10788, a KSEF award number 148-502-05-153, and ARO award number W911NF-0801-0255, and by an NSF award No. CBET-0730802

Funded by: DOD

Poster # 3

Biological Inspired Micro Air Vehicles

Yongsheng Lian, Mechanical Engineering Department, University of Louisville

Micro air vehicles (MAVs) have the potential to revolutionize our sensing and information gathering capabilities in environmental monitoring and homeland security areas. Due to MAV's small size, flight regime, and modes of operation, significant advancement will be needed to create this revolutionary capability. Aerodynamics, structural dynamics, and flight dynamics of natural flyers intersects with some of the richest problems in MAVs, including massively unsteady three-dimensional separation, transition in boundary layers and shear layers, vertical flows, unsteady flight environment, aeroelasticity, and nonlinear and adaptive control are just a few examples. In this poster, we offer sample results illustrating some of the efforts make from a computational modeling angle.

Full Funding Acknowledgement:
The work is partially supported by US Air Force

Funded by: DOE

Poster # 4

Pt electroplating on modified carbon nanotubes for methanol fuel cell membrane applications

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University of Kentucky

With increased energy demand and significant interest in bio-mass conversion to methanol, there is strong research focus on direct methanol fuel cells. Due to low methanol oxidation kinetics, fuel cells require noble metal Pt catalyst. However mass-transport (diffusion to surface) often limits the efficient use of these expensive catalysts. Aligned carbon nanotube (CNT) membranes show dramatically (>10,000 Xs) enhanced flow/mass transport due the atomically smooth interior surface of CNTs. CNTs are also electrically conductive, allowing for electroplating precisely at pore entrance, where mass transport is fastest. Bare CNTs have unfavorable surface energies, giving large Pt crystallites during electroplating. We find the treatment of graphite surface first with diazonium based electrochemical deposition allows for a Pt coating that is highly uniform and thin, thus dramatically improving Pt efficiency.

Full Funding Acknowledgement:
DOE EPSCoR

Funded by: DOE

Poster # 5

Investigation of Hydrogen Sensing Properties of Rutile-Phased Titanium Oxide Nanotube Thick Layer

Chi Lu, Young-Sik Song, and Zhi Chen, Department of Electrical and Computer Engineering, University of Kentucky

Titanium oxide nanotube clusters with the thickness of ~20μm were fabricated through anodisation at 35V in an organic media. Annealing at elevated temperatures (>400ºC) was apply to the sample and the anatase-to-rutile phase conversion was observed. As long as the nanotube layer was completely transformed into rutile phase, electrodes were fabricated on the layer and the conduction variations in response to different hydrogen concentration levels at 300ºC, 400ºC, 500ºC in nitrogen ambient, were investigated. The transient behaviors upon introduction and removal of hydrogen gas were also studied.

Keywords: titanium oxide nanotube layer, rutile phase, anatase phase, elevated temperatures, hydrogen sensor

Full Funding Acknowledgement:
This work was supported by Department of Energy (DE-FG26-04NT42171)

Funded by: DOE

Poster # 6

On tuning the spectral emission and absorption properties of photovoltaic and thermophotovoltaic devices: near-field radiative transfer effects

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Near-field radiative heat transfer can exceed Planck's blackbody distribution by several orders of magnitude due to radiation tunneling. Quasi-monochromatic radiant energy exchanges can also occur in the near-field when surface polaritons are thermally excited. Surface phonon-polaritons with resonance in the infrared can therefore play a key role in tuning the emission spectrum of thermal radiation. We have shown recently that it is possible to engineer the emission spectrum via thin films of polar crystals supporting phonon-polaritons coated on dielectric substrates. This has important applications in nanoscale thermophotovoltaic devices, where the idea is to design radiators emitting at selected frequencies in the near-field. We are also looking at selective absorption using surface plasmon-polaritons to improve conversion efficiencies of photovoltaic and thermophotovoltaic systems. We are currently investigating different structures for selective absorption such as deposition of nanoparticles, periodic gratings, and nanoscale antennas.

Full Funding Acknowledgement:
The authors acknowledge the US Department of Energy (DOE) for support (DE-FG02-07ER46375) through DOE EPSCOR grant.

Funded by: DOE

Poster # 7

An Enhanced Energy Harvesting Scheme Using Symmetrical Force Coupling on Piezoelectric Cantilevers

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Bruce Alphenaar, ECE Department University of Louisville
Walter Jones, Genscape Inc.
Deirdre Alphenaar, Genscape Inc.

This paper proposes various coupled magnet-cantilever schemes to enhance or to alter the energy output spectrum in a piezoelectric cantilever vibration scavenging device. It has been shown that the introduction of magnetic coupling to the piezoelectric cantilever beams provides the capability of frequency tuning. In this study, a balanced and symmetrical magnetic coupling scheme is characterized and found to broaden the frequency response without altering the resonant frequency. The total voltage output covering the resonant spectrum increases by 30% to 80%. Stronger coupling produces a new two-state vibration mode that is hysteretic in the driving amplitude, and that may potentially be applied to a mechanical digital filter defined by acceleration. The results agree qualitatively with solutions for the equation of motion for a one-dimensional driven oscillator containing a non-linear magnetic force.

Full Funding Acknowledgement:

Funded by: DOE

Poster # 8

Enhancment Mechanisms of Exciton Formation and Dissociation in Organic Solar Cells

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In organic solar cells, photo-voltage is generated as excitons dissociate across the interface between a light absorbing polymer and a charge accepting contact. Efficient conversion of photons to electricity requires that the charge separation rate across the interface be substantially larger than the charge recombination rate. Here we describe the use of a capacitive photocurrent technique to study the exciton formation and dissociation across a single metal-polymer interface. This technique provides us with the ability to distinguish between excitonic and free carrier states, to determine excitonic binding energies and recombination times, and study the influence of interface materials and conditions on exciton formation and dissociation.

