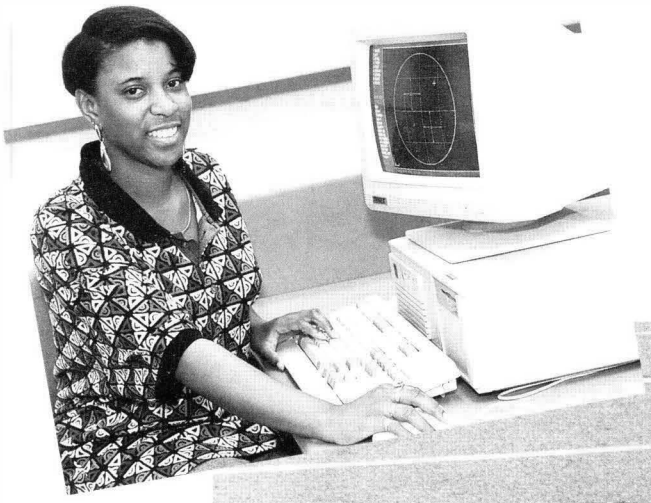
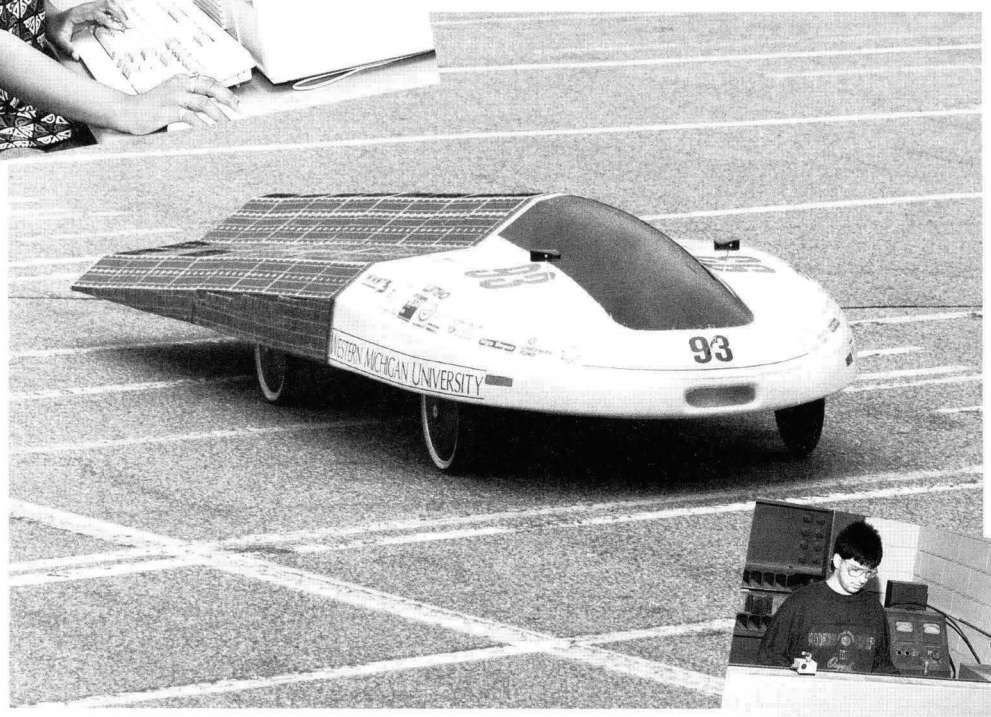
4-1995

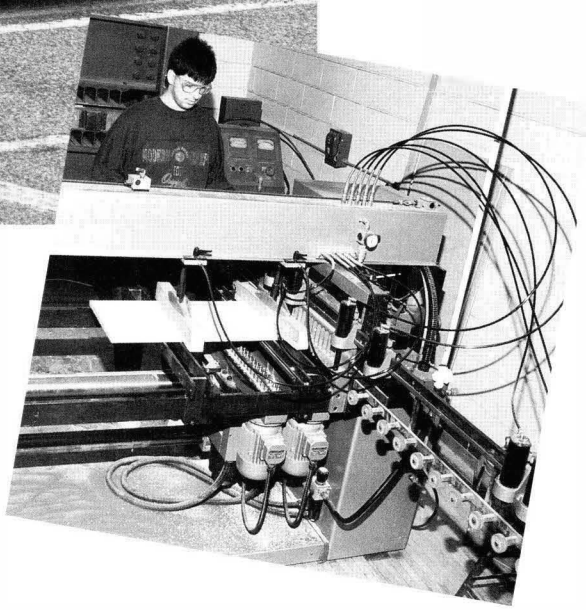
16th Conference on Senior Engineering Design Projects

College of Engineering and Applied Sciences

Conference On
Senior Engineering Design Projects







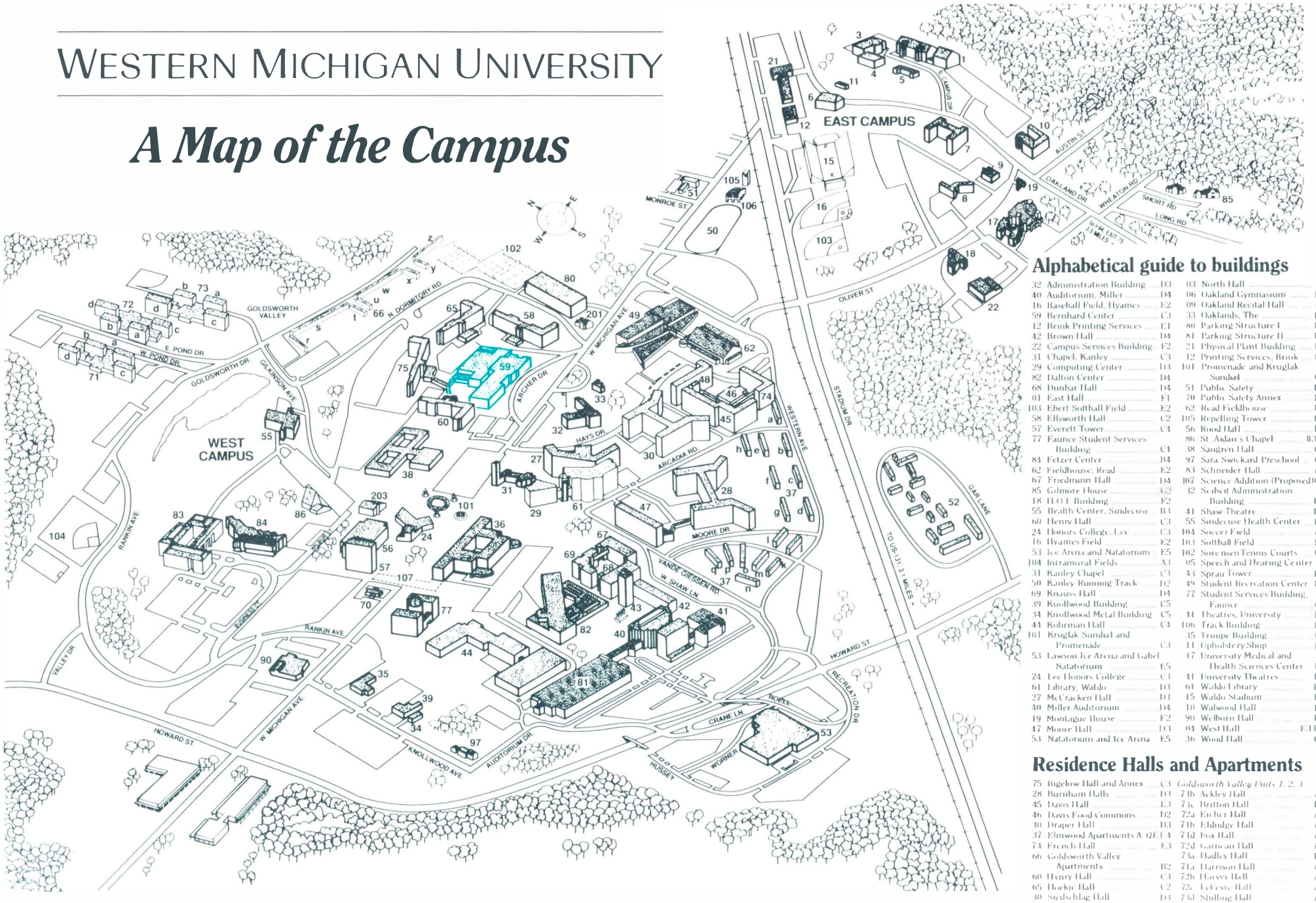
Tuesday, April 11, 1995
Bernhard Center
9 a.m. to 4 p.m.

