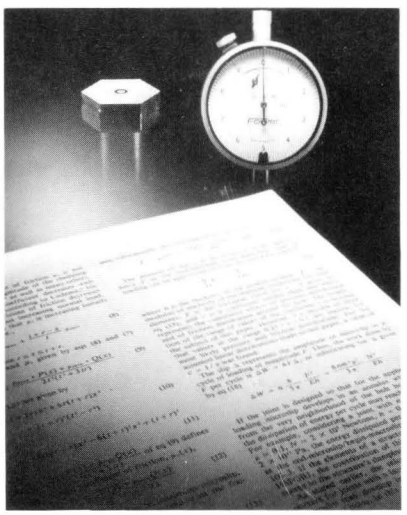
12-1988

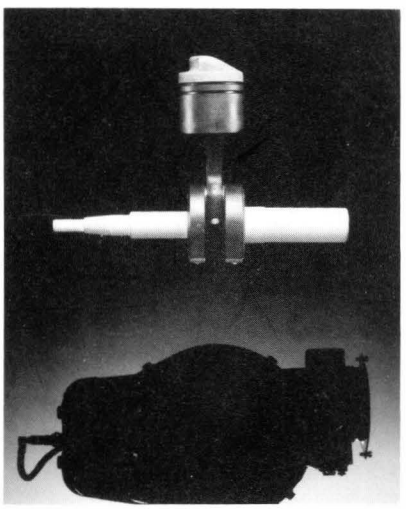
3rd Conference on Senior Engineering Design Projects

College of Engineering and Applied Sciences

3rd conference on

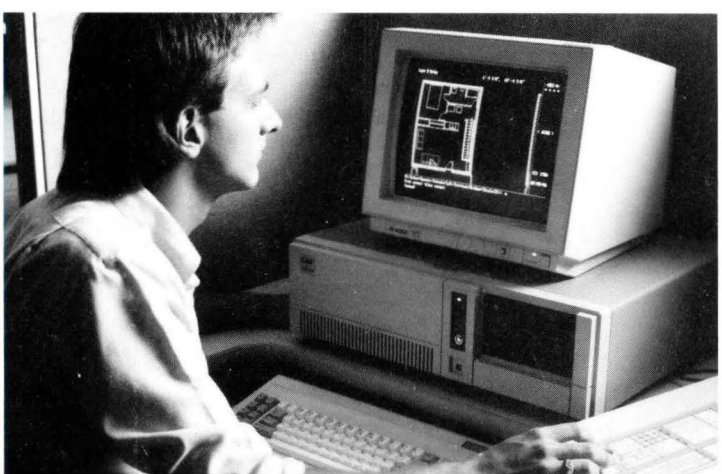


Senior Engineering Design Projects



College of Engineering and Applied Sciences

WESTERN MICHIGAN UNIVERSITY



Thursday, December 8, 1988
9 a.m. to 5 p.m.
Fetzer Business
Development Center

FORWARD

You are invited to attend the Third Conference on Senior Engineering Design Projects at Western Michigan University. The conference will be held from 9 a.m. to 5 p.m. Thursday, December 8, 1988, at the Fetzer Business Development Center on campus. A reservation form will be found at the back of this brochure.

The brochure presents summaries of senior engineering design projects by students enrolled in electrical and computer systems engineering, industrial engineering, mechanical engineering, and paper engineering in the fall semester, 1988.

Although senior design courses with project requirements have been an integral part of our program for a number of years, we have only recently initiated this college-wide presentation. Our first conference was held in December, 1987. It was so well received that we decided to continue the activity. We anticipate that our third conference will be the best to date, with a wide variety of student projects.

The quality of these projects and their design content result from a number of factors. Most significant is the cooperation of regional industry. Projects provided by industry give students the opportunity to address real, as opposed to academic, situations. This experience is one of the strengths of the engineering programs at Western Michigan University.

We acknowledge with sincere appreciation the help received from industrial organizations and extend our gratitude to the project advisors, both faculty and industrial, for their guidance. Our students deserve congratulations and thanks for a job well done. We also want to thank the many people who made this conference happen, with specific recognition of Dr. Curtis Swanson, chairman of the projects presentation committee, and committee members Drs. Bruce Fischer, John Gesink, Jerry Hemmye, David Peterson and Robert Wygant.