We have applied our technique to carbon nanotube / ITO junctions. Similar to polymers, carbon nanotubes have large excitonic binding energies, and exciton formation is the dominant light absorption mechanism. Our work on nanotubes has provided two possible strategies for enhancing charge generation in organic solar cells: 1) introduction of spin-orbit coupling to allow absorption into the triplet exciton state and 2) strain induced surface modifications to shift the excitonic peaks.

In the first set of experiments, nanotubes were coated with EuS, a ferromagnetic insulator with large spin orbit coupling.The application of a small magnetic field to align the electron spins in the EuS results in the appearance of a low-energy photocurrent peak. The energy spacing of this peak from the main exciton peak suggests that it is due to the triplet exciton which is normally optically inactive, but the spin orbit coupling provided by the EuS allows for its observation. In a second set of experiments, nanotubes were grown on a piezoelectric quartz substrate, and the excitonic features tracked as a function of strain. The strain induced static charge in the quartz changed the dielectric environment, and shifted the position of the exciton peak, by up to 0.25 eV. A similar technique could be used to shift polymer absorption peaks, to increase near IR absorption,or to enhance exciton dissociation. Finally some initial results on photocurrent measurements of graphene nanoribbons will also be discussed.

Full Funding Acknowledgement:

Funded by: NIH

Poster # 9

Sample Components for Information Technology Infrastructure for Genomics

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As a step towards a comprehensive infrastructure for University of Kentucky research projects in genomics, we have developed a software suite for storing, processing, and visualizing genomic information. With the Epichloë festucae Genome Project as our pilot project, we have developed a number of components, including a customized version of the GBrowse viewer; a web-based annotation system; and a database and related tools for managing genomic data.

Firstly, our group that includes a number of students working in Computer Science and Plant Pathology labs made enhancements to GBrowse, an open-source web-based tool for viewing genome annotations, to provide a template-based user interface, allowing for better separation between program logic and presentation. The template-based system allows projects to make more significant changes to a site's appearance without altering the GBrowse source code. Furthermore, these templates may be shared with other web application components, providing a more consistent user experience, and reducing the cost of designing a custom genome project web site.

Secondly, our group developed a web-based system allowing researchers to create, edit, and curate genome annotations. This tool assists in managing annotations to be displayed in GBrowse and exported to the open-access GenBank database. Researchers, with the help of automated analysis tools, identify regions of interest in the genome, then use the annotation system to describe those regions with standard GenBank ontology terms. This makes it simpler to publish data to to the genetics and bioinformatics communities.

Finally, we have developed a back-end system for storing and managing data . This includes a set of relational database schemas for storing genomic sequences and analyses, and a library for simplifying access to the databases. A collection of scripts uses this library to query, import, and manage this data, and to build an abstracted database used by GBrowse for fast and efficient visualization. The E.f. Genome project uses this system to manage approximately 5 gigabytes of data.

Full Funding Acknowledgement:
We acknowledge funding from the KBRIN-INBRE NIH 2 P20 RR-16481, the National Center for Research Resources
Institutional Development Award (IDeA) Program (sub-award from the University of Louisville).
University of Louisville)

Funded by: NIH

Poster # 10

Integrated Fiber-Optic Devices for Biosensors

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The focus of this project is the fabrication of side-polished optical fibers to measure absorbance and fluorescence of biological material using evanescent fields. Multimode, step index optical fibers mounted to a 5 v-grove silicon chip allow measurement of the aforementioned absorbance and fluorescence. Using a lapping machine, the fibers are side-polished, exposing the core of the fibers. Exposing the core allows us to access the evanescent field. The advantages of using this process, as opposed to other waveguides, are the ease of use, portability, and multi-functionality. This multifunctional platform will be used for advanced sensor technologies requiring the measurements of absorbance and fluorescence. In the near future these devices may be utilized for completely integrated surface plasmon excitation and Raman spectroscopy.

Full Funding Acknowledgement:
National Science Foundation (DBI-0352449) and the National Institutes of Health (RR022864)

Funded by:

Poster # 11

A novel poly-cis microRNA vector and its application

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Guiliang Tang: University of Kentucky, Plant and Soil Science department

Artificial microRNA (miRNA)-directed gene silencing has advantages over traditional inverted-repeats gene silencing vector in more gene silencing specificity and less off-target effects. Here we reported the design of a novel poly-cistronic (poly-cis) miRNA vector that can mediate multiple gene silencing in plants. A dedicated poly-cis miRNA vecotor design web service was established to help the users to design their poly-cis miRNA-directed gene silencing constructs to silence multiple genes of interest. Finally, the poly-cis miRNA vector was successfully applied to silence two Arabidopsis argonoute simultaneously. Thus, a new approach of using artificial miRNAs to silencing more than one gene at a time was made possible.

Full Funding Acknowledgement:

Funded by: NIH, NSF

Poster # 12

Computing infrastructure initiative and methods in biological modeling, survival analysis and statistical data mining

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Applications of statistical science have pervaded many disciplines. Recent advances in computing technology have helped in surmounting past computing hurdles and at the same time generated more statistical problems in the area of highdimensional data, computational biology, and analysis of large data sets. The authors will present their recent research results in biological modeling, survival analysis, the WestCalc project and the impact of computing technology in their respective researches. The authors also will describe collaborative research and educational initiative regarding the introduction of statistical data mining and the improvement of the statistical computing infrastructure at Western Kentucky University.

Full Funding Acknowledgement:
J. Quiton acknowledges funding support from the Kentucky EPSCoR Research Startup Fund No. RSF-031-06, the Department of Mathematics and Computer Science, Western Kentucky University, and the 2008 Western Kentucky University Summer Faculty Scholarship Award No. 222386 for the WestCalc project.

D. Wu acknowledges funding support from the Ogden College of Science and Engineering Startup Fund and NIH and NCRR Grant P20 RR16481 (KBRIN).

