



# MILWAUKEE SCHOOL OF ENGINEERING® FLUID POWER AND MOTION CONTROL PROFESSIONAL EDUCATION SEMINARS

## 2012

Register online at [www.msOE.edu/seminars](http://www.msOE.edu/seminars)

Introduction to  
Hydraulics

Hydraulic Specialist  
Certification Review

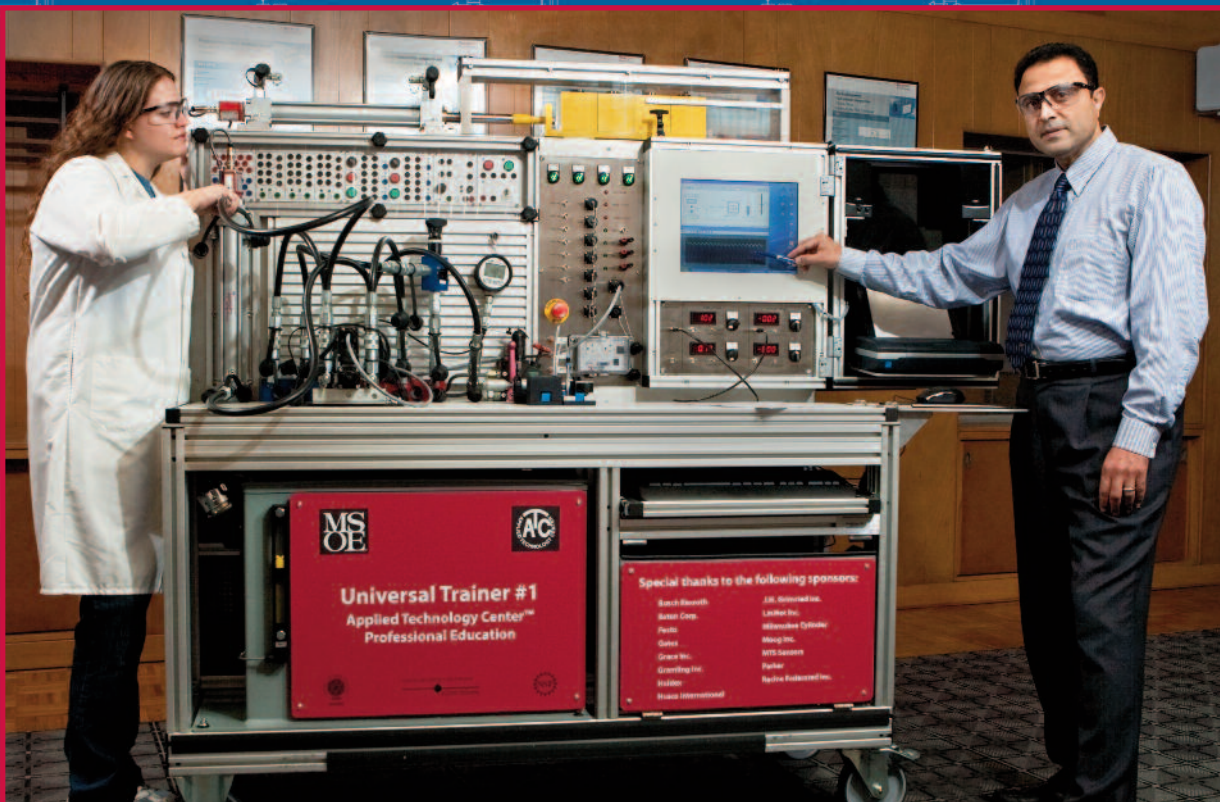
Hydraulic Systems  
Modeling and  
Simulation for  
Applications  
Engineers

Electro-Hydraulic  
Components and  
Systems

Service and Operation  
for Improved  
Hydraulic Systems  
Reliability

**New!**

PLC Programming and  
Servicing for Fluid  
Power Systems



**State-of-the-Art Training Equipment!**



**You will learn fluid power and motion control technology, brand non-biased,  
using state-of-the-art training hardware and simulation software**



## PROFESSIONAL EDUCATION

MSOE seminars offer participants the opportunity to explore technological developments and current applications and techniques. The programs are designed to keep practicing engineers abreast of new developments and applications, and also to provide a basic understanding of the technology to new entrants into the field.



### On-site Seminars

MSOE seminars are available for an on-site presentation at your company. The curriculum may be presented in its original format or be **modified to meet your specific needs**. Confidentiality protected! For more information, contact Dr. Medhat Khalil at (414) 277-7269 or khalil@msoe.edu.