I sincerely hope that you enjoy this conference. Please let us know your reactions and how we might improve future conferences. If you would like more information about a specific project or if you would like to sponsor a project, please call Linda Hager at (616) 387-4017.

James B. Matthews, Dean
College of Engineering and Applied Sciences
and
Conference Chairman

ELECTRICAL AND COMPUTER SYSTEMS ENGINEERING

Session Chair - John Gesink
Room 1010 (Lecture Hall)

AUTOMATED TEST STAND FOR ACCELERATED TESTING OF CONTACT SWITCHES

by Kurt Tribbett and Dave Weber
Industrial Advisor: Robin Dalchow
Faculty Advisor: Dean Johnson
9 to 9:30 a.m., Room 1010
Douglas Corps

An automated test stand was developed to accelerate testing of contact switches. The automated test stand connects various load circuits to contact switches and makes voltage measurements, greatly reducing the time needed to test and evaluate the contact switches for commercial purposes. Features of the automated test stand include a Micro Mint BCC52 computer controller (which contains a Basic Interpreter, 48K bytes of RAM/EPROM and three parallel ports), Micro Mint BCC30 A/D converter, MicroMint ST100 smart terminal, Samsung video monitor, and generic DC driver boards.

DISPLACEMENT TRANSDUCER FOR AIR CYLINDERS

by Michael Shaw and Fariborz Golshani
Industrial Advisor: David Klien
Faculty Advisor: Joseph Root
9:30 to 10 a.m., Room 1010

Air cylinders are pressure-controlled devices used in the positioning of an object. Injection of air into the cylinder regulates the pressure, causing extension and retraction of the piston rod. A displacement transducer was designed to measure the position of the piston rod. The output signal of the device is proportional to the location of the piston rod relative to the cylinder. The device may be interfaced with a system to control the positioning of the piston rod.

COFFEE BREAK IN THE LOBBY, 10 TO 10:30 A.M.

CONTROL SYSTEM FOR A RECEIVING AREA CONVEYOR SYSTEM

by Richard Hamilton
Industrial Advisors: Daniel Haraburda and Darl Wilson
Faculty Advisor: John Gejji
10:30 to 11 a.m., Room 1010

A control system was designed to automate the flow of product along transportation paths of a conveyor system. A programmable logic controller (PLC) was programmed with the required logic of the conveyor system. Motor status, push buttons, limit switches, photo-electric eyes, and a load cell provide input signals to the PLC. The PLC compares these inputs with the system logic to provide appropriate output signals to motor starters, horns, lights, and solenoids.

MEASURING CYLINDER POWER BALANCE OF INTERNAL COMBUSTION ENGINE

by John Chapin and Mark Mullett
Industrial Advisors: Joe Torre, Jim VanLent, and Steve Nichols
Faculty Advisor: John Gesink
11 to 11:30 a.m., Room 1010

Cylinder power balance of an internal combustion engine can be measured using instantaneous engine speed variations.. To determine angular velocity, an inductive pickup was placed on an ignition component to obtain a synchronizing pulse, and rotational optical encoders were mounted on the alternator and crankshaft. A frequency-to-voltage circuit was constructed to convert the signal produced by the encoders to a voltage proportional to engine speed. Engine speed variations produced by the power contribution of each cylinder are displayed as a voltage waveform. Comparison of data from the two encoders determines if the alternator can be used as a reliable source to measure cylinder power balance.

MICROPROCESSOR-BASED INSTRUMENT SYSTEM FOR PRIVATE AIRCRAFT

by Eric Baker, John Fahrenbruch, and Richard Malek
Industrial Advisor: James L. Butcher
Faculty Advisor: Dr. Frank Severance
11:30 a.m. to noon, Room 1010

Because the aviation industry turns out very durable products, it is sometimes difficult to find replacement electromechanical instruments for older aircraft. Substituting a digital display could solve the availability problem, produce a superior display format, and allow expansion. A microprocessor-based instrument system was developed which offers a continuous data display and warns the user of abnormalities.