Both authors acknowledge KBRIN which is supported by NIH National Center for Research Resources NIH Grant No. 2 P20 44-16841 for research and travel support for the 2008 Bioinformatics summit. Finally, both authors acknowledge SAS Institute for training, academic materials and information support regarding statistical data mining.

Funded by: NIH, NSF

Poster # 13

Development of Integrated Optical Waveguides for Applications in the Near-UV and Visible Spectral Regions

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A planar optical waveguide in the single-mode configuration is a valuable tool for the study of biomolecular thin films due to its extremely high sensitivity to probe surface-adsorbed chromophores. The technique provides spectroscopic information of surface-adsorbed species, does not require any labeling of the molecules under investigation, and can reach a limit of detection better than 1 pg/cm2. In this study, we report on the development of single-mode planar optical waveguides with low propagation loss in the visible and ultraviolet spectral regions, and on the fabrication of their integrated grating couplers. Slides of both soda-lime glass and fused silica (3" × 1" × 1 mm) are initially thoroughly cleaned and spin-coated with a photoresist film (Shipley 1805 with 1:1 dilution with thinner BTS-220) of 200-nm thickness. Holographic exposure with a He-Cd laser (442-nm) in a Loyd's mirror configuration is used to generate an interference pattern of desired spatial modulation on the photoresist film. Two patterns, which are separated apart by 34 mm, are created on the slide so that in the final device they will work as input and output couplers. Periodic modulations of 260-400 nm have been routinely fabricated in our labs. Next, the laser-exposed photoresist film is developed under an aqueous developer solution (Shipley 351) and monitored in real-time by following the diffractive pattern being formed. The holographically-writen pattern in the photoresist is transferred to the dielectric substrate through a deep reactive-ion-etching (DRIE) process under a fluorine plasma gas reaching depths of 40-120 nm. Then, the sample is chemically cleaned to remove any residual photoresist. The topology of the periodic modulation and the surface roughness of the devices are characterized by an AFM tool and optical measurements. The substrates are then overcoated with an Al2O3 film of approximately 180-nm thick by using an atomic-layer-deposition (ALD) technique to create a highly confined single-mode planar optical waveguide. Propagation losses in the 230-633 nm spectral region are experimentally measured and our results show an attenuation of about 3 dB/cm, which make those devices quite suitable for the aimed applications.

Full Funding Acknowledgement:
We would like to acknowledge support from the National Institute of Health (grant RR022864-01) and National Science Foundation.

Funded by: NIH, NSF

Poster # 14

Spectroscopic Studies in Protein Films with Highly Sensitive Guided-Wave Platform

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Protein adsorption to solid surfaces is a process that occurs spontaneously whenever aqueous dissolved species enters in contact with a solid interface. It is a topic of increasing interest because of its importance in biosensors, chromatography, biocompatibility, and many other applications in biotechnologies. A major difficulty in studying biomolecular monolayers is their low surface concentration (typically a full monolayer is only about 20 pmoles/cm^2). To overcome such major hurdle, we have developed in our labs an optical waveguide spectrometer that is highly sensitive and able to provide spectroscopic information on biomolecular assemblies at very low submonolayer levels. In this technique, broadband light is guided into a waveguide and the total internal reflection of the coupled light is partially attenuated by the absorbing thin layer of protein that was adsorbed onto the waveguide surface. The advantage of using this method when compared to the direct transmission mode is the number of times that light interacts with the sample. In this work, we study the adsorption of cytochrome c to an alumina surface, investigate possible conformational changes of the adsorbed protein, and its correlation with different surface coverage. Cytochrome c was dissolved in phosphate buffer at concentrations from 5 nM to 8,200 nM at physiological pH values. The waveguide was made from aluminum oxide deposited by atomic layer deposition in a glass substrate. Light in the spectral region from 440 nm to 720 nm was coupled into the waveguide for spectroscopic characterization of the protein film. We found that for a surface density of 2.3 pmol/cm^2 the molar absortivity measured at 695 nm was 335 cm^2/mol, however for a surface density of 14.6 pmol/cm^2 the molar absortivity was 720 cm^2/mol. For the solution dissolved of cytochrome c, the molar absortivity of the same transition band is 830 cm^2/mol. Our measurements indicate that the adsorption process affects the protein optical properties, most likely due to conformational changes, and those properties are also dependent on the surface concentration.

Full Funding Acknowledgement:
We would like to acknowledge support from the National Institute of Health (grant RR022864-01) and National Science Foundation

Funded by: NSF

Poster # 15

Towards the Synthesis of Biomimetic Iron Porphyrin-Ionic Liquid Hybrid Solvents for Lignin Degradation

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Terry L. Price, Jr., Brent Casper, Matthew Fields, Eastern Kentucky University

The primary limitation to the utilization of lignocellulosic biomass (cellulose, hemicellulose, lignin) resources is the difficulty in converting the components to usable feedstocks for biofuels and bioproducts. The current methods for delignification involve economically and energetically unsustainable processes utilizing enzymes or traditional chemical routes involving harsh conditions. Enzymes have limited function under the conditions required to dissolve lignin and cellulose. Metalloporphyrins have been shown to mimic the function of these enzymes in a wider range of conditions.

Ionic liquids recently have demonstrated great promise as tunable solvents for lignin and cellulose under ambient conditions. As a result, significant interest has developed in the possibility of these alternative solvents being utilized in “green” processes. This presentation will address current work in our group on the synthesis of linked porphyrin-ionic liquid materials, thereby creating a series of novel task specific ionic liquids (TSILs). These novel metalloporphyrin/ionic liquid complexes would function as both catalyst and solvent and therefore have the potential to significantly improve the efficient production of biofuels and bioproducts from biomass.