College of Engineering and Applied Sciences

WESTERN MICHIGAN UNIVERSITY

WESTERN MICHIGAN UNIVERSITY

A Map of the Campus



Alphabetical guide to buildings

32	Administration Building	D3	
40	Auditorium, Miller	D4	
16	Baseball Field, Hyames	E2	
59	Bernhard Center	C3	
12	Brink Printing Services	E1	
42	Brown Hall	D4	
22	Campus Services Building	F2	
31	Chapel, Kanley	C3	
29	Computing Center	D3	
82	Dalton Center	D4	
68	Dunbar Hall	D4	
01	East Hall	F1	
103	Ebert Softball Field	E2	
58	Ellsworth Hall	C2	
57	Everett Tower	C4	
77	Faunce Student Services Building	C4	
84	Fetzer Center	B4	
62	Fieldhouse, Read	E2	
67	Friedmann Hall	D4	
85	Gilmore House	G3	
18	H.O.M. Building	F2	
55	Health Center, Sindecuse	B4	
60	Henry Hall	C3	
24	Honors College, Lee	C3	
16	Hyames Field	E2	
53	Ice Arena and Natatorium	E5	
104	Intramural Fields	A3	
31	Kanley Chapel	C3	
50	Kanley Running Track	D2	
69	Knauss Hall	D4	
39	Knollwood Building	C5	
34	Knollwood Metal Building	C5	
44	Kohrman Hall	C4	
101	Kruglak Sundial and Promenade	C3	
53	Lawson Ice Arena and Gabel Natatorium	E5	
24	Lee Honors College	C3	
61	Library, Waldo	D3	
27	McCracken Hall	D3	
40	Miller Auditorium	D4	
19	Montague House	F2	
47	Moore Hall	D3	
53	Natatorium and Ice Arena	E5	
03	North Hall	F1	
06	Oakland Gymnasium	E1	
09	Oakland Recital Hall	F1	
33	Oaklands, The	D3	
80	Parking Structure I	D2	
81	Parking Structure II	D5	
21	Physical Plant Building	E1	
12	Printing Services, Brink	E1	
101	Promenade and Kruglak Sundial	C3	
51	Public Safety	D1	
70	Public Safety Annex	B4	
62	Read Fieldhouse	E2	
105	Repelling Tower	D2	
56	Rood Hall	B4	
86	St. Adam's Chapel	B3 4	
38	Sangren Hall	C3	
97	Sara Switckard Preschool	C5	
83	Schneider Hall	A4	
107	Science Addition (Proposed)	C4	
42	Seibert Administration Building	D3	
41	Shaw Theatre	D4	
55	Sindecuse Health Center	B3	
104	Soccer Field	A3	
103	Softball Field	E2	
102	Sorensen Tennis Courts	C2	
05	Speech and Hearing Center	F1	
43	Sprau Tower	D4	
49	Student Recreation Center	D2	
77	Student Services Building, Faunce	C4	
41	Theatres, University	D4	
106	Track Building	D2	
35	Trimpe Building	B4	
11	Upholstery Shop	E1	
17	University Medical and Health Sciences Center	F2	
41	University Theatres	D4	
61	Waldo Library	D3	
15	Waldo Stadium	E1	
10	Walwood Hall	F1	
90	Welborn Hall	B4	
04	West Hall	E1 D1	
36	Wood Hall	C4	

Residence Halls and Apartments

75	Bigelow Hall and Annex	C3	*Goldsworth Valley Units 1, 2, 3*
28	Burnham Halls	D3	
45	Davis Hall	E3	
46	Davis Food Commons	D2	
30	Draper Hall	D3	
37	Elmwood Apartments A, QE	E3 4	
74	French Hall	E3	
66	Goldsworth Valley Apartments	B2	
60	Henry Hall	C3	
65	Hoekje Hall	C2	
30	Siedschlag Hall	D3	
8	Spindler Hall	F2	
32	Stadium Drive Apartments	F3	
7	Vandercook Hall	F1	
48	Zimmerman Hall	D3	
74b	Ackley Hall	A2	
74c	Britton Hall	B2	
72a	Eicher Hall	A2	
74b	Eldridge Hall	A2	
74d	Fox Hall	A2	
72d	Garneau Hall	A2	
74a	Hadley Hall	B2	
71a	Harrison Hall	A2	
72b	Harvey Hall	A2	
72c	LeFevre Hall	A2	
74d	Shilling Hall	A2	
71c	Sturgeon Hall	A2	

Private Property

201	Lutheran Student Center	B2 3
203	Wesley Foundation	B3 4

Conference on Senior Engineering Design Projects

You are invited to attend the sixteenth Conference on Senior Engineering Design Projects. The conference will be held from 9 a.m. to 4 p.m. **Tuesday, April 11**, at the Bernhard Center on the campus of Western Michigan University.

The College of Engineering and Applied Sciences sponsors the conference to showcase the work of its graduating seniors, who are required to complete a capstone project that puts into practice what they have learned. Many of the projects are sponsored by business and industry.

The conference is **free** and open to the public. You are welcome to attend all or part of the day's events. Reservations are not necessary.

High school and community college teachers are encouraged to bring students to the conference. Buses can drop off passengers in the circular drive in front of the Bernhard Center and then park in the lot in front of Hoekje Hall. (See map; take North Dormitory Road. Hoekje is #65 on the map.)

Teachers who cannot accompany their students to the conference may ask their students to sign in and out at the information table in the lobby on the second floor of the Bernhard Center. Sign-in sheets will be mailed to teachers the day after the conference.

Parking is available in the ramp near the Bernhard Center.

Presentations begin on the hour and half hour. Please do not enter a room after a presentation has begun.

Session locations, starting times, and page numbers for project descriptions:

Electrical and Computer Engineering	210	9 to 1:30	p. 5
Engineering Technology	209	9 to 4	p. 8
Industrial Engineering	204	9 to 10:30	p. 12
Mechanical and Aeronautical Engineering - A	208	9 to 2:30	p. 14
Mechanical and Aeronautical Engineering - B	242	9 to 2:30	p. 17
Mechanical and Aeronautical Engineering - C	213	9 to 2:30	p. 21
Paper Science and Engineering - A	211	9 to 4.	p. 24
Paper Science and Engineering - B	212	9 to 3	p. 29
Paper Science and Engineering - C	204	1 to 2:30	p. 33

A **lunch** break is scheduled from noon to 1 p.m.

For more information, call Linda Hager at (616) 387-4017.

EE = Electrical and Computer Engineering
ET = Engineering Technology
IE = Industrial Engineering
MAE = Mechanical and Aeronautical Engineering
PSE = Paper Science and Engineering

Time	Room	Dept.	Topic
9	210	EE	Power Distribution Monitoring Network
	209	ET	Magnesium Mower Deck
	204	IE	The Goal ... Reduce Lead Time
	208	MAE-A	Re-design of a Retaining Clip
	242	MAE-B	Drag Reduction by Thermal Excitation
	213	MAE-C	Design of a Jaw System for a Laparoscopic Instrument
	211	PSE-A	Curing Effects of Coated Paper on Water Resistance
	212	PSE-B	Strength Effects of Saturating Paper Containing Synthetic Fiber
9:30	210	EE	Potentiometer Tester for Climate Control Systems
	209	ET	Handibow Crossbow
	204	IE	Improving a Metal Fabrication Machining Center
	208	MAE-A	Re-design of a Belt-driven Conveyor Drive
	242	MAE-B	Sun-tracking Solar Array Stand
	213	MAE-C	Design of a Vibration Excitation Device
	211	PSE-A	Effect of Light Exposure on Sizing Response
	212	PSE-B	Effects of Calcium Carbonate in the Coating Color
10	210	EE	Microprocessor-based Temperature Monitor
	209	ET	Solving Data Transfer Problems
	204	IE	Tool Tracking and Storage Design
	208	MAE-A	Experimental Verification of an Improved Water Tower Design
	242	MAE-B	Analysis of Stability and Control for a Competition Aircraft
	213	MAE-C	Water Spray Cooling of a Heated Copper Surface
	211	PSE-A	Effect of Retention Aids on AKD Size Response
	212	PSE-B	Effect of Wet Pressing on Migration of Sizing
10:30	210	EE	Induction Motor Speed Controller
	209	ET	Optimum Machining Parameters for Hard to Machine Materials
	204	IE	Analysis and Re-design of Oil Suction Tube Production Area
	208	MAE-A	Photovoltaic Array Support for Sunseeker 95
	242	MAE-B	Suspension Design for a High-performance Race Vehicle
	213	MAE-C	Central Tire Inflation for Wheel-end Design
	211	PSE-A	Effluent Characterization in Dioxirane Bleaching
	212	PSE-B	Powdered Activated Carbon for Color Removal

11	210	EE	Hydraulic Control Training Module
	209	ET	Diffusion Bonding During a Carburizing Process
	208	MAE-A	Design of a High Lift Wing for a Remotely Piloted Vehicle
	242	MAE-B	Design of an Accessory Drive System
	213	MAE-C	Four-ball Lubricant Test System
	211	PSE-A	Full Sequence Bleaching with Dimethyldioxirane
	212	PSE-B	Effect of a Serrated Slice on Paper Formation
11:30	210	EE	High Fidelity Stereo Audio System
	209	ET	Re-design of Patient Overbed Table
	208	MAE-A	Design of a Tissue-Measuring Gauge
	242	MAE-B	Analysis of Pneumatic Cylinder Deflection
	213	MAE-C	Computational Fluid Dynamic Analyses of a Fuselage Design
	211	PSE-A	Effluent Color Removal by Dimethyldioxirane
	212	PSE-B	Effect of Repeated Recycling on Surface Characteristics