LUNCH BREAK, NOON TO 1 P.M.
LUNCH WILL BE SERVED IN DINING ROOMS
PAID RESERVATIONS REQUIRED

MOTION CONTROL FEEDBACK SYSTEM

by Nasir Emad-Dahi, Saeid Khatami, and Elizabeth Melnyk
Faculty Advisor: Joe Kelemen
1 to 1:30 p.m., Room 1010

Motion control systems have applications in many industries, including robotics and laser/optics. Such systems can be used in tool positioners, telescope and antenna drives, reactor controls, and flight simulators. A closed-loop feedback control system was designed which utilizes the Hewlett-Packard HCTL-1000, a high performance, general purpose motion control chip. Other major components are the MC6801 Motorola host processor chip, a DC brushless motor, an encoder to provide rotor position information, and an amplifier to drive the motor. Information from the encoder is fed back to the HCTL-1000 chip, which compares the information to the desired command and outputs a compensated motor command.

RF MODEM RECEIVER

by Dale DeVries, Paul Mueller, and Ronald Scoppa
Industrial Advisor: Ronald J. Fredricks
Faculty Advisor: S. Hossein Mousavinezhad
1:30 to 2 p.m., Room 1010

A radio frequency (RF) modem receiver was designed for use in the communication system in Litton Corporation's Automated Guided Vehicles. The system requires that information be relayed quickly between robots and a central guidance unit. The RF modem receiver accepts digital frequency shift keying (FSK) coded responses of an existing computer program. Frequency modulation is utilized, using a carrier frequency of 460 MHz. The RF modem receiver offers low error rates through the use of integrated circuit chips and commercial RF chip technology.

RF MODEM TRANSMITTER

by Julius DeJongh, Ryan Fisher, and Kevin Kidston
Industrial Advisor: Ronald J. Fredricks
Faculty Advisor: S. Hossein Mousavinezhad
2 to 2:30 p.m., Room 1010

A radio frequency (RF) modem transmitter was designed to be used in conjunction with the receiver described above, as part of the communication system used by Litton to control Automated Guided Vehicles. The RF modem is capable of transmitting 5,000 bits per second and operating at 450 to 470 MHz.

NODE CONTROLLER

by Neil Morehouse and James Valle
Faculty Advisor: Lambert VanderKooi
2:30 to 3 p.m., Room 1010

Industry uses automated systems wherever possible to control the movement of production materials and parts in a factory. Controlling devices on the market are expensive and difficult to program. A cost-efficient, microprocessor-based device called a node controller was built to make decisions at nodes, the decision-making points in a materials handling system. Because it is microprocessor based, the node controller is flexible and easily programmed.

INDUSTRIAL ENGINEERING

Session Chair - Bruce Fischer
Room 2020

ANALYSIS OF CUSTOMER/SALES PERSONNEL ACTIVITIES

by Yvonne Cousineau, Earline Jenkins, Tom Rumler, and Garth Weaver
Industrial Advisor: Mustafa Gheriani
Faculty Advisors: Bruce Fischer and Robert Wygant
9 to 9:30 a.m., Room 2020

Customer/sales personnel ratios were examined at Highland Superstore, Inc. Time studies and queuing studies were done to develop recommendations for better customer coverage. Floor layout ideas were also presented that would improve product visibility and accessibility.

EVALUATION OF A PLASTIC BOAT DOCK

by Scott Franzen and Scott Taylor
Industrial Advisors: A. J. Malde and Jon Eickhoff
Faculty Advisors: Bruce Fischer and Robert Wygant
9:30 to 10 a.m., Room 2020

A prototype plastic boat dock made by Ronnigen Research was studied for mechanical strengths and environmental degradation. The feasibility of using recycled plastics and/or new plastics was investigated. Design changes were suggested, and ease of assembly was evaluated.

COFFEE BREAK IN THE LOBBY, 10 TO 10:30 A.M.

INVENTORY CONTROL SYSTEM

by Santiago Uribe, James Wiercinski, and Robert Wilder
Industrial Advisors: Robert Malnight and Joseph Lutes
Faculty Advisors: Bruce Fischer and Robert Wygant
10:30 to 11 a.m., Room 2020

In the interest of reducing inventory carrying costs and improving service levels of a chemical company, an inventory system was proposed that would run on an IBM PC using Lotus 1-2-3 software. The system uses production forecasting, material requirements planning, and economic order quantities on each inventory item.

MACHINERY JUSTIFICATION AND PLANT LAYOUT

by Rod Soat and Michael Davis
Industrial ADvisors: George Lebbos and Jim Livingston
Faculty Advisors: Bruce Fischer and Robert Wygant
11 to 11:30 a.m.,. Room 2020

Problems that National Sign and Signal was experiencing from rapidly increasing production were investigated. Recommendations were made for new of updated machinery and a revised plant layout to better accommodate the flow of materials.