### MSOE Seminars:

- ✗ are based on applied research conducted by scholars.
- ✗ use state-of-the-art laboratories with industrial-size equipment.
- ✗ use a hands-on approach to reinforce the concepts presented in class.
- ✗ are applications-oriented and often customized to the industry or companies of the seminar participants.
- ✗ are offered on the basis of strong long-term partnerships, with set objectives and outcomes.

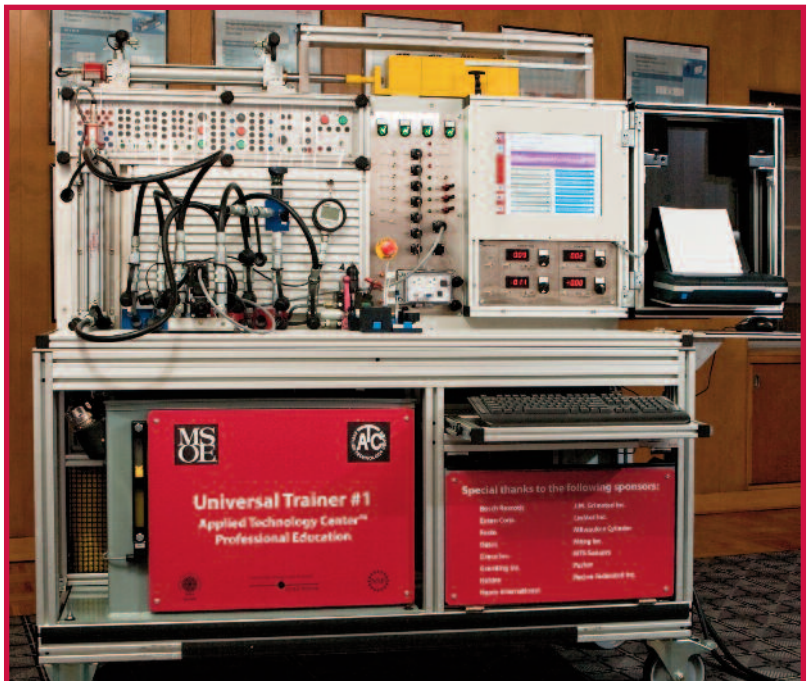
### MSOE's Seminars are unique in the industry because:

- ✗ seminar instructors are experts in their fields, including certified fluid power specialists, Professional Engineers and Ph.D.s.
- ✗ attendees are exposed to the latest fluid power research and industry projects being worked on at the Fluid Power Institute.™
- ✗ the professional education seminars use the latest software versions of MATLAB®/Simulink® and Automation Studio in the advanced courses.
- ✗ attendees can network and build professional relationships while benefitting from training, research and industrial projects.

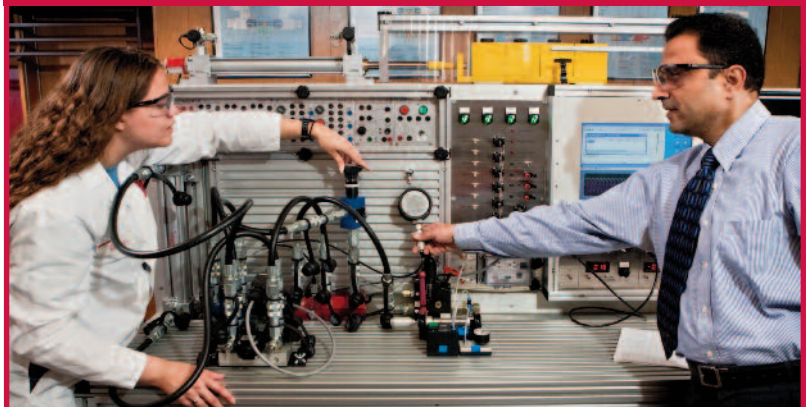
### Universal Fluid Power Trainer

A prototype of the state-of-the-art fluid power and motion control training unit has been recently redesigned and developed. The machine is universal, transportable, compact and is designed to be used for professional education programs at the customer's site. The prototype design was funded by CCEFP-ERC, and has been engineered to:

- ✗ cover a variety of disciplines, including hydraulics, electro-hydraulic, pneumatic, electro-pneumatic and electro-mechanical.
- ✗ include controlled parameters: position (linear and rotary), speed (linear and rotary), pressure, force and torque.
- ✗ include a controlled axis (linear and rotary) for each discipline.
- ✗ include controlled parameters: position (linear - angular), flow (linear - angular) and pressure, force and torque.