NOON TO 1 - LUNCH BREAK

1	210	EE	Audio Interface for a Personal Azimuth Sensor
	209	ET	Propulsion Unit for a Zero Emission Vehicle
	242	MAE-B	Scissor Test for an Endoscopic Ligating Clip Applier
	213	MAE-C	Automatic Dumping Mechanism
	211	PSE-A	Optimization of a Dioxirane Pulp-bleaching Stage
	212	PSE-B	Effect of Moisture Content on Sizing
	204	PSE-C	Effect of Black Liquor Carryover on Bleach Plant Effluent
1:30	210	EE	Driver Display Module
	209	ET	Compounding Glass With a Single Screw Extruder
	208	MAE-A	Scraper Blade Cylinder Mount Re-design
	242	MAE-B	Friction Torque-testing Device for Journal Bearings
	213	MAE-C	Drivetrain for a Solar Vehicle
	211	PSE-A	Estimation of Dryer Heat Transfer Coefficients
	212	PSE-B	Alcell Process Waste Behavior Study
	204	PSE-C	Effect of Atmospheric Ozone on Paper Strength
2	209	ET	CAD/CAM Database Creation From a Scanned Image
	208	MAE-A	Design of a Bowling Ball
	242	MAE-B	Drag Analysis of Virtual Winglet
	213	MAE-C	Test Fixture and Pressure Applicator Design
	211	PSE-A	Hiding Power of Various Coating Formulations
	212	PSE-B	Wet Strength Resin Analysis
	204	PSE-C	Use of Plastics as Ink Collectors During Deinking

2:30	209	ET	Shock-absorbing Unit for a Snow Plow
	208	MAE-A	Landing Gear Design for a Remotely Piloted Vehicle
	242	MAE-B	High-performance Automotive Radiator Fan
	213	MAE-C	Control System for Hybrid Electric Vehicle
	211	PSE-A	Coating Weight Estimates on a Cylindrical Laboratory Coater
	212	PSE-B	Effect of Drying Delay Time on Paper Coatings
	204	PSE-C	Identification of Stickies by Infrared Detection
3	209	ET	Gearing a Wheelchair for Better Propulsion
	211	PSE-A	Fiber- and Water-borne Chemical Contaminants
	212	PSE-B	Magnesium Oxide as a Coating Pigment
3:30	209	ET	Motorized Chair Lift for Scooters
	211	PSE-A	Contaminants' Effect on Sizing of Recycled Office Paper
4	209	ET	Portable Video Mini-Disc Recording System
	211	PSE-A	Comparison of Kraft and Chemithermomechanical Fluff Pulps

ELECTRICAL AND COMPUTER ENGINEERING

Session Chair - John Gesink
Room 210

POWER DISTRIBUTION MONITORING NETWORK

by John Deising, Anil George, and Dipak Patel
Sponsor: Kraft Foods (USA), Post Division
Technical Advisor: Brian Cronk
Faculty Advisor: Garrison Greenwood
9 to 9:25 a.m., Room 210

A major manufacturing facility uses about 75 million kilowatts of electricity annually. The tasks of power distribution monitoring, consumption monitoring, and maintaining the distribution equipment are carried out manually. System specifications were developed for a power distribution monitoring network that automates the process of distribution system data collection and provides real-time system monitoring and control options. The core components of the network include a group of microprocessor-based field monitoring devices, network interface cards, and a remote monitoring station.

POTENTIOMETER TESTER FOR CLIMATE CONTROL SYSTEMS

by Paul Leek, Tim Mrosewske, and Rob Sherwood
Sponsor: Craig Leek - Ford Motor Company
Faculty Advisor: Janos Grantner
9:30 to 9:55 a.m., Room 210

The potentiometer tester for climate control systems developed from the need to check existing potentiometers that control the climate in certain vehicles. Defective or incorrect potentiometers were sometimes being installed, and the manufacturer had no simple or inexpensive way to prevent the problem. A tester was designed and built to check suspicious potentiometers. The tests include a check for continuity and the type of vehicle the potentiometer comes from. The testing unit also plots a graph of the potentiometer's resistive characteristics.

MICROPROCESSOR-BASED TEMPERATURE MONITOR

by Dwayne Bontrager, David Gilbert, and Anthony Lim
Sponsors: Jim Brewer, James Gillis, and Larry Davis - Dow Chemical Company
Faculty Advisor: Garrison Greenwood
10 to 10:25 a.m., Room 210

A chemical company needs to monitor the temperatures of liquids and gases during the manufacturing process. The current design uses analog processing to determine temperature measured with a resistive temperature detector (RTD. To achieve greater accuracy and resolution, a digital temperature monitor was built. Processing capabilities are handled by a Motorola 68HC11 microprocessor. The output of the system is a voltage that is dependent on the temperature measured by the RTD. The output is fed into a data processing system.

INDUCTION MOTOR SPEED CONTROLLER

by Sygn Benibo and Ng En Lin
Faculty Advisor: Dean Johnson
10:30 to 10:55 a.m., Room 210

An induction motor speed controller has been designed and built that provides a low-cost method for varying the speed of fractional horsepower induction motors (FHIM) such as are found in fans. The FHIM speed controller is a portable unit that plugs directly into a 115V AC power outlet. It consists of a receptacle for the motor power connector and a knob that sweeps through a semicircle for continuous adjustment of motor speed. The lowest and highest settings of the FHIM speed controller correspond to half and twice the speed of the motor with the controller.

HYDRAULIC CONTROL TRAINING MODULE

by Richard Brown, Timothy Hale, Wai Tak Lam, and Kristin Peck
Sponsors: John Styf and Carlyle Brown - Allied Signal Automotive
Faculty Advisor: Frank Severance
11 to 11:25 a.m., Room 210

Allied Signal Automotive needs a hydraulic control training module for its hydraulic machine operators. A unit was designed, built, and tested that includes a motor, pump, four valves, two cylinders, and limit switches. A programmable logic controller regulates the system, which provides several methods of machine-to-operator interaction as well as computer controls to simulate a fully automated system. The system is designed for manual control using an instructional handbook or for automatic control by means of a computer program. An instructor can use either method to demonstrate various forms of hydraulic machine control.

HIGH FIDELITY STEREO AUDIO SYSTEM

by John Lentz and Angel Martinez-Garrido
Sponsor: Greg Fitzgerald - WMU's Harper C. Maybee Music and Dance Library
Faculty Advisor: Dean Johnson
11:30 to 11:55 a.m., Room 210

A high fidelity stereo audio system was designed and built to update the listening equipment in the Dorothy U. Dalton Center. The system will support three different audio inputs: CD player, phonograph, and tape player. The user can adjust the response of up to nine different frequency bands, and volume can be controlled. The electronic design ensures high signal-to-noise ratio and very low distortion.

AUDIO INTERFACE FOR A PERSONAL AZIMUTH SENSOR

by Constantinos Parpas, Kevin Stephens, and Tuan Hwee Tan
Faculty Advisor: John Gesink
1 to 1:25 p.m., Room 210

Visually impaired persons may veer to the left or right when attempting to walk in a straight line. An existing training device has been shown to be effective in reducing this veering. This device, worn by the trainee, senses his/her veering. To program the device for a particular training routine, the user must enter as many as 15 different pieces of information. The device must confirm these entries and must also provide the user with feedback on training task performance. To simplify communication between the device and the user, an audio prompt system was designed and incorporated into the training device. The system uses electronically stored speech, a telephone-style keypad, a speaker, and a micro-controller. The system uses spoken messages to prompt the user for keypad input, to confirm keypad entries, and to provide feedback on the amount of veering.

DRIVER DISPLAY MODULE

by Kok Yuen Chong, Sin Giap Lim, and Luen Seng Wan
Sponsors: Bruce Vincent and Warren Dedow - Eaton Corporation
Faculty Advisor: Richard Taylor
1:30 to 1:55 p.m., Room 210

Every gear lever position of a semi-automatic transmission of a heavy-duty vehicle has two gears. The purpose of the Driver Display Module is to indicate to the driver of the heavy-duty vehicle which gear is engaged and the next available gear. The DDM consists of a microcontroller, Control Area Network chip, a power supply, and indicator lights. The microcontroller and CAN chip allow the DDM to communicate with a parent unit and show the results by illuminating the indicator lights. Different colors indicate the current and available gear. The project involved the specification, design, development, and testing of the reliability and performance of the device.

ENGINEERING TECHNOLOGY

Session Chair - Sam Ramrattan
Room 209

MAGNESIUM MOWER DECK

by Aric Boyer, John Mamuscia, and Scott Peters
Sponsor: Fred Veresch - Pinnacle Landscaping, Inc.
Faculty Advisor: Charles Woodward
9 to 9:25 a.m., Room 209

An existing commercial mower was re-designed so the original steel mower deck was replaced with a magnesium deck. Properties and characteristics of magnesium were researched and evaluated to reduce or eliminate any limitations or problems. Weight of the mower deck was reduced to one fourth the original weight. Maneuverabiity was increased by providing the operator a lighter, more controllable mower. Vibration was also reduced, in part by the vibration-dampening characteristic of magnesium.

HANDIBOW CROSSBOW

by Ron Armock, Todd Joynt, and Ken Popp
Sponsors: Pat Mitchell - Proline, and Ted Brooks - Ted Brooks Archery
Faculty Advisor: Charles Woodward
9:30 to 9:55 a.m., Room 209

A Michigan law that became effective in 1993 allows a person to hunt with a crossbow if that person has a proven disability that prevents bowhunting. Crossbow hunting requires a great deal of force to cock the bow-string into firing position. A universal crossbow cocking device and a crossbow containing a built-in cocking device were designed, built, and evaluated to solve the problem.