Full Funding Acknowledgement:
Funding for this project came from KY-NSF-EPSCoR and Eastern Kentucky University

Funded by: NSF

Poster # 16

An Adaptive Traceability Link Based Database Intrusion Detection Scheme

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Cyberspace is far from secure today. With the increasing number of databases that are accessible through the Internet, the database security is a growing concern to companies and government agencies. These databases may store sensitive information such as social security numbers, credit card numbers, and other financial or medical information. The attackers exploit vulnerability of the database system to steal or corrupt the critical information. Currently, limited efforts have been pursued toward database security. Organizations spend significant amount time and money on network and host security, but database are often left open. This proposed research concentrates on studying new methodology for identifying information attacks against database. Existing research efforts using accessing patterns or time signatures of transactions can be employed to identify some anomalous activities performed by each individual database transaction, but it's hard to find the anomalous activities carried out by a group of transactions, each of which satisfies signature based or non-signature based accessing patterns. One main goal of this research is to develop new approaches that allow well-hidden malicious actions to be identified over a series of seemingly harmless queries. This proposed project employs data mining methods to generate traceability links and profile inter-transaction data access patterns for identifying malicious database transactions.

Full Funding Acknowledgement:
The research project "A Method Employing Transaction Clustering and Traceability Link Mining for Identifying Information Attacks against Database" has been selected to be funded by KY NSF EPSCoR (currently waiting for the funding to be secured)

Funded by: NSF

Poster # 17

Computational studies of photon and neutron transport for active interrogation systems

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The nondestructive technique to rapidly determine bulk elemental content of various containers is based on the accelerator-based neutron interrogation. When the investigated object is irradiated with pulse neutrons, the photons are emitted with characteristic energies as a result of neutron-induced nuclear reactions within the cargo materials. By counting the number of these specific gamma rays, the cargo's isotopic content can be measured, and the possible hidden threat can be detected. To evaluate threat detection effectiveness of a neutron-based system, and to determine its optimal physical parameters, the detailed computer analysis of nuclear processes is required.
The MCNP5 code has been used to model radiation transport for various scanning systems and in different environmental conditions and to prove feasibility of the proposed approach. We developed MCNP models and conducted series of simulations for two systems: 1) the cargo scanning system; 2) underwater material detection and identification system. Both systems consist of the 14-MeV pulse neutron source, neutron and photon detectors.
Neutron and gamma coupled transport has been used. The 10-kHz frequency of neutron pulses with various duty factors has been simulated using the time variable in the source definition card with the source probability distribution that corresponds to the square pulse. Energy spectra of neutrons and gamma rays in the detectors and irradiated object cells have been calculated.
The threat has been simulated as an explosive or hazardous chemical object hidden inside the cargo. The distances from the irradiated object to neutron source and detectors, and its material composition have been varied to study minimum detectable amounts for various cargo scenarios. The results of calculations will be discussed.

Full Funding Acknowledgement:
EPSCoR NSF award RSF-023-05

Funded by: NSF

Poster # 18

Generation and Kinetic Studies of High-Valent Metal-Oxo Porphyrin Intermediates

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The major focus of the research is to understand important catalytic oxidations via high-valent transition metal-oxo species with the aims of detecting these highly reactive transients spectroscopically and conducting kinetic studies of their oxidation reactions in real time.

Following the known literature procedures, the trans-dioxoruthenium(VI) complexes in three porphyrin systems are synthesized and characterized. The kinetics of two-electron oxidation of various para-substituted phenyl methyl sulfides to corresponding sulfoxides was studied by using the rapid stopped-flow spectroscopy. The decay of trans-dioxoruthenium(VI) porphyrins in the presence of reactive sulfides follows a biexponential process. The kinetic effect by substituents in sulfides and in dioxoruthenium(IV) complexes was investigated.

Our particular interest is to photochemically generate highly reactive ruthenium(V)-oxo intermediate that can be utilized for catalytic oxidations, because photochemical reactions are intrinsically advantageous and activation is obtained by the absorption of a photon, which leaves no residue. Photo-disproportionation reaction of the diruthenium(IV) dimer appears to be a promising way to produce the powerful ruthenium(V)-oxo oxidizing transient that still remains elusive. Moreover, this approach will also lead to the development of a “green” oxidation photo-catalysis that uses atmospheric oxygen and visible light (sunlight) for selective oxidation reactions.

Full Funding Acknowledgement:
EPSCoR REG grant and Petroleum Research Fund (ACS)

Funded by: NSF

Poster # 19

Admicelle Extraction of Phenols Using Cationic Surfactants in the Hydroxide Form

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Admicelle based extractions, where sorbents used are prepared by immobilizing charged surfactants in a bilayer arrangement onto a silica or aluminum oxide surface, have been used for preconcentrating a wide variety of analytes. These analytes have a certain degree of hydrophobicity interacting with the alkyl chains of the surfactant or they are counter-charged interacting electrostatically with the charged polar group of the surfactant. Weakly hydrophobic molecules are more challenging to efficiently extract onto this type of medium. Presented is an admicelle extraction procedure for extracting weak acid phenols. An acid-base reaction takes place between modified surfactants containing hydroxide counter ions and weak acid phenols. The result of this reaction is the production of phenolate ions that remain counter to the cationic surfactant. The acid-base reaction together with the fluid nature of the surfactant phase protects the phenolate ions from being removed by counter ions in natural solutions. High extraction efficiencies result.