The Universal Fluid Power Trainer was recently redesigned and developed by MSOE to help mobilize the advanced courses to the customer site.



- ✗ feature state-of-the-art software, HMI loaded with MATLAB®/Simulink®, Automation Studio and custom-made software.
- ✗ feature a hydraulic power supply and a variable displacement pump with a flexible and interactive pump control mode of the user's choice.
- ✗ include a manual and automated setting of the maximum working pressure and/or flow rate.
- ✗ deliver safety warnings in case of oil overheating, cavitation, low oil level or filter clogging.
- ✗ feature an automated sub-systems test wizard.
- ✗ feature smart and interactive maintenance and troubleshooting test wizards.

### For more information:

#### Dr. Medhat K. Bahr Khalil

Director of Professional Education & Research Development

[www.msoe.edu/seminars](http://www.msoe.edu/seminars)

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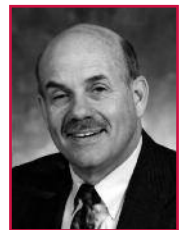
### Welcome

The incredible capabilities of software and digital computation are redefining the applications of fluid power and motion control. Major improvements in performance are possible through excellent virtual system prototyping, which leads to reliable system design and manufactured products.

MSOE offers short courses and certificate education that improve the knowledge and capabilities of engineers to effectively use these new tools. Authentic hands-on laboratory experiments using the redesigned, versatile Universal Trainer reinforce theory and simulations. These are supplemented with excellent notes and lectures involving animation plus interactive questions and professional discussion. The very active applied research programs in MSOE's Fluid Power Institute™, plus MSOE's renowned academic programs and faculty, form the basis for excellence! The academic environment ensures true education independent of specific manufacturers. Advanced fluid power research in the United States is being conducted through the National Science Foundation and fluid power industry-sponsored Engineering Research Center for Compact and Efficient Fluid Power, led by a consortium of universities of which MSOE is a member. Learn more about it online at [www.fperc.org](http://www.fperc.org).

Help others learn about these unique seminars at MSOE. I look forward to having you visit the exciting, expanding MSOE campus.

Tom Bray  
Dean of Applied Research



**Tom Bray**  
Dean of Applied  
Research

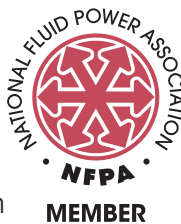
## MSOE: A UNIVERSITY THAT WORKS

At Milwaukee School of Engineering, theory® is brought to life and reinforced for students through extensive integration of laboratory experimentation. Understanding theoretical concepts and knowing how to apply them is key to the success of MSOE graduates. Established in 1903, MSOE has enjoyed a long history of interdependence with business and industry. Industrial support in the form of scholarships, laboratories and

facilities, and involvement and counsel enables MSOE to provide educational solutions and graduates to meet industry needs. MSOE is a close-knit university nestled within a vibrant downtown neighborhood. The 15-acre, user-friendly campus is located in a historic district downtown, just blocks from beautiful Lake Michigan.

## THE MSOE APPLIED TECHNOLOGY CENTER™

The Applied Technology Center™ (ATC) is the research arm of MSOE. It serves as a technology transfer catalyst among academia, business, industry and governmental agencies. The close association between MSOE and the business, industrial community has long been one of its strengths; applied research serves as a renewable resource in this linkage. In addition to the FPI and Professional Education, the ATC is organized into several "centers of excellence:"



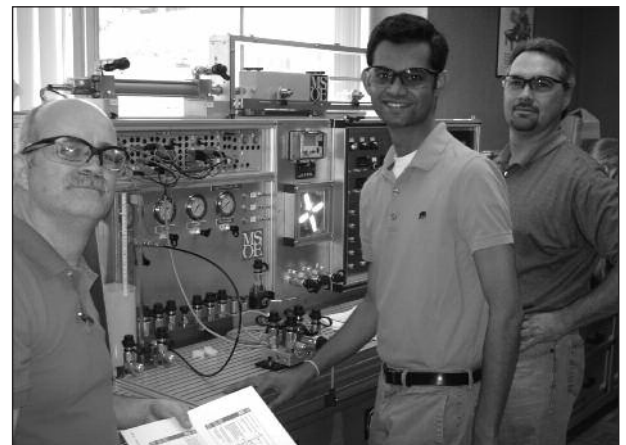
- ✕ Rapid Prototyping Center (RPC)
- ✕ NanoEngineering Lab
- ✕ Construction Science and Engineering Center
- ✕ Photonics and Applied Optics Center
- ✕ Center for BioMolecular Modeling

For more information:  
[www.msoe.edu/research](http://www.msoe.edu/research)



## ELECTRO-HYDRAULIC MOTION CONTROL LABORATORY

MSOE's fluid power seminars merge classroom theory with intense, practical laboratory sessions. The state-of-the-art laboratory contains four advanced workstations, each specifically designed for the individual interested in gaining a detailed and thorough understanding of all aspects of fluid power, including electrohydraulic system design. Seminar participants use servo and proportional valves in tests and systems, and make system interconnections. Computers collect data that facilitate the construction and analysis of feedback control systems. This Electrohydraulic Motion Control Laboratory is not found at any other educational institution in the world.