SOLVING DATA TRANSFER PROBLEMS

by John Baibak, Ken Ladd, and Ken Rowley II
Faculty Advisor: Michael B. Atkins
10 to 10:25 a.m., Room 209

Differences in data format of the many CAD/CAM systems used in industry have presented problems in data transfer. Direct and indirect data transfer systems have been developed; unfortunately, the transfer systems themselves have problems. A study was conducted to find solutions to the data transfer problems encountered. Results were reported in a Data Transfer User's Guide.

OPTIMUM MACHINING PARAMETERS FOR HARD TO MACHINE MATERIALS

by James Benson, Aaron Denbow, and Abrheasion Melake
Sponsors: Philip Combes and Michelle Boyle - General Motors Powertrain
Faculty Advisors: Mahesh Nallakatla and Sam Ramrattan
10:30 to 10:55 a.m., Room 209

A major problem that manufacturing industries must deal with during the machining operation of boring is "chatter." Chatter occurs when the inside surface of the hole is not even and the cutting tool vibrates excessively, making it necessary to machine at different speeds. The best cutting speeds were determined for machining hard-to-machine materials so that chatter will not occur. A tool dampening device was tested that all but eliminated the chatter, allowing for much higher cutting speeds and feeds.

DIFFUSION BONDING DURING A CARBURIZING PROCESS

by Joy Finnila, Ray Thompson, and Ryan Trzybinski
Sponsors: Ralph Larson - Eaton TCONA, and Joe Flanagan - American Axle & Manufacturing, Inc., Three Rivers Propshaft Facility
Faculty Advisor: Sam Ramrattan
11 to 11:25 a.m., Room 209

Eaton TCONA produces an auxiliary mainshaft for their transmissions that uses welding to join a shaft to a gear. The gear is carburized to obtain specific improvements in areas such as surface hardness and mechanical properties. Diffiusion bonding is the joining of two metals using heat and applied pressure. The main objective of this study is to create a bond between two steel parts using copper as the bonding medium. The bonding will be attempted during the carburizing cycle of the auxiliary mainshaft. By diffusion bonding during this carburization process, the welding step in the overall production cycle could be eliminated. This would reduce the number of steps necessary to produce the auxiliary mainshaft, therefore reducing the total cost of the component.

RE-DESIGN OF PATIENT OVERBED TABLE

by David Abdella, Brian Dykeme, and Steve Hoogendyk
Sponsors: Steve Meier and Joseph Wentzlof- Stryker Patient Care
Faculty Advisor: Dmitry Azrikan
11:30 to 11:55 a.m., Room 209

Overbed tables are found in every hospital across the country. They provide the patient with both storage and personal space. They are the center of many activities, including eating, reading, and writing. Previous designs lacked user-friendliness, suitable adjustment range, and ergonomic styling. The existing overbed table was re-designed after intensive field research. Personal interviews and questionnaires helped to generate an interactive design that incorporates knowledge from both patients and medical staff. The new design reflects the trend of cutting edge patient care products.

PROPULSION UNIT FOR A ZERO EMISSION VEHICLE

by Mike Cromwell, Kelly Petrillo, and Scott Wawrzyniak
Faculty Advisor: Vladimir Tsukruk
1 to 1:25 p.m., Room 209

The group constructed a propulsion unit which uses the principles of flywheel technology to convert and store electrical energy into kinetic energy that can be used in the form of mechanical energy. Batteries are used to power water pumps which supply water to injectors. The injectors provide streams of water which are directed at fins inside the perimeter of the flywheel. As the flywheel spins the water is trapped in the perimeter of the flywheel thereby increasing the weight of the flywheel, which increases its energy storage capacity. Through mechanical linkages the stored energy can be used to drive small vehicles.

COMPOUNDING GLASS WITH A SINGLE SCREW EXTRUDER

by Mike Collins, Marc Nelson, and Jennifer Woodruff
Sponsors: Robert Morgan - Robert Morgan & Company, Inc., and Ray Meeker - Thermofil Inc.
Faculty Advisor: Paul Engelmann
1:30 to 1:55 p.m., Room 209

The addition of glass reinforcement to extruded material is widely utilized in industry because it increases product strength. An additive feeder was designed and constructed for use in delivering glass fibers into the plastic stream at the end of a single screw extruder barrel to make the production of reinforced plastics possible within the Western Michigan University Plastics Processing Laboratory. The reinforced plastics were then tested for tensile strength. The team then evaluated the single screw compounding process to detect if further changes in machinery were necessary to improve the system.

CAD/CAM DATABASE CREATION FROM A SCANNED IMAGE

by Timothy J. Hicks, Eric J. Maichele, and Craig S. Netemeyer
Sponsor: Frank Lucatelli - Software Ventures
Faculty Advisors: Michael B. Atkins and Ralph Tanner
2 to 2:25 p.m., Room 209

With the development of computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-numerical control (CNC) in the engineering profession, there have been many great strides in productivity. The problem lies in further developing the abilities to link these technologies in a more efficient manner. Advancements in image scanning and raster-to-vector conversion technologies have brought about an opportunity to further unite CAD and CAM processes for manufacturing.

SHOCK-ABSORBING UNIT FOR A SNOW PLOW

by Tony Herman, Mike Owens, and Shawn Welch
Faculty Advisor: Charles Woodward
2:30 to 2:55 p.m., Room 209

Snow plows attached to personal vehicles are mounted directly to the vehicle's frame; any impact on the blade is transferred directly to the frame. Front-mounting a snow plow voids the vehicle's warranty and drastically reduces the life of the vehicle. A shock-absorbing unit was developed to reduce the forces transmitted to the vehicle's frame.

GEARING A WHEELCHAIR FOR BETTER PROPULSION

by Ana Fontes, Fred Mueller, and Vishnu Rajasingam
Faculty Advisor: Dmitry Azrikan
3 to 3:25 p.m., Room 209

To make it easier for a handicapped person to negotiate ramps and steep inclines, three-speed bicycle hubs were attached to the wheels so that speed ratios can be varied as needed. A single caster was incorporated to allow for tighter turning and a clean and uncomplicated design. A working prototype was built, tested, and evaluated for efficiency. A focus group of wheelchair users was consulted frequently.

MOTORIZED CHAIR LIFT FOR SCOOTERS

by Mary Ann Kay, Lisa Michele Langwell, and Mior Zaharin Mior
Faculty Advisor: Charles Woodward
3:30 to 3:55 p.m., Room 209

A lifting system was designed for motorized scooters such as those used by the disabled at grocery stores. Individuals using the existing scooter have difficulty reaching the upper shelves in stores. The lifting system would raise the seat of the scooter approximately 18 inches in order to solve this problem. Three systems were evaluated during the design stages of the project, and a single mechanical system was decided upon. A computer analysis was used to test the system, and a working prototype was created.

PORTABLE VIDEO MINI-DISC RECORDING SYSTEM

by Kevin Grinnell, Phil Hall, and Karen Wann
Faculty Advisors: Dmitry Azrikan and Charles Woodward
4 to 4:25 p.m., Room 209

A more user friendly camcorder was designed that reduces battery consumption and records on fast access, high-quality digital recording media. Using a mini-disk instead of tape allows fast on-the-spot editing, low energy consumption, and enhanced recording capability. A new shape was designed to replace the present boxy camcorder. Weight reduction was accomplished by use of smaller batteries. Human factors tests were conducted with novice and professional users.

INDUSTRIAL ENGINEERING

Session Chair - Larry Mallak
Room 204

THE GOAL ... REDUCE LEAD TIME

by Aimee Thorsberg, Omprakash Voruganti, Jim Woodard, and Terri Worthey
Sponsors: Toby Dobrzelewski and Bart Shaw - TruHeat Corporation
Faculty Advisor: Larry Mallak
9 to 9:25 a.m., Room 204

A manufacturer of electrical heating elements was shipping 75-80% of its orders on time. All aspects of the job shop manufacturing environment were examined; late shipments were attributed to long manufacturing lead times. Techniques to reduce lead time were analyzed and evaluated for their value in increasing on-time shipment. Operations were analyzed and recommendations offered for areas with the greatest improvement potential.

IMPROVING A METAL FABRICATION MACHINING CENTER

by Benjamin McMahon, John L. Wright III, Mark Lee, Robert J. DeRose, and William F. Clarke III
Sponsors: Biju Suseelan, Mark Anderson, Kal Kalkowski, and Dave Benedict - Aero-Motive Company
Faculty Advisor: Larry Mallak
9:30 to 9:55 a.m., Room 204

A local manufacturer was experiencing low productivity and long lead times in its machining center. Using time study analysis, plant layout techniques, simulation software, and quick set-up technology, the existing machining center layout was improved to achieve higher productivity. Changes were recommended to shorten lead time.

TOOL TRACKING AND STORAGE DESIGN

by Paola Alvarez, Diamond Simpson, Kuo Chuan Sun, and Scott Woodin
Sponsor: Darrell Trent - Triple S Plastics Inc.
Faculty Advisor: Larry Mallak
10 to 10:25 a.m., Room 204

A tool tracking and storage system was designed for a local plastics company. The system reduces set-up time and built-in hindrances to material flow, and eliminates disorganized and inefficient cube storage, confusion at the dock, and lack of standardization. An analysis of material flow and storage was completed to identify main factors involved in effective material handling.