PLANT EXPANSION/MATERIAL FLOW DESIGN

by Dan O'Keefe, Ali Agely, and Rick Gippert
Industrial Advisor: Dave Sebright
Faculty Advisors: Bruce Fischer and Robert Wygant
11:30 a.m. to noon, Room 2020

A plan was developed for a plant expansion of Sebright Products, Inc. The expansion includes implementation of a bridge crane, an increase in the number of work stations, and an increase in raw material storage area. Recommendations were also made on work flow and material-handling techniques.

LUNCH BREAK, NOON TO 1 P.M.
LUNCH WILL BE SERVED IN DINING ROOMS
PAID RESERVATIONS REQUIRED

MECHANICAL ENGINEERING (BIO-MECHANICAL PROJECTS)

Session Chair - Judah Ari-Gur
Room 2020

ANALYSIS OF PROTOTYPE SURGICAL IRRIGATION PUMP

by John Pinto
Industrial Advisor: James Evans
Faculty Advisor: Iskender Sahin
2:30 to 3 p.m., Room 2020

Stryker Corporation is developing a two-piston, compressed-nitrogen-powered irrigation pump to be used during surgery to clean bone joints. The nozzle being used seems to greatly reduce pump efficiency, and a reduction in the amount of water delivered is observed. Analysis of the pump was performed using an analogous spring-mass-damper system. The dynamic analysis included ideal and viscous flows. Critical loads were determined, and the pump was tested. Friction losses were established so that recommendations to improve the pump's efficiency could be made.

BREAK IN THE LOBBY, 3 TO 3:30 P.M.

STRUCTURAL REDESIGN OF THE IRON HORSE WHEELCHAIR

by Joel Markucki and Jerry Williams Jr.
Industrial Advisor: George Y. Duffy Jr.
Faculty Advisor: Judah Ari-Gur
3:30 to 4 p.m., Room 2020

An existing wheelchair for outdoor use has been judged too heavy. A new, light-weight design is proposed to satisfy endurance, safety, environmental, and appearance requirements and to meet the current standards of the Rehabilitation Engineering Society of North America.

USE OF FEM IN REDESIGN OF A WHEELCHAIR

by Michael Janowski
Industrial Advisor: George Y. Duffy Jr.
Faculty Advisor: Judah Ari-Gur
4 to 4:30 p.m., Room 2020

A wheelchair was redesigned to reduce its weight without making major changes in the basic design. The new design uses epoxy fiberglass composite tubing to replace the stainless steel tubing now in use. ANSYS, a finite element method program, was used to analyze the new design.

STANDARDS AND TESTS FOR ALL-TERRAIN WHEELCHAIR

by David Beck and Patrick Kealy
Industrial Advisor: George Y. Duffy Jr.
Faculty Advisors: Judah Ari-Gur, Pnina Ari-Gur
4:30 to 5 p.m., Room 2020

Engineers are designing a new type of wheelchair for use in rugged terrain. The new design will render obsolete the wheelchair standards and testing procedures established by the Rehabilitation Engineering Society of North America. New standards of quality were developed for the all-terrain wheelchair, as were the specific tests used to determine if a wheelchair meets the new standards.

MECHANICAL ENGINEERING

Session Chair - Jerry Hemmye
Room 1005 (Auditorium)

MATERIAL FEED AND STACKING SYSTEM FOR RIBBON FIN DIE AND PRESS

by Roger Tetzloff
Industrial Advisor: Galen Harman
Faculty Advisor: Jerry Hemmye
9 to 9:30 a.m., Room 1005

The Burr Oak Tool and Gauge Company manufactures equipment used by the heating and cooling industries for the production of radiator fins. The fins are produced on high-speed presses and dies. The method previously used to feed material through the press, cut the fins to length, and stack the fins requires that the fins be re-struck by the die. The re- strike causes slivers of material to be formed within the die. The system of feeding the material and cutting and stacking the fins has been redesigned to eliminate this problem.