## FLUID POWER INSTITUTE™

### FPI™ at MSOE

The Fluid Power Institute™ (FPI) at MSOE is one of the leading academic fluid power research laboratories in the nation. Established in 1962, FPI is a leader in fluid power, research, evaluation, mechatronics and education.

### Test and Evaluation Programs

FPI conducts testing and evaluation for some of the largest hydraulic companies in the world, including Caterpillar, John Deere, Husco, and Parker Hannifin, as well as system evaluation for the U.S. military. The institute has specialized equipment for pump, valve, motor, cylinder and filter testing. FPI has specialized equipment for most hydraulic component evaluations and has the capacity to operate a wide variety of hydraulic components under a wide range of pressure and flow conditions. It also has the instrumentation and expertise to safely control and monitor endurance tests 24 hours a day seven days a week. Tests can be conducted in accordance with appropriate NFPA, ANSI, SAE, ISO and MIL standards.

### Laboratory capabilities

- ✖ Test Cell 1: 150HP, 65 gpm, 5,000 psi
- ✖ Test Cell 2: 450HP, 120 gpm, 6,500 psi
- ✖ Test Cell 3: 200HP, 65 gpm, 5,500 psi
- ✖ Test Cell 4: 100HP, 13.5 gpm, 15,000 psi
- ✖ Test Cells 5 and 6: 50HP, 8 gpm, 10,000 psi
- ✖ Test Cell 7: 200HP hydraulic motion testing
- ✖ 60,000 psi static burst pressure chamber
- ✖ 1,000 psi filter center tube collapse chamber

### Engineering Services

The key to developing a reliable, available and maintainable fluid power system is to make it an integral part of the engineering process, and to eliminate failures and failure modes through identification, classification, analysis and removal or mitigation. When developing fluid power systems, it is imperative to select the right activities and to conduct those activities at the right time. The engineering faculty and staff at FPI are experts in fluid power, and can help you develop highly reliable, available and maintainable fluid power systems and components. We can assist in developing your fluid power application from a simple design to an efficient and reliable hydraulic or pneumatic system.



200 HP dynamometer with electrical regeneration capabilities used for testing energy efficient fluids.

### Tribology Services

The FPI has been a leader in contamination analysis and filtration technology for decades. In the 1980s, FPI pioneered the use of automatic particle counters in hydraulic fluid analysis. In the 1990s, FPI pioneered the development of surgically clean fluids for initial-fill applications. In the 2000s, FPI was the very first to use Atomic Force Microscopy in wear particle analysis. FPI's role as a practitioner and educator in these areas has truly advanced the fluid power industry. Our current research thrust incorporates the study and formulation of energy-efficient hydraulic fluids—an endeavor funded by a grant from the National Science Foundation and industry partners.

Many of the world's largest equipment manufacturers use FPI to test new hoses, tubes, cylinders, coolers, reservoirs, pumps, bearings and valve assemblies to determine the type and size of manufacturing contamination, left in the component as received by the customer. Through the use of advanced diagnostic methods such as ferrography, atomic force microscopy, stereomicroscopy and laser particle imaging, early detection and root-cause analysis are possible.

For more information, visit [www.msos.edu/fpi](http://www.msos.edu/fpi).

## INTRODUCTION TO HYDRAULICS

This 27-hour seminar is designed to acquaint individuals with the fluid power field and provide a practical working knowledge of this important and growing industry. This program features laboratory sessions where participants will gain practical experience working with actual fluid power components and systems. Specifically, laboratory sessions will treat the disassembly, inspection and assembly of individual components, as well as system design examples.

### Who Should Attend?

This program is intended for individuals with limited exposure to fluid power, including engineers, technical sales personnel, technicians and management personnel.