ANALYSIS AND RE-DESIGN OF OIL SUCTION TUBE PRODUCTION AREA

by Mark Emeott, Rosanne Forgione, Matt Lytle, and Earl Moore
Sponsors: Eric J. Giese, Timothy M. Schaab, and Bruce Gillig - Benteler Industries, Inc.
Faculty Advisor: Larry Mallak
10:30 to 10:55 a.m., Room 204

A manufacturer of automotive parts using a Just-In-Time system had opportunities for improvement in the product flow and layout of their oil suction tube line. All relevant production processes were analyzed with the primary goal of cost reduction. Non-value-added operations were eliminated, and alternative production layouts were developed.

MECHANICAL AND AERONAUTICAL ENGINEERING - A

Session Chair - Dennis VandenBrink
Room 208

RE-DESIGN OF A RETAINING CLIP

by Daniel J. Armock and Micheal B. Large
Sponsor: Roger Veldman and Karen Powell - Donnelly Corporation
Faculty Advisor: Dennis VandenBrink
9 to 9:25 a.m., Room 208

A leading supplier of automotive parts produces rear view mirror assemblies with a breakaway feature that contains a retaining clip to lock the mirror assembly in place. During assembly the retaining clip is being permanently deformed. Finite element software was used to determine high stress areas within the retaining clip. The software was used in conjunction with a parametric study to re-design the retaining clip with optimum dimensions to eliminate deformation. Computer-generated results were compared with experimental results for validity.

RE-DESIGN OF A BELT-DRIVEN CONVEYOR DRIVE

by Lee Black and Chad Pung
Sponsors: Phil Schaafsma, Ricardo Schiesser, and Thomas Pelak - Rapistan Demag Corporation
Faculty Advisor: Dennis VandenBrink
9:30 to 9:55 a.m., Room 208

A current conveyor design is limited to a length of 200 feet by the strength of the belt. A conveyor with a length of 300 feet is desirable. It is required to use the same belt to avoid the cost of re-designing related components. Three design alternatives are presented that extend the length of the conveyor while using a limited number of new components. The designs were developed to meet the design requirements inexpensively. One alternative has been chosen for implementation.

EXPERIMENTAL VERIFICATION OF AN IMPROVED WATER TOWER DESIGN

by Skip Herold and Norm Rezmer
Faculty Advisors: Meshulam Groper and Keyu Li
10 to 10:25 a.m., Room 208

Water towers are essentially vertical bars subjected simultaneously to axial and lateral loadings. The water's weight is the axial loading, while the wind acts horizontally on the water tank. An improved design for a tower's support was considered, consisting of a two portion bar (beam column) with the lower portion having a larger flexural rigidity, because in the case of a beam-column with constant cross-section, failure occurs at the base of the structure. An analytical solution to the two portion beam-column was recently derived by faculty in the Department of Mechanical and Aeronautical Engineering at Western Michigan University. Experimental analysis was performed within this project to obtain data for the derived analytical solution.

PHOTOVOLTAIC ARRAY SUPPORT FOR SUNSEEKER 95

by Richard E. Costello and Niels F. Moreno
Faculty Advisor: Dennis VandenBrink
10:30 to 10:55 a.m., Room 208

A lightweight structure was designed to support the photovoltaic array of the WMU solar-powered car that will compete in Sunrayce 95. A support is necessary to hold the solar panels in the shape of the vehicle's body. The design adheres to race regulations and is lighter that the array support used in the previous solar car. It provides greater reliability and easier handling and maintenance.

DESIGN OF A HIGH LIFT WING FOR A REMOTELY PILOTED VEHICLE

by David W. Fanjoy and Paul M. Klahn
Faculty Advisor: Parviz Merati
11 to 11:25 a.m., Room 208

A wing was designed for a remotely piloted vehicle to be flown in an inter-collegiate competition. Design requirements were to maximize lift and minimize drag. Two critical aspects of a high-lift wing were considered: the airfoil shape and wing configuration. After researching modern airfoils, a number were selected for further analysis. These airfoils were analyzed with computer simulation codes, and slight modifications were made to increase performance characteristics. The best airfoil was then modeled and tested in a water tunnel using a five-component electronic balance system to obtain precise experimental data. With the research and testing completed, the wing configuration was designed. Structure and materials were chosen such that the wing was structurally sound. Wingspan, chord, and wingtip shape were designed to optimize the efficiency of the wing.

DESIGN OF A TISSUE-MEASURING GAUGE

by John Ellis and Scott Weisgerber
Sponsor: Lars R. Chrisman - Richard-Allan Medical Industries, Inc.
Faculty Advisor: James Kamman
11:30 to 11:55 a.m., Room 208

During surgery that involves internal endoscopic stapling, the surgeon needs an instrument that can indicate the correct size staple to be used. The tissue-measuring gauge is a disposable surgical instrument that measures the thickness and compressibility of tissue before application of surgical staples. The gauge's purpose is to indicate whether a 2.5 mm staple or a 3.5 mm staple is suitable to ensure proper closure of an incision.

SCRAPER BLADE CYLINDER MOUNT RE-DESIGN

by John Barnes and Matt Slocum
Sponsor: Robert Slocum - Barry County Road Commission
Faculty Advisor: James Kamman
1:30 to 1:55 p.m., Room 208

A problem has been found with the scraper trucks used for snow removal and grading. When the scraper blade strikes an immovable object on the top portion of the blade, the hydraulic piston rod that is extended is damaged. A cylinder mount was designed that can take the force and distribute it so the equipment is not damaged. The new equipment can be reset in the field, and operation can continue. The new design is easily integrated with the existing equipment.

DESIGN OF A BOWLING BALL

by Chong Bin Wong and Cuong Van Kim
Sponsor: John F. Timberlake - AZON USA, Inc.
Faculty Advisor: John Ward
2 to 2:25 p.m., Room 208

A bowling ball was designed to provide consistency and predictability of reaction and a high probability of strikes. The most important factors affecting performance of the bowling ball are the configuration of the core and the material of the ball. Equations were derived and solved to express the ball's path from its beginning on the bowling lane to its striking the pins. The solutions defined the ideal dimensions and geometry of the core and the best material for the core and outer shell.

LANDING GEAR DESIGN FOR A REMOTELY PILOTED VEHICLE

by Douglas Drew and Brian McKay
Faculty Advisor: John Ward
2:30 to 2:55 p.m., Room 208

The Society of Automotive Engineers sponsors an annual competition to find the best student-designed high-payload, radio-controlled aircraft.This project focused on the landing gear of the aircraft being designed for the competition by a team of students from Western Michigan University. Scaled-down designs from actual cargo aircraft were considered, but they proved too heavy. Several new designs were evaluated based on theory and computational methods. The most favorable design was tested using finite element analysis and will be used on the airplane.

MECHANICAL AND AERONAUTICAL ENGINEERING - B

Session Chair - Judah Ari-Gur
Room 242

DRAG REDUCTION BY THERMAL EXCITATION

by Eric Langnes and Chad Stachnik
Faculty Advisor: Parviz Merati
9 to 9:25 a.m., Room 242

An experimental device was constructed to observe turbulent boundary flow over a flat plate in Western Michigan University's water tunnel. Experimental drag reduction using thermal energy was examined. Drag reduction has the potential to save fuel. Laser Doppler velocimetry was used to quantitatively measure the velocity profiles in the boundary layer with and without the effects of the thermal energy. Fluid flow visualization was used to qualitatively illustrate and compare the laminar and turbulent boundary layer phenomena.

SUN-TRACKING SOLAR ARRAY STAND

by John Lester and Kirk Thomas
Faculty Advisor: Jerry Hamelink
9:30 to 9:55 a.m., Room 242

Photovoltaic cells are used to convert the sun's rays into DC electrical energy. To maximize the energy conversion, the photovoltaic cell panel must be perpendicular to the sun's rays. The WMU solar car team that will compete in Sunrayce 95 must recharge the car's battery supply after each day's competition. The stand to hold the solar panel was equipped with a positive tracking system that adjust the array's position to optimize the battery charging. Analysis using computer software aided in the design of a stand that is lightweight and strong.

ANALYSIS OF STABILITY AND CONTROL FOR A COMPETITION AIRCRAFT

by William T. Hyde and Paul A. Kowalski
Faculty Advisor: Judah Ari-Gur
10 to 10:25 a.m., Room 242

A team from Western Michigan University will enter a remotely piloted vehicle in an international competition where the aircraft is required to carry the heaviest cargo for a specified powerplant and takeoff distance. To maximize performance, aircraft stability was analyzed. The analysis determined placement of the required cargo box, location of the wing, and size, placement, and range of motion of the control surfaces, including ailerons, flaps, and vertical and horizontal stabilizers.

SUSPENSION DESIGN FOR A HIGH-PERFORMANCE RACE VEHICLE

by Bart E. Cann
Faculty Advisor: Richard Hathaway
10:30 to 10:55 a.m., Room 242

An improved suspension was designed and constructed to allow an increased number of adjustments and cleaner aerodynamic packaging for a high-performance race vehicle. Kinematic software and finite element analysis programs were used to verify geometric design and structural integrity. Laboratory experimentation and extensive field testing and evaluation proved that the design meets or exceeds all performance and safety requirements.