Full Funding Acknowledgement:
US NSF Office of International Science and Engineering (grant 0553369)
REU grant (EAR 0353651)
ACS Project Seed
National Science Council of Taiwan (Grant No. NSC 95-2218-E-005-009)

Funded by: KY EPSCoR

Poster # 21

Synthesis and Characterization of Novel Organic-inorganic Hybrids Containing Polytungstates

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Bipyridine ligands have important applications in catalysis, photochemistry, and electrochemistry. Zinc complexes of bipyridine ligands have been shown to be active catalysts for allylation of aldehydes. Covalent tethering of homogeneous catalysts is one approach to immobilize metal complexes to achieve high enantioselection in heterogeneous asymmetric catalyst. Our interest is to use polymetalates as ligands to metal complexes to synthesize new functionalized solid materials. The reaction of sodium tungstate with zinc chloride and 2,2'-bipyridine (bpy) under hydrothermal conditions gave a new molecular compound $(H_3O)[Zn(bpy)_3]_{1.5}[H_2W_{12}O_{40}Zn(H_2O)(bpy)_2]$. The structure of this compound contains $[H_2W_{12}O_{40}Zn(H_2O)(bpy)_2]^{4-}$ anions and $[Zn(bpy)_3]^{2+}$ cations. The anion $[H_2W_{12}O_{40}Zn(H_2O)(bpy)_2]^{4-}$ consists of a Keggin anion $[H_2W_{12}O_{40}]^{6-}$ coordinated by the complex $[Zn(H_2O)(bpy)_2]^{2+}$. In the anion, the Zn atom is coordinated by two bpy ligands, one water molecule and one Keggin unit, with Zn–O 2.09(4) Å and Zn–N 2.12(5)–2.21(4) Å. In the cation $[Zn(bpy)_3]^{2+}$, Zn atom is coordinated by three bpy molecules, with Zn–N 2.13(4)–2.22(6) Å

Full Funding Acknowledgement:
Kentucky EPSCoR , WKU start-up fund

Funded by: Other

Poster # 22

Comparing DRS with MRP Strategies in Manufacturing Systems

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1 University of Louisville, 2 Factory Physics Inc.

We compare a dynamic risk-based scheduling (DRS) strategy with the traditional Material Requirements Planning (MRP) strategy for scheduling the release of orders into a manufacturing system. Simulation and analytical models are used to estimate key performance measures of a manufacturing system processing multiple products under the two strategies. Results from the simulation models match well with those obtained from the analytical models. Often, it is beneficial to use the DRS strategy.

Full Funding Acknowledgement:
Factory Physics Inc.

Funded by: Other

Poster # 23

Optimal Allocation of Trucking Workload at Ge Consumer and Industrial

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The Consumer and Industrial group of the General Electric Company allocates its shipping truckload to seventeen different trucking companies over 701 different routes from one of its nine terminals to 48 contiguous states. Eight optimization models were developed to allocate the shipping capacity to its subsidiary and the third party logistics. In order to better implement these optimization models, two user friendly tools were developed for long-term daily use by the managers. Results from one of the models (the most realistic one) indicate that GE Consumer and Industrial could save approximately 15.59% of its shipping cost through an optimal re-allocation of its trucking workload. Future research areas are also presented.

Full Funding Acknowledgement:

Funded by: NASA

Poster # 24

Database Design and Implementation of KySat Orbital-1

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The goal is to create a database and web front end for the KySat Orbital-1 cubesat. The database software will be integrated into the satellite command and control software to store all data packets sent and received, as well it will watch a multitude of APRS-IS streams and parse packets into the database for several layers of redundancy.

The web front end will be the face of KySat Orbital-1 and will include many auxiliary functions in addition to displaying database information. It will implement a Content Management System to ensure ease of use for the KySat team. The website will make use of PHP to call on the mySQL database for information printouts. Light use of Javascript will be necessary for dynamic graphs and charts as well as some minor website functions.

The main challenges in this project are the distanced work group which is spread across several universities in Kentucky, keeping the front end simple while supplying a large amount of information, and a short deadline of just 3.5 months for design, construction and testing.

Full Funding Acknowledgement:
NASA EPSCoR

Funded by: NASA

Poster # 25

A Cosmological Solgi Void Probability Function for Gadget II Lambda CDM Models and SDSS Data

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We use the numerical N-body cosmological simulation, Gadget II, to investigate the Solgi representation of the Void Probability Function and the redshift, z, dependence of Void Probability Functions as an indicator of structure formation in the universe. The Solgi form of the Void Probability Function focuses on a scaling model inspired from percolation theory that gives an analytical form for the distribution function. For large redshifts the early universe was smooth and the probability function has a simple mathematical form and mimics the two point correlation results that lead to a Zipf's Law probability distribution. As various large scale galactic structures emerge a number of relatively empty regions have been observed and catalogued, these are the void regions. The number density of these regions is such that the universe has a large scale "sponge-like" appearance with voids of all scales permeating the field of observation, hinting at an underlying scaling law. Here we will examine a number of model cosmologies using the SPH GADGET-2 code run on a local Beowulf cluster. The numerical data are also compared to recent observational data from SDSS and Deep2 where an unbiased z dependence of medium size voids can be determined. We examine the range of critical void probability function parameters that give rise to the best fit to the numerical and observational data.

Full Funding Acknowledgement:
This work supported by KYSGC Grant 51960 at WKU

Funded by: NASA

Poster # 26

Discovering And Cataloging Variable Objects In The Nearby Galaxies Supernova Search Data

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Originally completed in 2001, the Nearby Galaxies Supernova Search (NGSS) Project surveyed approximately 900 square degrees along the celestial equator to find low redshift supernovae. This survey intended to measure the rate of supernovae occurrences in nearby galaxies, and map out the diversity of supernova characteristics. I will present our recent re-analysis of the NGSS data, using careful, pixel-by-pixel examinations of new time intervals between templates and search images to locate supernovae that may have been missed in the original survey. We also use a more comprehensive method, making use of multi-wavelength archival data from Great Observatories (Hubble, Chandra, etc.), to distinguish active (optically variable) galaxy nuclei (AGN) from possible supernovae within the cores of these galaxies. To date, in addition to the 42 supernovae originally discovered, we have uncovered at least one strong supernova candidate that was missed in the original survey, and approximately 15 less definitive candidates, including possible AGN. When complete, our results should improve the precision of the event rates for supernovae of all types in galaxies in the local ($z < 0.1$) universe.

Full Funding Acknowledgement:
This is a KSGC funded project.

Funded by: NASA

Poster # 27

Efficacy of Countermeasures to Cardiovascular Deconditioning in Men and Women During Simulated Moon Explorations

JM Evans, Patwardhan, CF Knapp, University of Kentucky; MK Sharp, University of Louisville; B Girten, R Globus, C Wigley NASA Ames Research Center; SH Platts, MB Stenger, TT Schlegel, Johnson Space Center; FB Moore, Alter-G Corp, Menlo Park CA; A. Diedrich, Vanderbilt University; H. Hinghofer-Szalkay, University of Graz, Austria.