*Save with  
Early and Multiple  
Registration*

### Objectives

Upon completion, participants should be able to:

- ✗ identify the distinguishing features of hydraulic systems.
- ✗ recognize hydraulic components by symbols and read schematics based on ISO standards.
- ✗ analyze hydraulic circuits from a schematic drawing using animated schematics modeled by Automation Studio.
- ✗ explain the operation and applications of pumps, rotors, valves, cylinders, rotary actuators and accumulators.
- ✗ utilize continuity and energy balance equations.
- ✗ understand the basic configuration and operation of hydrostatic transmissions.

"This seminar will help me in the future with customers and help with troubleshooting."

**Aaron Schaefer**  
**KTI Hydraulics Engineering**

### Laboratory Sessions

#### ✗ Component Laboratory

Participants will have an opportunity to view take-apart hydraulic system components and learn, in detail, their operation.

#### ✗ Hydraulic Systems Laboratory

Participants will have an opportunity to build hydraulic circuits and analyze data on state-of-the-art hydraulic trainers.

## Introduction to Hydraulics

### Dates

I. March 19-23, 2012  
II. Sept. 17-21, 2012

**Standard Fee** \$1,920

**Early Registration Fee** \$1,820

I. By Feb. 19, 2012  
II. By Aug. 17, 2012

**Fee for Multiple Registrants  
From the Same Company** \$1,720

**CEUs** 2.7

### Instructor

Dr. Medhat Khalil

### Program

**Day 1 Session** 9 a.m. - 4 p.m.  
**Lunch Reception** Noon - 1 p.m.

**Day 2-4 Sessions** 9 a.m. - 4 p.m.  
**Lunch on your own** Noon - 1 p.m.

**Day 5 Session** 9 a.m. - Noon  
**Box Lunch provided**

Continental breakfast served daily.  
Beverages/snacks provided throughout the day.

### Location

MSOE  
Milwaukee

## HYDRAULIC SPECIALIST CERTIFICATION REVIEW



Sponsored by the International Fluid Power Society, IFPS, <http://www.ifps.org/>

### What is the IFPS Hydraulic Specialist Certification?

It is a certification granted by IFPS based on passing a three-hour written test provided and proctored by IFPS. For more information, please visit: <http://www.ifps.org/Certification/index.htm>

### Objectives:

It is a three day review session held and provided by MSOE followed by the certification exam on the fourth day. The objective of the course is to provide instructions and review basics of hydraulics to maximize the chance of passing the exam. It is a non-CEU program, meaning MSOE will not grant credit units or a certificate. Study material is based on the IFPS study guide.

### Who should attend?

It is designed for candidates who are involved in hydraulic system sales, design, modeling and supervising system operation.

### Topical Outline:

- ✖ Job Responsibility 1.0: Apply hydraulic circuits to perform desired tasks.
- ✖ Job Responsibility 2.0: Analyze loads and motion.
- ✖ Job Responsibility 3.0: Select components for hydraulic applications.
- ✖ Job Responsibility 4.0: Prepare bills of material and schematics.
- ✖ Job Responsibility 5.0: Recommend fluid, fluid conductors and fluid filtration.
- ✖ Job Responsibility 6.0: Analyze and troubleshoot hydraulic systems.

### Notes

- ✖ Review session and exam can be taken to a customer's site for a minimum of 10 registrants.
- ✖ Please consider bringing a pencil, eraser and nonprogrammable scientific calculator. Reference handbook will be distributed.
- ✖ Review session fee does not include exam fee. **It is the responsibility of the attendees** to apply for the exam, pay the exam fee at IFPS and obtain study manual no later than two weeks before the review session.
- ✖ Register for the exam online at <http://www.ifps.org/Certification/> or call (800) 308-6005 x14

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Early and Multiple  
Registration*

### Hydraulic Specialist Certification Review

#### Dates

April 2-5 2012

#### Standard Fee

\$840

#### Early Registration Fee

\$790

By March 2, 2012

#### Fee for Multiple Registrants From the Same Company

\$740

#### Instructor

Dr. Medhat Khalil

#### Program

Day 1 Session 9 a.m. - 4 p.m.  
Lunch reception Noon - 1 p.m.

Day 2-3 Sessions 9 a.m. - 4 p.m.  
Lunch on your own Noon - 1 p.m.

Day 4 Session 9 a.m. - Noon  
Box lunch provided (exam day)

Continental breakfast served daily.  
Beverages/snacks provided throughout the day.