FEASIBILITY STUDY OF BY-PRODUCT DISPOSAL SYSTEM

by Kimberly Nehmer and Larry Richert
Industrial Advisors: Clare Gildea and David Dolenski
Faculty Advisor: Jerry Hemmye
9:30 to 10 a.m., Room 1005

Ralston Purina Company in Battle Creek needs a new system to dispose of cereal by-products. They now manually unload hoppers into trucks at two locations, producing dust within and around the plant and prompting complaints from neighbors. A new system was proposed which is dust-free, conveniently located, and financially acceptable.

COFFEE BREAK IN THE LOBBY, 10 TO 10:30 A.M.

AUTOMATED MIXER WASHING SYSTEM

by Randy Newsome
Industrial Advisor: Brice Haywood
Faculty Advisor: Dennis VandenBrink
10:30 to 11 a.m., Room 1005

A plastics manufacturing company needs a washing system to reduce product changeover time and eliminate employee contact with hazardous substances in the color concentrate production process. A single washing unit was designed that is attached to an electric trolley to serve two 500-liter resin mixers. The unit cleans the interior of the mixers by injecting a mild soap solution onto rotating scouring elements. The entire washing process is controlled by a programmable logic controller.

FINITE ELEMENT ANALYSIS AND REDESIGN OF A SCULPTURE

by Jackie Eysol
Industrial Advisor: Kevin Bassett
Faculty Advisor: Dennis VandenBrink
11 to 11:30 a.m., Room 1005

A sculpture design proposed by Spectrum Industries was analyzed using the finite element method. Structural noise was studied, as were deflections and stresses due to wind effects. The sculpture was modeled and analyzed on the Applicon BRAVO CAD system. An internal support system was added, and the sculpture was re-analyzed. A design was presented for an attractive, safe and feasible sculpture.

PRESSURE DISTRIBUTION IN BOLTED JOINTS

by Mark Molitor
Faculty Advisor: Dennis VandenBrink
11:30 a.m. to noon, Room 1005

When two plates are fastened by a single bolt-washer-nut combination, there is a variable coefficient of friction between the plates. This coefficient can be calculated if the pressure distribution between the plates is known. The pressure distribution was modeled through use of a finite element analysis program called Super Sap. With the variable coefficient of friction and the clamping force known, the amount of tangential force required to cause slippage between the plates was calculated.

LUNCH BREAK, NOON TO 1 P.M.
LUNCH WILL BE SERVED IN DINING ROOMS
PAID RESERVATIONS REQUIRED

FINITE ELEMENT ANALYSIS OF A NON-UNIFORM CROSS SECTION IN BENDING

by Ken Ward
Faculty Advisor: Dennis VandenBrink
1 to 1:30 p.m., Room 1005

A basic assumption in beam bending is that a plane cross section perpendicular to the length of the beam will remain plane after bending. Finite element analysis was used to determine when this theory can be applied to beams not having uniform cross sections. A variety of cross sections were chosen.

ANALYSIS OF MULTI-CROSS-SECTIONED BEAM COLUMN

by Timothy Peterson and Jeffrey Rodgers
Faculty Advisors: Meshulam Groper and Dennis VandenBrink
1:30 to 2 p.m., Room 1005

A numerical analysis of the post-buckling behavior of a non-prismatic beam column was performed to establish the relationship between maximum deformation of the section of separation of the beam column at the change in its cross section and the lateral deflection of the structural element considered. Experimental work was done to verify the results.

OPTIMIZATION OF PIPE THREAD SEALANT

by Joseph Deverell
Industrial Advisor: Stan Bragdon
Faculty Advisor: Jerry Hamelink
1:30 to 2 p.m., Room 1005

The Brass Products Division of Parker Hannifin Corporation has reported cracks in joint assembly of parts with male pipe thread. Excess sealant over-stresses the assembly, but leakage results if too little sealant is used. A factorial design was used to establish the optimum amount of sealant.

VIBRATION ANALYSIS IN MACHINERY

by Matthew Bossory
Industrial Advisor: Rick Woodward
Faculty Advisor: Jerry Hamelink
2 to 2:30 p.m., Room 1005

Mechanical vibrations caused by impending bearing failure in production equipment can result in a poor-quality product and, if neglected, can result in destruction of equipment. In the paper industry, conventional inspection methods have proven inadequate in predicting failures of high-speed roller bearings. Vibration analysis equipment was used to predict failure and draw up a preventive maintenance program.

BREAK IN THE LOBBY, 3 TO 3:30 P.M.