The goal of our project is to develop a countermeasure to mitigate human cardiovascular consequences of adaptations to microgravity during missions to the moon and Mars. Over the next three years, in collaboration with NASA JSC and Ames investigators, we will test: At JSC: 1) a human model of space flight-induced cardiovascular deconditioning using a hypovolemia protocol, 2) efficacy of compression stockings with spatially distributed pressure as a countermeasure to cardiovascular deconditioning, 3) a model of deconditioned cardiovascular responses to the first day of lunar activity and at Ames 4) a model of deconditioned cardiovascular responses to lunar mission g profiles. The educational component of our program involves support for graduate students and continuation of our outreach program for undergraduate and high school students with emphasis on recruitment of women and minorities.
Relevance to NASA's research emphases. Three key risks are addressed: The risk of orthostatic intolerance during re-exposure to gravity: In the earth to moon (or Mars) to earth scenario, risks of orthostatic intolerance may be increased over risks of current space flights since the time spent in the gravity fields of the moon and Mars has an unknown effect on astronaut's tolerance to a return to earth gravity. 83% of crew returning from long duration (Meck, 2001) and 30% from short duration flight (Fritsch-Yelle, 2001, Waters, 2002) experience presyncope. The occurrence of serious cardiac dysrhythmias, and diminished cardiac and vascular function will be addressed by adding advanced ECG analysis and measures of fluid distribution to our standard measures. Finally, the study will allow us to estimate 1) beneficial vs deleterious effects of the lunar 1/6 g environment on lower body fluid shifts and storage as well as 2) compensatory cardiovascular reflex responses evoked to regulate blood pressure in altered g environments.

Full Funding Acknowledgement:
Supported by a Grant from KY NASA EPSCoR WKURF 516204-08-01

Funded by: NASA

Poster # 28

Biosensors Based on Site-Specific Labeling of Antibodies

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Antibodies have been used for the detection of various analytes. However there has been a quest since long to develop highly sensitive, selective, simple, and reagentless sensor based on antibody. Herein we report the development of a biosensing system based on semi-synthetic antibody. This method is generic as it can be employed for any biomolecule of interest provided there is an antibody capable of binding it. We take advantage of the unconventional nucleotide-binding site that resides between the light and the heavy chains of variable domain of antibody. Sensing element, the semi-synthetic antibody is formed by docking the covalently attached environment sensitive fluorophore to the nucleotide probe in the unconventional nucleotide binding site. The bound probe does not affect the binding of target analyte to the antibody. However, binding of the analyte to the antibody causes a change in the microenvironment of the nucleotide binding site resulting in a change in the fluorescence. The observed changes in the fluorescence intensity of the nucleotide conjugated probe can, therefore, be employed to monitor the concentration of analyte in the samples. Hence, this approach allows for the development of a highly sensitive, selective, simple, and reagentless biosensing system based on fluorescence. To demonstrate this principle, Interleukin-6 (IL 6) and Osteonectin (ON) were selected as model analytes. IL-6 is a pleiotropic cytokine and elevated concentrations of IL-6 have been reported in various disease states, including cardiac myxomas and cardiovascular disease, while ON is a salivary biomarker associated with periodontal disease. Recognition site, the unconventional binding site of anti-IL6 and the anti-ON antibody were docked with the nucleotide probe 2-azido ATP conjugated to the fluorophore, Alexa Fluor 594 cadaverine. An increase in the fluorescence intensity was observed due to the conformational changes of the individual labeled antibody upon interaction with its corresponding analyte.

Full Funding Acknowledgement:
National Aeronautics and Space Administration (NASA)

Funded by: NASA

Poster # 29

Development of High Temperature Shape Memory Alloys for Aerospace Applications

Haluk Karaca and Michael Seigler
University of Kentucky

Shape memory alloys (SMAs) are an extraordinary group of materials that can produce very high recoverable shape changes (up to 20% uniaxial strain) as a result of reversible martensitic phase transformations, which are first-order, diffusionless, displacive solid-state structural changes and can be triggered by changes in temperature, stress state or magnetic field. Due to their remarkable properties in actuation, vibration damping, noise reduction, sensing, magnetocalorimetric and constant force spring response, SMAs have permeated into the mainstream of many industries, particularly in the biomedical, transportation, energy, aerospace and oil & gas industry. NiTi has been the workhorse of SMA applications because of its superior mechanical properties, but its usage is restricted by its transformation temperature(<100 °C). However, when some ternary elements such as Hf, Zr, Pt are added significant increase in transformation temperature has been observed. In this study, one of the most promising candidates for high temperature SMAs, NiTiHf alloys system, has been studied with an aim of increasing the transformation temperatures and improving the cyclic stability. NiTiHf(Cu,Pt) alloys are vacuum arc-melted and extruded with a ratio of 7:1 at 900 °C. Transformation temperatures and hardness values of as-processed and homogenized samples and as functions of aging time and temperature are being systematically investigated. The future work will include an in-depth study on microstructure-mechanical property relation, cyclic stability and model development.