#### Location

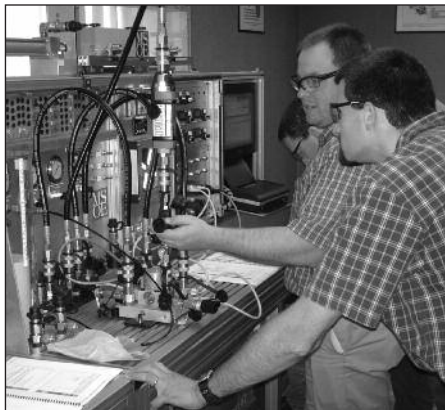
MSOE  
Milwaukee

## HYDRAULIC SYSTEMS MODELING AND SIMULATION FOR APPLICATION ENGINEERS

This 27-hour seminar focuses on the technique of building mathematical models with the least amount of design parameters needed. This technique is designed to help application engineers who are responsible for modeling systems at large. The simulation process of a component is based on existing data published by the component manufacturer or subsystem dynamics identified experimentally.

### Who Should Attend?

Hydraulic component designers, application engineers, system integrators, electrohydraulic motion control engineers, and end users of fluid power components and systems. Familiarity with Laplace transforms, block diagrams and state space is desirable for portions of the dynamic analysis.



### Objectives

Upon completion, participants should be able to:

- ✗ evaluate the importance of component sizing and simulation in the design process.
- ✗ apply principles of steady state and limited dynamic characteristics in both time domain and frequency domain.
- ✗ discuss different modeling approaches and levels for hydraulic components and systems.
- ✗ discuss the differences between simulation packages available in the market.
- ✗ exercise knowledge using MATLAB®/Simulink® to build mathematical models, define the simulation parameters, run a simulation and analyze the results.

### Laboratory Sessions

This seminar involves many laboratory exercises including software simulation. Some of these include component performance capturing experimentally, identify its dynamics, use the identified dynamics in building the component model.

### Topical Outline

- ✗ Introduction to Physical System Modeling and Simulation
- ✗ Dynamic Systems Modeling, Simulation and Analysis Review
- ✗ Hydraulic Components and Systems Modeling Approaches
- ✗ Fluid Properties Modeling
- ✗ Hydraulic Conductors Modeling
- ✗ Hydraulic Pumps Modeling
- ✗ Hydraulic Motors Modeling
- ✗ Hydraulic Cylinders Modeling
- ✗ Three Position Proportional and Servo Valves Modeling
- ✗ EH Cylinder Position Control System Modeling
- ✗ EH Motor Speed Control System Modeling
- ✗ Demo of Automation Studio

"This seminar provides several different approaches to modeling hydraulic components."

**Steven Gluck**  
Sauer-Danfoss

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Early and Multiple  
Registration*

## Hydraulic Systems Modeling and Simulation for Application Engineers

### Dates

April 23-27, 2012

### Standard Fee

\$2,240

### Early Registration Fee

\$2,040

By March 23, 2012

### Fee for Multiple Registrants

From the Same Company \$1,840

### CEUs

2.7

### Instructor

Dr. Medhat Khalil

### Program

**Day 1 Session** 9 a.m. - 4 p.m.  
**Lunch Reception** Noon - 1 p.m.

**Day 2-4 Sessions** 9 a.m. - 4 p.m.  
**Lunch on your own** Noon - 1 p.m.

**Day 5 Session** 9 a.m. - Noon  
**Box Lunch provided** Noon - 1 p.m.

Continental breakfast served on daily.  
Beverages/snacks provided throughout the day.

### Location

MSOE  
Milwaukee



## ELECTRO-HYDRAULIC COMPONENTS AND SYSTEMS

This 27-hour seminar is designed to cover the knowledge of electro-hydraulic components including solenoid operated valves, proportional valves, servo valves and amplifiers. The seminar also covers the technicalities of in-field tuning of open-loop and closed-loop electro-hydraulic systems. The state-of-the-art Universal Fluid Power Trainers are used to demonstrate the theory presented.

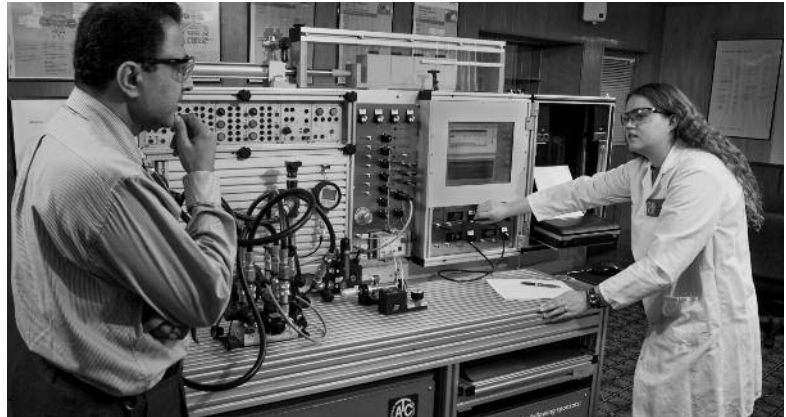
### Who Should Attend?