FLOW CHARACTERISTICS INSIDE SOLAR PANELS

by Fred Landis
Faculty Advisor: Richard Schubert
3:30 to 4 p.m., Room 1005

The typical air solar collector design has symetrical and parallel channels which do not have balanced fluid flows. Reduced thermal efficiencies result. A method was devised to design solar panels with balanced flow. Prototypes and models were tested to determine friction factors, and the factors were used in a computer program to evaluate channel flow by pipe network theory. Finite difference technique was used to analyze flow characteristics. Both methods were validated experimentally.

ALUMINUM/GRAPHIC-FIBER COMPOSITE CASTING PROCEDURE

by Hartley Troman
Industrial Advisor: Robert Monteith
Faculty Advisor: Jay Easwaran
4 to 4:30 p.m., Room 1005

A procedure was designed to cast an aluminum/graphite-fiber composite using evaporative pattern casting. The process of evaporative pattern casting utilizes a polystyrene pattern formed in the shape of the part to be cast. The pattern was produced with precisely oriented graphite fibers in it, and aluminum was cast in the pattern. The result was a selectively reinforced composite casting.

DOCUMENTATION OF FLOW CHARACTERISTICS IN A WIND TUNNEL

by Olufemi Ajiwe and Ali Adhal
Faculty Advisor: Parviz Merati
4:30 to 5 p.m., Room 1005

A hot-film anemometry technique was used to determine wind tunnel flow statistics such as streamwise mean velocity and turbulence intensity profile. A hot-film probe and data acquisition system were also used. Computer programs were written to process the flow statistics. A new traversing mechanism for the anemometer was purchased, and a mounting frame was designed and built.

PAPER SCIENCE AND ENGINEERING

Session Chair - David Peterson
Room 2030

EFFECT OF pH ON EVOLUTION OF NON-CONDENSIBLE GAS

by Gregory Goode
Industrial Advisor:
Faculty Advisor:
11:30 a.m. to noon, Room 2030

A distillation process utilizing hardwood black liquor samples from Mead in Escanaba was used to determine the effect of pH on non-condensible gas evolution. Results indicate that as pH increases, volumetric production of non-condensible gas decreases. Residual analysis of the data points indicated that pH is best correlated to gas volume reduction in the pH range of 11.5 to 12.5.

LUNCH BREAK, NOON TO 1 P.M.
LUNCH WILL BE SERVED IN DINING ROOMS
PAID RESERVATIONS REQUIRED

PULP VISCOSITY VS. ZERO SPAN TENSILE TESTS TO

by John Shulstad
Faculty Advisor: Raymond Janes
1 to 1:30 p.m., Room 2030

Pulp fibers, which are the main component of paper, should be as strong as possible to make quality paper; but tests to determine pulp fiber strength are not very reliable. In this study, wood chips were degraded into pulp fibers by adding sodium chlorite and acetic acid and then made into paper. Zero span tensile and pulp viscosity tests were performed and were correlated with paper quality strength tests to determine which testing method is superior.

BLACKENING EFFECT OF SUPERCALENDER PRESSURES AND TEMPERATURES

by Valerie Bland
Faculty Advisor: Ellsworth Shriver
1:30 to 2 p.m., Room 2030

Supercalendering densifies a sheet to increase smoothness. A decrease of opacity called blackening occurs when a critical density is reached during supercalendering; it is undesirable because transparent spots occur in the sheet. Supercalender nip loadings and roll temperatures affect blackening, as does paper moisture content. A control range of safe nip loadings, roll temperatures, and incoming moisture content of the sheet was designed for uncoated rotogravure paper.

ANALYSIS OF WIRE MARK ON NEWSPRINT

by Karen Birks
Industrial Advisor: Ronnie Stevens
Faculty Advisor: Ellsworth Shriver
2 to 2:30 p.m., Room 2030

Paper is formed on a continuous polyester woven belt, which often leaves an imprint called a wire mark in the final web of paper. The wire mark is more apparent in light-weight, cheaper grades of paper such as newsprint and causes the surface of the sheet to be less uniform, which in turn creates problems with the sheet's strength and printability. In this project, different forms of surface modifications were carried out on sample wires to see if newsprint sheets formed on them showed reduced wire mark.