DESIGN OF AN ACCESSORY DRIVE SYSTEM

by Carrie L. Grimard, Annette M. Martin, and Roy Masters
Sponsor: John Cerone - Torque Engineering Corporation
Faculty Advisor: Judah Ari-Gur
11 to 11:25 a.m., Room 242

A mechanical drive system was designed using belts, pulleys, and standard gears to replace an existing system that consisted of expensive, custom-made gear mechanisms. The system, driven by the crankshaft, drives the accessories (oil pump, water pump, etc.) on a 12-cylinder gasoline engine.

ANALYSIS OF PNEUMATIC CYLINDER DEFLECTION

by Jeff Converse and Steve Mohney
Sponsor: Craig Whetham - Humphrey Products
Faculty Advisors: Judah Ari-Gur and Ralph Tanner
11:30 to 11:55 a.m., Room 242

A local manufacturer of pneumatic components planned to install a machining cell for a new line of twin-bore actuators. One key to the success of the cell was the design of the work-holding fixtures for the actuator housings (referred to as cylinder barrels). The cylinder barrels are made from aluminum extrusions that require minimum distortion during the clamping and machining process. Finite element analysis was used to evaluate deflection of the cylinder barrel geometry under a series of clamping conditions. Fixture design specifications were developed outlining optimum clamping locations and maximum allowable clamping forces. Analytical predictions were verified experimentally.

SCISSOR TEST FOR AN ENDOSCOPIC LIGATING CLIP APPLIER

by Matthew G. Barnhart and Mark E. Zyzelewski
Sponsor: Mike Zamora - Richard-Allan Medical Industries, Inc.
Faculty Advisor: Judah Ari-Gur
1 to 1:25 p.m., Room 242

An endoscopic ligating clip applier is used in laparoscopic surgery to clamp or close off vessels or ducts. The quality of each lot of clip appliers must be tested to determine if it is suitable for shipping and usage. Previously the testing procedure involved extensive human control of the clip applier, which led to variability in the results. To provide more accurate and consistent results, we designed, built, and verified a scissor-testing mechanism that eliminates the human control and associated error during testing.

FRICTION TORQUE-TESTING DEVICE FOR JOURNAL BEARINGS

by Marc Heinzman and Curt Johnson
Sponsor: WMU's Tribology Laboratory
Faculty Advisor: Philip Guichelaar
1:30 to 1:55 p.m., Room 242

Friction torque-testing devices for journal bearings measure the friction torque between a bearing and a shaft and are fundamental to understanding journal bearing design. A versatile unit was designed for the Western Michigan University Tribology Laboratory. The final design incorporates instrumentation that measures small changes in torque that occur in very short periods of time.

DRAG ANALYSIS OF VIRTUAL WINGLET

by Chin Chan Chen and Mitsuharu Nakagiri
Sponsor: Jim Stephenson - Aero Sports Connection
Faculty Advisor: Iskender Sahin
2 to 2:25 p.m., Room 242

A tip vortex occurs as high pressure air underneath a wing spills over the tip due to the difference in air pressure above and below the wing. The resulting tip vortex creates an increase in drag. By blowing high velocity air laterally from the tip of a wing, an "air seal" is created, preventing direct air leakage from the lower to the upper wing surface. Simultaneously the tip vortex is displaced outwardly, resulting in a decrease in drag. We analyzed the difference between the datum obtained prior to and during the activation of the "air seal," varying the direction and the velocity of air at the wing tip. A low-order potential-flow panel code, PMARC, for modeling complex three dimensional geometries, was chosen for the method of this analysis.

HIGH-PERFORMANCE AUTOMOTIVE RADIATOR FAN

by Sean Couch and David Larson
Faculty Advisor: Daniel Dorney
2:30 to 2:55 p.m., Room 242

Computer analyses were used to design a high-performance radiator fan blade for automotive applications. The blade geometry was optimized to yield the highest mass flow rate (to increase engine cooling) with the least amount of input power. The design procedure involved use of two computer analyses: a quasi-one-dimensional flow analysis and a two-dimensional panel method technique. The geometric design was based on a synthesis of the current technology in the field of radiator fan development.

MECHANICAL AND AERONAUTICAL ENGINEERING - C

Session Chair - Koorosh Naghshineh
Room 213

DESIGN OF A JAW SYSTEM FOR A LAPAROSCOPIC INSTRUMENT

by Christopher W. Newman and Chad W. Omo
Sponsor: John Klinger - Richard-Allan Medical Industries, Inc.
Faculty Advisor: Koorosh Naghshineh
9 to 9:25 a.m., Room 213

A linkless jaw system was designed for a laparoscopic grasping device. The work encompassed the entire process of product development including idea development, product criteria, conceptual design, detailed design, and product debug. Computer modeling, failure analysis, optimization techniques, and detailed parts drawings were completed.

DESIGN OF A VIBRATION EXCITATION DEVICE

by Brandon Dawe and Brian Wallace
Faculty Advisor: Koorosh Naghshineh
9:30 to 9:55 a.m., Room 213

A vibration excitation device has been designed for use in laboratory demonstrations of beam and plate vibration. It is capable of providing single frequency excitations below 500 cycles per second (Hz). Since it will be used in a variety of experiments by students, ease of use and quick setup time have been major design considerations. Performance has been evaluated and will be presented with a sample application.

WATER SPRAY COOLING OF A HEATED COPPER SURFACE

by Paul H. Miller II and David R. Monette
Faculty Advisor: Chris Cho
10 to 10:25 a.m., Room 213

Spray cooling can remove high heat fluxes, the rate of heat transfer through a material, while creating very little superheat at the metal/fluid interface. To plot the critical heat flux of the surface on a copper rod, the temperature distribution across the face must be determined. This distribution will vary as different size nozzles are used on the spray cooler. The best size nozzle is the one that allows the surface of the copper rod to have the highest critical heat flux. This experimental method of spray cooling can be used in computer chip cooling, steel rolling processes, and metal quenching.

CENTRAL TIRE INFLATION FOR WHEEL-END DESIGN

by Mike V. Kalavitz and Mark E. Leineke
Sponsor: Paul Kalavitz - Eltek Inc.
Faculty Advisor: Koorosh Naghshineh
10:30 to 10:55 a.m., Room 213

Central tire inflation is a system in which the operator of a vehicle can automatically control the tire pressure of the vehicle from the cab while on the move. These systems are available on military, logging, and crash-fire rescue trucks. They are not available for light-duty vehicles because of inability to transfer air from the stationary air hoses to the rotating wheel. A wheel-end was designed that allows central tire inflation to be used on light-duty vehicles while maintaining the integrity of the vehicle's original components.

FOUR-BALL LUBRICANT TEST SYSTEM

by Mark Slimak and Delbert Thomas
Sponsor: WMU's Tribology Laboratory
Faculty Advisor: Philip Guichelaar
11 to 11:25 a.m., Room 213

Lubrication testing is extremely important to eliminate the money and energy loss that can result from lubrication failure. A lubrication-testing system was developed for Western Michigan University's research laboratory dedicated to the sciences of wear, friction, and lubrication. The testing device is based on the widely used four-ball lubrication testing format, which uses three metal balls submersed in a lubricant and in rotational contact with a fourth ball. The testing system that was developed is extremely versatile and uses computerized data acquisition to obtain information on the testing conditions and the lubricant's performance.

COMPUTATIONAL FLUID DYNAMIC ANALYSES OF A FUSELAGE DESIGN

by Robert Gleason and Jin Suzuki
Faculty Advisor: Daniel Dorney
11:30 to 11:55 a.m., Room 213

An effective fuselage for a remotely piloted vehicle is essential for success at the Society of Automotive Engineers' Aero Design '95 competition. The fuselage must be capable of carrying the SAE-required payload box, gas tank, and radio mechanisms while demonstrating favorable flow characteristics during flight. A suitable fuselage profile was developed using two-dimensional computational fluid dynamic analyses. The use of computational fluid dynamic analyses greatly reduced testing and research costs by allowing a variety of fuselage profiles to be tested in a relatively short amount of time. Flow interaction between the fuselage and the main wing was accomplished using a three-dimensional computational fluid dynamic analysis. When a suitable fuselage shape had been determined, a prototype was built for verification of flow characteristics.

AUTOMATIC DUMPING MECHANISM

by Jason Baughman and Rick McCormick
Sponsor: Bruce L. Block - Simpson Paper Company, Vicksburg
Faculty Advisor: John Ward
1 to 1:25 p.m., Room 213

A local paper manufacturer needs an automatic mechanism to dump scrap paper into a recycling tank to be ground up for introduction into the papermaking process. The mechanism will replace awkward manual methods. A compact dumping mechanism was designed that is safe and efficient.

DRIVETRAIN FOR A SOLAR VEHICLE

by Tory Decker and Kenneth Lemke
Faculty Advisor: Richard Hathaway
1:30 to 1:55 p.m., Room 213

Special attention was needed in the drivetrain for Western Michigan University's solar-powered vehicle, which will compete in Sunrayce 95. Speeds attained in the race, output capabilities of the electric motor, and other factors were observed so that peak efficiencies could be obtained through the drivetrain at all times. A cartridge system was designed that allows matching drive ratios to be changed quickly and easily. The drivetrain was bench-tested for efficiency and reliability.