Application engineers, system integrators, motion control engineers, sales engineers, field engineers and end users of electrohydraulic components.

### Objectives

Upon completion, participants should be able to:

- ✗ recognize the difference in construction, principle of operation and characteristics between ON/OFF valves, proportional valves and servo valves.
- ✗ apply real-time control technique for EH systems and perform in-field tuning to adjust the system performance.
- ✗ read the basic electronic schematics of the proportional/servo valve amplifiers.
- ✗ make the best selection of the components required to build open- and closed-loop electro-hydraulic control systems.



### Laboratory Sessions

- ✗ Circuits for on/off valve operation
- ✗ Electro-hydraulic pump controls
- ✗ Electro-hydraulic cylinder position control
- ✗ Electro-hydraulic motor speed control
- ✗ Proportional and servo valve characteristics measurement



### Topical Outline

- ✗ Hydro-mechanical vs. electro-hydraulic solutions
- ✗ Electro-hydraulic system application
- ✗ Switching valves—construction and operation
- ✗ Switching valves—circuits for basic functions
- ✗ Proportional valves
- ✗ Servo valves
- ✗ Valve selection for an electro-hydraulic controlled actuator
- ✗ Electro-hydraulic system design considerations
- ✗ Control electronics for electro-hydraulic systems
- ✗ Electro-hydraulic valves commissioning and maintenance

## Electro-Hydraulic Components and Systems

### Dates

Aug. 27-31, 2012

### Standard Fee

\$2,240

### Early Registration Fee

\$2,040

By July 27, 2012

### Fee for Multiple Registrants

From the Same Company \$1,840

### CEUs

2.7

### Instructor

Dr. Medhat Khalil

### Program

#### Day 1 Session

9 a.m. - 4 p.m.

#### Lunch Reception

Noon - 1 p.m.

#### Day 2-4 Sessions

9 a.m. - 4 p.m.

#### Lunch on your own

Noon - 1 p.m.

#### Day 5 Session

9 a.m. - noon

#### Box Lunch provided

Continental breakfast served daily.

Beverages/snacks provided throughout the day.

### Location

MSOE

Milwaukee

## PLC PROGRAMMING AND SERVICING FOR FLUID POWER SYSTEMS

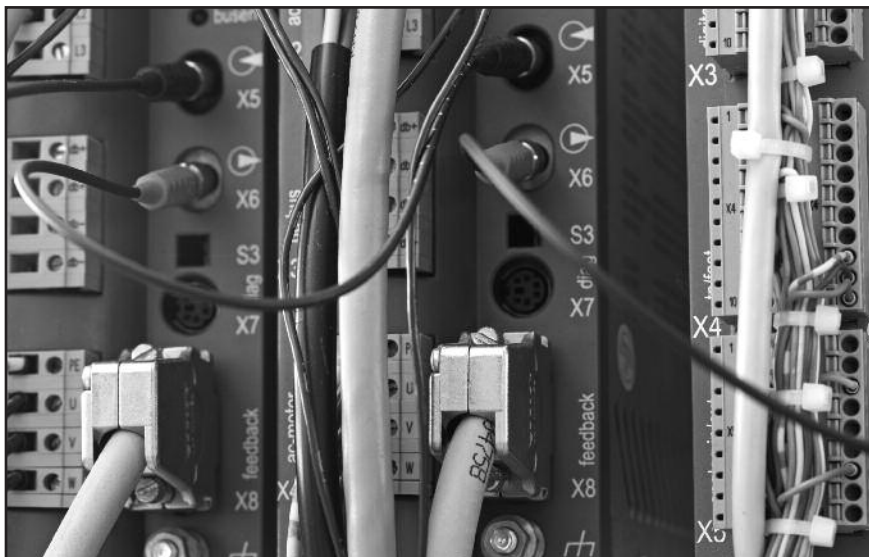
**New!**

### Who Should Attend?

This 27-hour seminar is designed for maintenance and engineering services personnel who have to identify and solve problems with PLC processors, commission machine changes and start PLC programmers focused on fluid power applications. The class will be PLC platform independent and will use a selection of PLC technology across the Allen-Bradley (Rockwell Automation) and Siemens platforms during hands-on exercises.