EVALUATION OF FOIL DESIGN FOR PRESSURE SCREENING OF PAPER STOCK

by Christopher Reidenbach
Faculty Advisor: Bill Forrester
2:30 to 3 p.m., Room 2030

During the process of papermaking, a tree is converted to a fibrous slurry which may contain fiber bundles, which must be removed to develop a uniform dispersion. A pressure screen is used to remove the fiber bundles from the fibrous flow. A hydraulically designed foil rotates parallel to the screen surface, creating a pulse which lifts the fibrous suspension, clearing the screen and allowing individual fibers to flow through. Research was done to determine how different foil designs affect screening efficiency.

BREAK IN THE LOBBY, 3 TO 3:30 P.M.

A STUDY OF FINES IN THERMOMECHANICAL PULPING

by Pete Peterson
Faculty Advisor: Raja Aravamuthan
3:30 to 4 p.m., Room 2030

About 30% of the yield of pulp produced in the thermomechanical pulping process is fines. The percentage of fines affects the properties of the sheets produced. To determine to what extent and at what percentages fines influence the sheet, pulp samples were prepared with the WMU Sunds Defibrator. Pulps were separated into different size fractions which were mixed to produce various percentages of fines. Handsheets were made and tested for strength.

OXYGEN BLEACHING IN AN M-K DIGESTER

by Dean DeVries
Faculty Advisor: David Peterson
4 to 4:30 p.m., Room 2030

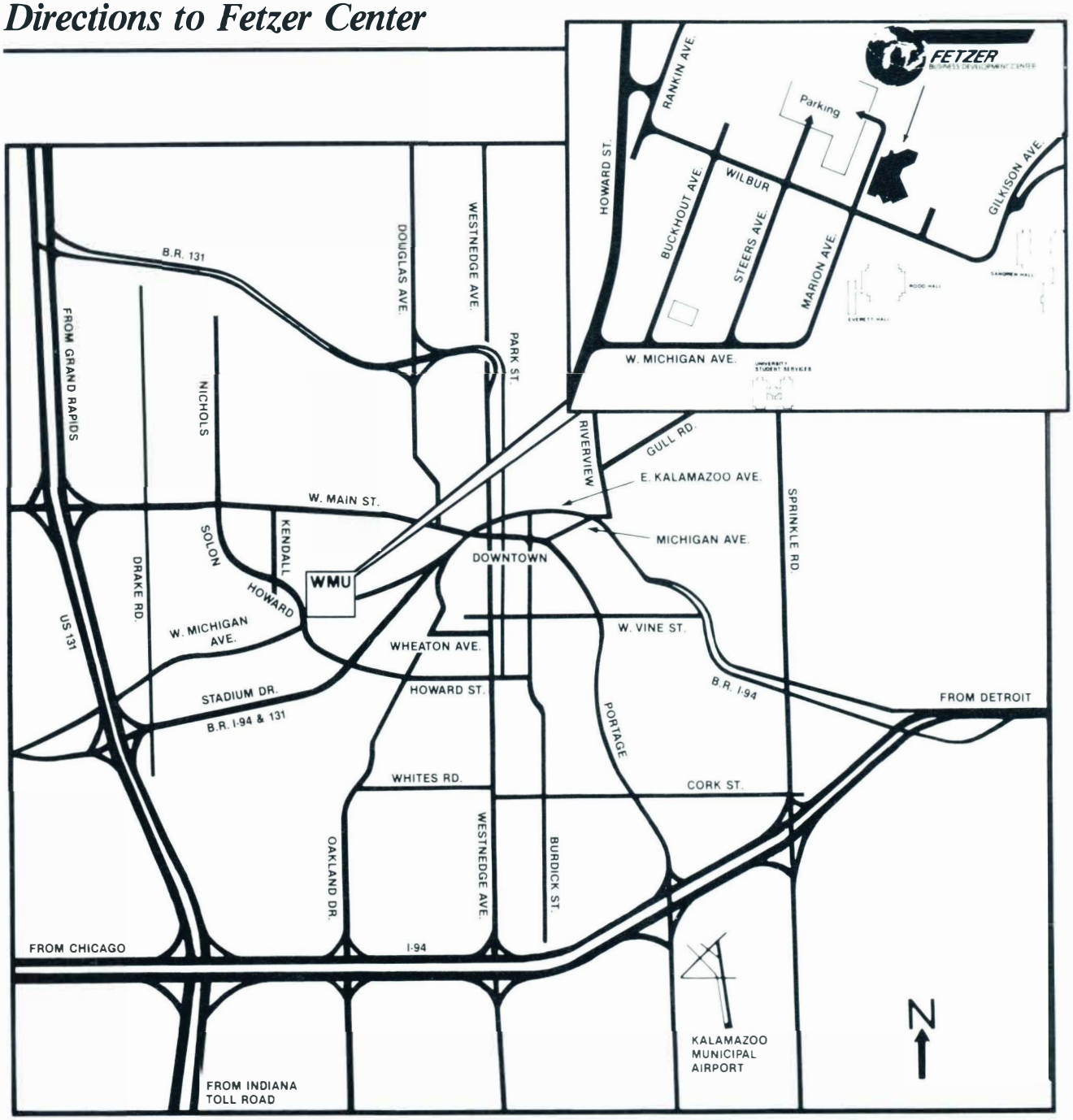
Oxygen bleaching has gained much attention as a viable alternative to chlorine bleaching of pulp. Oxygen bleaching is affected by pH. The higher the pH, the faster the rate of delignification (the removal of lignin, which causes the paper to appear dark). The delignification rate is broken down into an initial, high-rate stage and a slower stage. A study was done to see if adding excess sodium hydroxide will maintain the initial stage so that delignification of the pulp is equal to a regular chlorine bleach. The effectiveness of oxygen bleaching on different pulps was also compared.