TEST FIXTURE AND PRESSURE APPLICATOR DESIGN

by Daniel Lizak and Charles Tornow
Faculty Advisor: Keyu Li
2 to 2:25 p.m., Room 213

A fixture was designed to secure a metal plate around its edges so that a concentrated load may be applied to the plate while keeping it stationary. A second device was designed to apply and measure the load applied at the center of the plate. Once the load had been applied, a laser sensing device measured the stress, strain, and deflection of the plate. The results were compared to analytical results to determine the accuracy of the laser.

CONTROL SYSTEM FOR HYBRID ELECTRIC VEHICLE

by Paul Schryer and Lamar Stewart
Faculty Advisor: Richard Hathaway
2:30 to 2:55 p.m., Room 213

A control system was needed to optimize the internal combustion engine and electric motor in WMU's hybrid electric vehicle. A computer capable of handling numerous inputs and outputs was used as the controller. The system was designed to handle any control strategy desired. Depending on the strategy, the controller changes vehicle parameters through various actuators.

PAPER SCIENCE AND ENGINEERING - A

Session Chair - Raymond Janes
Room 211

CURING EFFECTS OF COATED PAPER ON WATER RESISTANCE

by Laurel A. Carver
Faculty Advisor: Raymond Janes
9 to 9:25 a.m., Room 211

The effects of insolubilizer type, drying intensity, alkali type, and binder type on the water resistance of pigmented coating were studied. The coatings were formulated with three insolubilizers and with starch and latex binders. Alkalinity was adjusted with ammonia water and caustic. The coatings were applied and dried at three drying rates. The results showed latex is easier to insolubilize than starch. The three insolubilizers had different reactivities with the two binders and the drying intensities. Ammonia water gave better results than caustic.

EFFECT OF LIGHT EXPOSURE ON SIZING RESPONSE

by Ron W. Aulbach
Faculty Advisor: Raymond Janes
9:30 to 9:55 a.m., Room 211

Sizing is the process by which a chemical additive provides paper with resistance to liquid wetting, penetration, and absorption. A problem in the paper industry is size reversion, where the paper loses its ability to withstand liquid penetration. Many variables have been studied, but the effect of light exposure has not. Paper was made with alkyl ketene dimer as the sizing chemical additive. Samples were exposed to both ultraviolet and fluorescent light. Both light forms contributed to the paper's losing more than 50% of its initial sizing in a short period of time.

EFFECT OF RETENTION AIDS ON AKD SIZE RESPONSE

by Jeremy Matthews
Faculty Advisor: Raymond Janes
10 to 10:25 a.m., Room 211

Paper must maintain a high enough sizing level to reduce the rate of liquid penetration of the paper. Alkyl ketene dimer is a synthetic sizing agent widely used in alkaline papermaking. Under certain papermaking conditions, however, initial size response is poor and/or size levels degenerate over time, a phenomenon called "size reversion." Various types of retention aids (materials used to help retain small particles) were studied to better understand the effect they have on AKD size development and permanence. The various positive and negative charges on the retention aids had significant effects on sizing performance.

SESSION CHAIR - Raja Aravamuthan

EFFLUENT CHARACTERIZATION IN DIOXIRANE BLEACHING

by Holly L. Dunnill
Faculty Advisor: Raja Aravamuthan
10:30 to 10:55 a.m., Room 211

Impending environmental regulations have caused the pulp and paper industry to change many processes. The most recent change has been the decline in the amount of chlorine and chlorine derivatives used for pulp bleaching. The effluent characteristics were studied of a new bleaching process using dimethyl dioxirane as a bleaching agent instead of chlorine. The effluent from this process has lower bio-chemical oxygen demand (five-day), chemical oxygen demand, and total organic carbon and color than do conventional chlorine bleach effluents.

FULL SEQUENCE BLEACHING WITH DIMETHYLDIOXIRANE

by Daniel Krueger
Faculty Advisor: Raja Aravamuthan
11 to 11:25 a.m., Room 211

Research has shown dimethyldioxirane, an organic peroxide, to be a very powerful, yet highly selective, oxidant. DMD is mild toward cellulose and reacts under neutral conditions. Since DMD contains no chlorine, it is an option for mills that are heading toward elemental or totally chlorine-free bleaching because of proposed legislative restrictions on chlorine-based bleaching. A full sequence bleaching was developed on kraft hardwood pulp using only DMD and other chlorine-free bleaching agents. The DMD-bleached pulps matched or exceeded the brightness and strength characteristics of similar chlorine-bleached pulps.

EFFLUENT COLOR REMOVAL BY DIMETHYLDIOXIRANE

by Lori Jo Shafer
Faculty Advisor: Raja Aravamuthan
11:30 to 11:55 a.m., Room 211

Dimethyldioxirane, an oxidant, was used to remove color from water tainted with direct dyes. The water was treated to different levels of pH to create varying visual appearances. The effectiveness of DMD as a color-removing agent under these conditions was studied. Experimentation consisted of measuring the variations in absorbance (using a spectrophotometer) between untreated samples and those bleached with DMD. Absorbance variations occurred with increased mixing times, pH variations, and the levels of DMD.

OPTIMIZATION OF A DIOXIRANE PULP-BLEACHING STAGE

by Eric A. Thompson
Faculty Advisor: Raja Aravamuthan
1 to 1:25 p.m., Room 211

Dioxirane bleaching with dimethyldioxirane is an emerging paper industry process that does not generate environmentally regulated chlorine byproducts. Statistically designed experiments using response surface methodology were used to characterize and optimize the bleaching potential of a single dioxirane stage on an oxygen-delignified hardwood kraft pulp. The dioxirane is produced in-situ using a caroate and acetone under controlled conditions. The generated dioxirane then bleaches the pulp. The effects of bleaching consistency (solids), temperature, and dioxirane concentration on pulp properties were determined and the optimum levels were located with respect to final brightness and pulp strength.

ESTIMATION OF DRYER HEAT TRANSFER COEFFICIENTS

by Russell J. Weiandt
Sponsor: Gerald L. Timm - The Johnson Corporation
Faculty Advisor: Raja Aravamuthan
1:30 to 1:55 p.m., Room 211

The hardware installed in the interior of paper machine dryer cans was evaluated through a series of tests. A set of hardware (siphon, foot, and joint) was tested under typical conditions to find the heat transfer coefficients produced. By analyzing the results of the tests, heat transfer coefficients were estimated according to the hardware involved and the conditions to which the hardware was subjected. The results can be used to determine optimum conditions to maximize the heat transfer coefficients.

SESSION CHAIR - Brian Scheller

HIDING POWER OF VARIOUS COATING FORMULATIONS

by Matthew D. Stevens
Faculty Advisor: Brian Scheller
2 to 2:25 p.m., Room 211

Ink particles are the main contaminant in recycled fibers, and de-inking is costly. Coating over non-deinked recycled fibers is a cost-effective way to produce quality paper while reducing process and landfill costs. Titanium dioxide, calcined clay, and #2 clay were used in separate top coat formulations; the hiding power was determined based on the opacity, TAPPI dirt count, and visual inspection of the sheet. Each coat weight was held constant; thus a cost-effective coating could be determined based on the price per pound and the quality of its hiding power.

COATING WEIGHT ESTIMATES ON A CYLINDRICAL LABORATORY COATER

by Jared G. Glover
Faculty Advisor: Brian Scheller
2:30 to 2:55 p.m., Room 211

Coating paper creates a smooth, even printing surface. A popular technique uses a blade to distribute the coating evenly over the paper surface. The production blade coater's action is simulated by a cylindrical laboratory coater. To maximize accuracy and efficiency, it would be helpful to predict a coat weight (the amount of coating present in a specified area) before running the CLC. Predictive coat weight methods were compared to CLC experimental results for a specific coating formulation.

FIBER- AND WATER-BORNE CHEMICAL CONTAMINANTS

by Michelle Graflund
Faculty Advisor: Brian Scheller
3 to 3:25 p.m., Room 211

Chemical contaminants are foreign materials that can be found in paper when it is recycled. They can be injected through water or through pulp. The effect that each of these chemical contaminants has on paper is critical. Five different contaminants were chosen to show their effect on the sizing or liquid penetration of the paper. Different contaminants had different effects. Defoamers, biocides, and surfactants had a negative effect, while the starches, wet-strength additives, and retention aids had a positive effect.

CONTAMINANTS' EFFECT ON SIZING OF RECYCLED OFFICE PAPER

by Mary T. Jesionowski
Faculty Advisor: Brian Scheller
3:30 to 3:55 p.m., Room 211

Water-borne chemicals such as defoamers, biocides, retention aids, wet strength, and dry strength affect the sizing of recycled mixed office paper. The effect of each chemical contaminant was determined on an individual basis on a control handsheet of virgin hardwood and softwood fibers and on deinked mixed office paper. Handsheets were made from each pulp with varied levels of chemical addition and a constant level of size. The handsheets were cured and tested for Hercules size and contact angle. These tests correspond to ink holdout and the affinity of water to the handsheet.

COMPARISON OF KRAFT AND CHEMITHERMOMECHANICAL FLUFF PULPS

by Chris W. Hutchings
Sponsor: Mark Bolyen - Marketing/Technology Services
Faculty Advisor: Brian Scheller
4 to 4:25 p.m., room 211

Fluff pulp is widely used in many absorbent products, including diapers. Kraft and chemithermomechanical fluff pulps were produced by defiberizing pulp sheets in a laboratory cell mill that uses mechanical action to separate the fibers. The cell mill was run at various speeds and screen sizes. The absorbent properties, fiber damage, and energy consumed were analyzed and compared. Various absorbency tests were conducted to determine the absorption rate, maximum capacity, and capacity under load. The kraft outperformed the CTMP pulp for initial absorbency, but under a pressure load the CTMP retained a greater volume of liquid.