Full Funding Acknowledgement:
NASA EPSCOR- N08R02B

Funded by: NASA

Poster # 30

Status of the 21 m Earth Station and Radio Telescope at Morehead State University

Benjamin K. Malphrus, Thomas G. Pannuti, Jeffrey A. Kruth, and Michael S. Combs

Morehead State University

The Space Science Center at Morehead State University (Morehead, KY, U.S.A.) has developed a 21 Meter full-motion antenna system that serves as: 1.) a ground station capable of tracking Earth-orbiting satellites in a variety of orbital configurations 2.) a test bed for advanced RF systems, and 3.) a radio telescope for astronomical research. The instrument supports undergraduate student research projects in observational astrophysics, hardware and software design related to radio astronomy observations, telecommunication systems, and space systems operation. The 21 M is engaged in radio observations of microvariability in active galactic nuclei (AGNs), of transient events, (i.e. radio afterglow of Gamma Ray Bursts) and surveys (i.e. kinematic surveys of atomic hydrogen in the Milky Way Galaxy). In Earth station mode, the 21 M is capable of tracking a variety of satellites including LEOs, MEOs, GEOs, and lunar orbiting and fly-by spacecraft. A major goal of this project is to assist in the development of a workforce for the space operations industry. Toward that end, satellites are tracked with the system to train students in the principles of satellite operation. The 21 M was brought on-line in 2006 and currently operates two receivers: an L-band receiver (1.4-1.7 GHz) and a Ku-band receiver (11.2-12.7 GHz). Other frequency bands (including an S-band 2.2-2.5 GHz receiver for satellite mission support and a 6 cm (C-band) feed for radio astronomy research are in the development stages. Empirical measurements of the instrument's performance characteristics (including system temperature, radiation patterns, gain, G/T, aperture efficiency, surface shape and tolerance, and pointing and tracking errors), have been made and are discussed herein. The 21 M will serve as the primary Earth station for the KySat-1 and -2 orbital missions, as an Earth station for NASA's PharmaSat mission, and as an important Earth station for future NASA missions.

Full Funding Acknowledgement:
This project was made possible by grants received from the National Aeronautics and Space Administration, the U.S. Small Business Administration, and the Kentucky Science and Engineering Foundation, under the auspices of the Kentucky Science and Technology Corporation. Transfer of key components of NASA systems was made possible by the Kentucky National Science Foundation Experimental Program to Stimulate Competitive Research (KY NSF EPSCoR) and the National Science Foundation. Additional equipment was donated by Lockheed-Martin and Kruth Microwave Electronics (K-MEC).

Funded by: NASA

Poster # 31

A Study of Extra-Galactic Supernova Remnants in Irregular Galaxies with the Chandra X-ray Observatory

Thomas G. Pannuti, Nathan D. Fite and Thomas B. Wells (Space Science Center, Morehead State University)

Supernova remnants (SNRs) are intimately linked with many processes associated with the evolution of the interstellar medium (ISM) of a galaxy. While the number of known Galactic SNRs is large, studies of these sources are hampered by significant observational limitations, such as severe absorption along Galactic lines of sight and considerable distance uncertainties. This situation has motivated searches for extragalactic SNRs which provide an opportunity to study this class of sources in a manner which addresses these limitations. To help advance our general understanding of SNRs and to extend comparisons made between samples of extragalactic SNRs and the Galactic SNR population, we are conducting a search for X-ray emitting SNRs in five nearby ($d < 5$ Mpc) irregular galaxies using archival data from observations made with the Chandra X-ray Observatory. Our goal is to search for differences (if any exist) between SNRs located in irregular galaxies and SNRs located in normal spiral galaxies (like the Milky Way): this work also draws upon observations made at other wavelengths (such as optical and radio) to help make the classification of detected discrete X-ray sources as SNRs more certain. Initial results will be presented and discussed.

Full Funding Acknowledgement:
Funding for this project was received through the KY NASA EPSCoR Research Infrastructure Development Program.

Funded by: NASA

Poster # 32

Making Meteorology Better on Uranus and Neptune

Xiaolong Deng and Raymond P. LeBeau, Jr., University of Kentucky

While Jupiter and Saturn get more attention, the ice giants of Uranus and Neptune present the most interesting pair of atmospheres in the solar system. These planets have nearly the same size (about 25,000 km in radius), rotate at nearly the same rate (16-17 hours), and both atmospheres have similar composition (primarily hydrogen and helium with some methane) and similar vertical structures. Despite these similarities, Neptune has evidenced the far more dynamic atmosphere, with several large atmospheric vortices or Great Dark Spots, numerous cloud features, and other interesting atmospheric phenomena. Meanwhile, Uranus had generally remained a near-featureless blue-green sphere for more than a decade after the Voyager encounter. This image has changed dramatically in the past few years as Uranus has moved slowly out of its 21-year northern hemispheric winter into spring in December of 2007. Because of the dramatic axial tilt of Uranus, this means parts of Uranus are now receiving sunlight for the first time in decades, driving dramatic atmospheric changes including for the first time an observed Great Dark Spot.

Therefore, this is a particularly fortuitous time to study both of these planets, with their similarities and differences creating a unique opportunity to employ comparative planetology to increase our understanding of these atmospheres. To this end, we are developing the first comprehensive numerical model of these planetary atmospheres, encompassing dynamics, thermodynamics, chemistry, radiation, and cloud physics. Recent results in several of these areas will be presented, notably vortex dynamics, cloud modeling, and the effects of changing solar insolation on the zonal wind structure of the planet. By using a single model to simulate both planets, we can achieve greater confidence in the accuracy of our numerical approach; by comparing similar features on these planets to those on Earth, we can likewise better understand our own atmosphere.

Full Funding Acknowledgement:
This research is supported by a grant from the Kentucky Space Grant Consortium.

Funded by: NASA

Poster # 33

Flight Test Results from Near Space Balloon-1

Kentucky Space Consortium (UK, Morehead, WKU, UofL, Murray, KCTCS): James Lumpp (jel@uky.edu)

Balloon-1 is was a near-space experiment launched by the Kentucky Space Consortium on July 14, 2008. A payload developed by college students throughout the state of Kentucky developed the payload that was carried to 98,000 feet on a high-altitude balloon launched from Bowling Green Kentucky. This poster will describe the design, development, testing, launch and data analysis from the flight of Balloon-1.