ALKALINE SULFITE PULPING OF SPRUCE

by Mike Griffith
Faculty Advisor: Ellsworth Shriver
4:30 to 5 p.m., Room 2030

Alkaline sulfite pulping is a part of the pulping process in which the pH of the cook can be varied over the alkaline range. To show the effects of pH variation on the pulp and sheet properties of a spruce furnish, various cook parameters were adjusted to give similar cooks, and sheet properties were evaluated at four different freeness values.

Directions to Fetzer Center



From I-94 Detroit and Chicago
At exit #75, turn north onto Oakland Drive, go 2.7 miles; turn left onto Howard Street, go 1.1 miles; turn right onto Michigan Avenue, proceed easterly to WMU campus.

From U.S. 131 Grand Rapids, Muskegon
Turn east onto Stadium Drive; go 2.2 miles to Howard Street; turn left and go 0.6 miles to Michigan Avenue; turn right and proceed easterly to WMU campus.

From M-43 North of Kalamazoo
Turn left off M-43 (Gull Road) in Kalamazoo onto Riverview Drive; then turn right onto Michigan Avenue under railroad overpass. Continue westerly on Michigan Avenue for 0.4 miles, which then becomes Kalamazoo Avenue, which is one way westbound; after 1.4 miles turn left onto Michigan Avenue and go 0.3 miles. Cross Main Street and rejoin Michigan Avenue; proceed westerly on Michigan Avenue to WMU campus.

From M-43 West of Kalamazoo
Go easterly past U.S. 131, and after 1.9 miles, turn right onto Solon Avenue; go south 0.5 miles, turn left onto Howard Street, go 0.6 miles to Michigan Avenue; turn left and proceed easterly to WMU campus.

From Downtown Kalamazoo
Go westerly on Kalamazoo Avenue as in above directions or go westerly on Lovell Street, then turn left onto Michigan Avenue and proceed to WMU campus.

Conference on Senior Engineering Design Projects
9 a.m. to 5 p.m. Thursday, December 8, 1988
Fetzer Business Development Center
Western Michigan University

Coffee will be available in the lobby from 10 to 10:30 a.m. Lunch will be available ($6 per person) at noon for those who have sent in paid reservations by December 1. Limited seating is available, and reservations will be accepted on a first come/first served basis. No reservations will be accepted after December 1 or at the door.

RETURN THIS FORM BEFORE DECEMBER 1, 1988, IF YOU PLAN TO HAVE LUNCH.

Name_____

Organization or School_____

Address_____

City _____ State _____ Zip _____

Name_____

Organization or School_____

Address_____

City _____ State _____ Zip _____

Enclosed is a check for $____ for _____ lunches (at $6 each).

BEFORE DECEMBER 1, MAIL THIS FORM AND YOUR CHECK TO:

Assistant to the Dean/Marketing
College of Engineering and Applied Sciences
Western Michigan University
Kalamazoo, MI 49008

Office of the Dean
College of Engineering and Applied Sciences
Western Michigan University
Kalamazoo, MI 49008