PAPER SCIENCE AND ENGINEERING - B

Session Chair - David Peterson
Room 212

STRENGTH EFFECTS OF SATURATING PAPER CONTAINING SYNTHETIC FIBER

by Chris Berndt
Sponsor: Mike Lindquist - Kimberly-Clark (Munising)
Faculty Advisor: David Peterson
9 to 9:25 a.m., Room 212

The process of saturation involves permeating a paper web with latex to improve its strength. Synthetic fiber, which is stronger than wood fiber, can also be added to paper to impart strength. Since synthetic fiber does not bond well in the sheet, a saturant is used to achieve better synthetic fiber bonding. The strength correlation between synthetic fiber content and the latex saturation process was determined by varying the amount of latex and synthetic fiber in standard paper samples.

EFFECTS OF CALCIUM CARBONATE IN THE COATING COLOR

by Kerry L. Brenner
Faculty Advisor: David Peterson
9:30 to 9:55 a.m., Room 212

Varying levels and types of calcium carbonate were added to a coating color as a substitute for clay to correlate the effects on gloss and print gloss. The coating colors were applied using the cylindrical laboratory coater at Western Michigan University at a speed of 3500 ft./min. Coatings containing calcium carbonate are thought to have lower gloss in comparison to clay, and the effect on print gloss is thought to be positive.

EFFECT OF WET PRESSING ON MIGRATION OF SIZING

by Joseph D. Gamrat
Faculty Advisor: David Peterson
10 to 10:25 a.m., Room 212

The effects of a varying pressure applied to the unconsolidated paper web were evaluated by determining the distribution of an applied size in paper. Laboratory handsheets were made using the Noble and Wood handsheet maker and evaluated using image analysis. This evaluation revealed the distribution of the starch sizing in the sheet. The results indicate that as the pressure applied increases, the depth of distribution decreases.

POWDERED ACTIVATED CARBON FOR COLOR REMOVAL

by Jeannine M. LaForge
Sponsor: William Thacker - Simpson Paper Co.
Faculty Advisor: David Peterson
10:30 to 10:55 a.m., Room 212

Powdered activated carbon is an effective means of cleaning water of color and contaminates. An experiment was conducted to evaluate whether powdered activated carbon can remove color from paper mill effluent. Known amounts of carbon were put into effluent samples and mixed for a known amount of time; the color remaining was measured. An activated carbon system was planned and its cost-effectiveness assessed.

EFFECT OF A SERRATED SLICE ON PAPER FORMATION

by Tim Maldag
Faculty Advisor: David Peterson
11 to 11:25 a.m., Room 212

A technique has been devised that orients fibers. This method makes use of a specially designed, vibrating serrated slice. The serrated slice causes stock valleys and ridges to occur in a controlled manner as the pulp suspension leaves the headbox. These variables can be used to manipulate fiber direction. Fiber-oriented paper properties were evaluated, resulting in improved formation (uniformity of the formed sheet).

EFFECT OF REPEATED RECYCLING ON SURFACE CHARACTERISTICS

by Jasvinder Singh Sidhu
Faculty Advisor: Brian Scheller
11:30 to 11:55 a.m., Room 212

Demand for printing and writing papers with increasing recycled fiber content has resulted in more fibers being recycled repeatedly. A study was done to examine the effect of repeated recycling on the surface properties of paper. Two sets of handsheets were recycled four times, one containing small additions of virgin pulp, the other using only recycled. Results showed an increase in smoothness, an increase in gloss with calendering, and a decrease in porosity for the recycled-only papers when compared to those with virgin pulp addition.

EFFECT OF MOISTURE CONTENT ON SIZING

by Scott K. Sabourin
Faculty Advisor: David Peterson
1 to 1:25 p.m., Room 212

"Surface sizing grades" of paper, such as copy paper, require the majority of the sizing material to be deposited on the paper surface instead of throughout the sheet. Absorption characteristics of the size solution vary with moisture content of the paper. Laboratory handsheets were created and analyzed for size distribution by cutting the samples precisely and viewing them under image analysis.

ALCELL PROCESS WASTE BEHAVIOR STUDY

by Brian K. Campbell
Sponsor: Burton Branch - Alcell Development
Faculty Advisor: David Peterson
1:30 to 1:55 p.m., Room 212

Alcell is a pulping process being developed in Canada that uses methyl and ethyl alcohol. The process has operations that are unique in the pulping industry. Some of the waste materials produced are also unique and have not been studied thoroughly. A bench-scale aeration basin and infrared spectroscopy analysis generated data showing the composition of the waste and its behavior in biological treatment systems. The data were compared with data from the more conventional kraft pulping process.

SESSION CHAIR - Ellsworth Shriver

WET STRENGTH RESIN ANALYSIS

by Todd Meyers
Sponsor: Jeff Peters - Hercules
Faculty Advisor: Ellsworth Shriver
2 to 2:25 p.m., Room 212

Three types of wet strength resins were compared at levels of 0.5, 1.0, 1.5, and 2.0 percent in the paperboard. The purpose of these resins is to improve strength properties when paperboard is wet. The resulting handsheets were tested and the resins evaluated. An important finding was the cost of each treatment.

EFFECT OF DRYING DELAY TIME ON PAPER COATINGS

by Richard Bentley
Faculty Advisor: Ellsworth Shriver
2:30 to 2:55 p.m., Room 212

Coating of paper is done to enhance optical properties, smoothness, printing ink transfer, and ink holdout. Factors that influence coated sheet properties are the base sheet, coating formulation, application system, and drying of the coating. It was found that increasing drying delay time decreased the strength properties of the coating but increased the optical properties.

MAGNESIUM OXIDE AS A COATING PIGMENT

by Stephen O'Driscoll
Sponsor: Patrick Theut - Packaging Corporation of America
Faculty Advisor: Ellsworth Shriver
3 to 3:25 p.m., Room 212

In paper coatings, pigments like titanium dioxide are added to increase the brightness and opacity of the sheet. The use of titanium dioxide to enhance these properties is expensive compared to other pigments. Magnesium oxide has had relatively little use as a coating pigment. Magnesium oxide is a very white pigment and has a refractive index better than all other pigments except titanium dioxide. The use of magnesium oxide yielded the same high brightness as titanium dioxide. The opacity levels were lower. Other quality tests showed the two pigments to be relatively equal. Magnesium oxide costs half as much as titanium dioxide.

PAPER SCIENCE AND ENGINEERING - C

Session Chair - Paul Wiegand
Room 204

EFFECT OF BLACK LIQUOR CARRYOVER ON BLEACH PLANT EFFLUENT

by Thomas Bishop
Faculty Advisor: Paul Wiegand
1 to 1:25 p.m., Room 204

Black liquor, the spent chemical from wood pulping, is removed from the pulp in a series of washers to reclaim the chemical. Because of inefficiencies of the washers and an attraction between the liquor and pulp, some of the liquor is carried over to the bleaching process. The effects of the carryover are reduced bleach efficiency, increased pulping chemical makeup, and an increased biological load to the effluent treatment plant. The effluent characteristics were evaluated as a function of carryover.

EFFECT OF ATMOSPHERIC OZONE ON PAPER STRENGTH

by Ki Harmon
Faculty Advisor: Paul Wiegand
1:30 to 1:55 p.m., Room 204

High concentrations of ozone have been found in many urban centers. Ozone is formed in polluted atmospheres when oxides of nitrogen react with volatile organic compounds. The effect of different concentrations of ozone on paper strength was determined using concentrations of 0.12 ppm, 0.5 ppm, and 1.0 ppm. Each concentration was exposed for 60, 360, 720, and 1440 minutes. Zero-span tensile, burst, and edge-plane tear tests were evaluated.

SESSION CHAIR - William K. Forrester

USE OF PLASTICS AS INK COLLECTORS DURING DEINKING

by Scot Miller
Faculty Advisor: William K. Forester
2 to 2:25 p.m., Room 204

Deinking of electrostatically printed papers is difficult because the ink is fused to the sheet. The use of plastics as collecting bodies for inks was shown to improve deinking. The plastics, and attached ink particles, are easily removed from the pulp slurry. Plastics used were polyethylene, polyester, polypropylene, and polystyrene. Their selection was based on their melting temperatures and surface energies.

IDENTIFICATION OF STICKIES BY INFRARED DETECTION

by Tim Lobbes
Faculty Advisor: William K. Forester
2:30 to 2:55 p.m., Room 204

Stickies present a significant problem in the recycling of paper. Stickies are adhesives that agglomerate in the dryer section of a paper machine and cause structural defects in the finished product. An infrared camera was used to capture the thermal image of stickies. The images were compared to thermal conductivity and heat capacity data to allow identification of the type of sticky without extensive chemical analysis.

THANK YOU

The College of Engineering and Applied Sciences is grateful to these firms, which have provided or cooperated in Senior Engineering Design Projects being presented in April 1995. If you have a project for our students or if you would like more information, please call Linda Hager at (616) 387-4017.

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