Full Funding Acknowledgement:
KSGC, NASA EPSCoR, KSTC

Funded by: NASA

Poster # 34

KySat-1: A Test-Bed for Small Satellite Technologies

Kentucky Space Consortium (UK, Morehead, WKU, UofL, Murray, KCTCS): James Lumpp (jel@uky.edu)

KySat-1 is the first orbital satellite developed by the Kentucky Space Consortium. KySat-1 is a pico-satellite conforming to the CubeSat standard developed by university students across Kentucky. This poster will describe the design, development, testing, integration, launch and operation of KySat-1 which is expected to launch in the second quarter of 2009.

Full Funding Acknowledgement:
KSGC, NASA EPSCoR, KSTC

Funded by: NASA

Poster # 35

Space Express Mission Summary

Kentucky Space Consortium (UK, Morehead, WKU, UofL, Murray, KCTCS): James Lumpp (jel@uky.edu)

KySat Space Express was a rapid turn-around, suborbital experiment launched in December 2007. The Space Express mission was designed to help test subsystems and processes being developed for future orbital Kentucky Space missions. A primary goal of the Kentucky Space Consortium is to facilitate inexpensive and rapid access to space for small payloads. The Space Express mission was launched from the White Sands Missile Range on a Lunar Rocket and Rover Shadow 1B launch system. The space express payload consisted of telemetry package that gathered temperature, pressure, and mission time on board the rocket. The telemetry gathered onboard the rocket was transmitted to three redundant ground stations using the VHF amateur ham radio band. While the launch system suffered a failure during the boost phase, the payload functioned as designed. This poster overviews the design, development, and launch of the Space Express mission.

Full Funding Acknowledgement:
KSGC, NASA EPSCoR, KSTC

Funded by: NASA

Poster # 36

Vision-Based Fusion of Laser Data with Application in Robot Navigation

Asem Ali, Aly A. Farag, Mike Miller

University of Louisville

The generation of an accurate context sensitive labeled image is one of the most elusive aspects of the perception for autonomous mobility. In this work, we exploit multiple sensor phenomenologies and multiple visual cues to analyze a scene for a rich set of relevant environmental features over the full set of operating conditions driven by the requirements of the specific application. In particular, calibrated stereo cameras are used to reconstruct a simple 3D model for the current scene of the robot vehicle. The 3D data is used to generate a context sensitive labeled image. This image is used for the robotic vehicle to autonomously find a good path for navigation avoiding different hazards. To support the reactive autonomous navigation, an algorithm is proposed to produce an estimated position for the robot that can be successfully fed back in a navigation system. In this algorithm, we exploit the stereo pair to construct 3D patches by triangulation at each pose. Two consecutive sets of 3D patches are used with the RANSAC algorithm to estimate the rotation and translation that the stereo pair is moved by. A laser scanner which measures the shape of the environment in plane parallel to the ground is used for relative position estimation via a scan matching algorithm. An Extended Kalman filtering is used to fuse the estimated position using the scan matching algorithm and the estimated position using vision-based algorithm. The proposed method is systematic, simple and yields good results.

Full Funding Acknowledgement:
Kentucky NASA EPSCoR Program

Funded by: NASA

Poster # 37

Modeling Technology Development Risk for Space Exploration Systems

Cynthia Forgie, Ph.D., University of Southern Indiana
Gerald W. Evans, Ph.D., University of Louisville

Management of technology programs of the type undertaken by NASA is difficult for several reasons, including the large amounts of uncertainty and inherent risks associated with the costs, milestone completion dates, safety, and other performance measures. Unfortunately, mitigation of risk attributed to technology development has been frequently overlooked in scholarly research. This methodology proposes the use of discrete event simulation to aid in the planning and budgeting of long range, strategic programs.

The technology maturation life cycle is modeled in terms of sector-specific discrete development stages. Work is completed in a series of successive stages and funding is allocated separately for each stage. The duration of each stage is based on a theoretical probability distribution which was derived from an extensive literature review.

The simulation model execution begins by identifying the portfolio of desired technologies. The model samples the appropriate probability density function for each stage, yielding individual development times. Total development time for each technology is the sum of the corresponding transition times. Total development time for a portfolio of technologies is simply the longest individual technology development time. The output from the simulation model is a joint probability distribution over various performance measures of interest, including program cost, completion time and probability of program success.

The platform for the simulation model is OptQuest and Arena software. The combined functionality of these software tools creates a powerful optimization modeling tool. Furthermore, Arena software proved to be very flexible and eliminated some of the constraints exhibited by traditional program management constructs such as PERT or CPM.

Full Funding Acknowledgement:
The authors would also like to thank the Kentucky Space Grant Consortium for the financial support provided.

Funded by: NSF

Poster # 38

Simulation Based Experimental Design To Identify Factors Affecting Performance of Avs/Rs

Banu Y. Ekren and Dr. Sunderesh S. Heragu

We perform a simulation based experimental design for automated unit-load (UL) storage and retrieval systems based on autonomous vehicle technology to identify factors affecting their performance. The factors considered include: dwell point policy, the vehicle-lift combination, scheduling rule, input/output (I/O) locations and interleaving rule. In the design of experiments (DOE), three different responses, storage and retrieval transactions' average cycle time, average utilizations of vehicles and lifts, are considered. However, because the ANOVA assumptions are not met for the average cycle time response, an inverse transformation method is applied on this response. The results show that all factors have significant effects on the responses at a 95% confidence level. In addition, all two-way interaction effects are also significant except the vehicle-lift combination and scheduling rule interaction effects on the average utilization of vehicles. After determining the main and the interaction effects, a Tukey test analysis is completed on the responses.

Full Funding Acknowledgement:
National Science Foundation

Funded by: NSF

Poster # 39

Conceptualization Tools for AVSR and AS/R systems

Sunderesh S. Heragu, Xiao Cai, Ananth Krishnamurthy, Charles J. Malmborg

This online tool embeds different algorithms of two material handling technologies: autonomous vehicles storage/retrieval system (AVSRS) and automated storage/retrieval system (AS/RS) to provide warehouse designs in a real time interactive environment.

Full Funding Acknowledgement:
This work is part of the project supported by National Science Fundation