### Objective

Learning the techniques required to design and maintain a technical PLC-based control system focused on fluid power technology. The components required (such as sensors, actuators, PLCs and conventional components) and their application and functions are discussed to gain an understanding of how to automatically control a process. All tasks of software construction will be addressed with hands-on exercises and use of sample applications.



### Laboratory Sessions

- ✗ Creating hardware configurations
- ✗ Hardware trouble shooting exercises
- ✗ First basic PLC program
- ✗ Software troubleshooting exercises
- ✗ Creating reusable program blocks
- ✗ Sequence programs
- ✗ PLC-based Hydraulic Cylinder Position Control
- ✗ PLC-based Hydraulic Motor Speed Control

## PLC Programming and Servicing for Fluid Power Systems

### Dates

Sept. 10-14, 2012

### Standard Fee

\$2,240

### Early Registration Fee

\$2,040

By Aug. 12, 2012

### Fee for Multiple Registrants

From the Same Company

\$1,840

### CEUs

2.7

### Instructor

Rob Arbouw

### Program

Day 1 Session 9 a.m. - 4 p.m.  
Lunch Reception Noon - 1 p.m.

Day 2-4 Sessions 9 a.m. - 4 p.m.  
Lunch on your own Noon - 1 p.m.

Day 5 Session 9 a.m. - Noon  
Box lunch provided

Continental breakfast served on daily.  
Beverages/snacks provided throughout the day.

### Location

MSOE  
Milwaukee

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Early and Multiple  
Registration*

## SERVICE AND OPERATION FOR IMPROVED HYDRAULIC SYSTEMS RELIABILITY

This 27-hour seminar focuses on the topics that must be considered to maximize hydraulic system reliability. The introduced topics can be broadly classified as service-related and operational-related. In the service topics, maintenance, troubleshooting and failure analysis techniques will be discussed. In the operational-related topics, hydraulic fluids, contamination control and filtration technology will be discussed.

### Prerequisites

A fundamental understanding of hydraulics systems and components is necessary. MSOE's Introduction to Hydraulics seminar is an excellent preparation.

### Who Should Attend?

Filtration, maintenance and design engineers; fluid power sales professionals; multi-craft maintenance personnel; millwrights; pipe fitters, plumbers; mechanics; machinery maintenance mechanics and electromechanical repair technicians. If you're responsible for the ongoing operation of a fluid-power system, or if you manage or train workers who are, this seminar can show you what you need to know to keep the systems up and running.

### Objectives

Upon completion, participants should be able to:

- ✖ identify appropriate hydraulic fluids for given applications.
- ✖ extract fluid samples from operating hydraulic systems for fluid sample analysis.
- ✖ interpret the results of a fluid sample analysis.
- ✖ explain the effects of contaminants on hydraulic systems.
- ✖ evaluate the differences of filter ratings and specifications.
- ✖ select an appropriate filter for specific applications.
- ✖ understand cost-effective filtration.
- ✖ plan and schedule hydraulic system maintenance.
- ✖ significantly reduce the system leakage through a better handling and understanding of hydraulic systems seals and conductors.
- ✖ utilize a logical approach for hydraulic systems troubleshooting.
- ✖ identify hydraulic system failure and the approach to solve it.

"I gained a better understanding of cavitation and the difference in oil and the additives."

**Troy Davis**  
Charter Steel

### Topical Outline

- ✖ hydraulic fluids
- ✖ hydraulic fluid seals
- ✖ filtration technology and contamination control
- ✖ oil conductors
- ✖ hydraulic system safety
- ✖ hydraulic accessories and system reliability
- ✖ hydraulic system maintenance
- ✖ hydraulic system troubleshooting and failure analysis

## Service and Operation for Improved Hydraulic Systems Reliability

### Dates

Dec. 10-14, 2012

### Standard Fee

\$1,920

### Early Registration Fee

\$1,820

By Nov. 10, 2012

### Fee for Multiple Registrants From the Same Company

\$1,720

### CEUs

2.7

### Instructors

Dr. Medhat Khalil  
Paul Michael, CLS  
Thomas Wanke, CFPE

### Program

**Day 1 Session** 9 a.m. - 4 p.m.  
Lunch provided Noon - 1 p.m.

**Day 2 Sessions** 9 a.m. - 4 p.m.  
Lunch on your own Noon - 1 p.m.

**Day 3 Session** 9 a.m. - Noon  
Lunch provided

Continental breakfast served on daily.  
Beverages/snacks provided throughout the day.

### Location

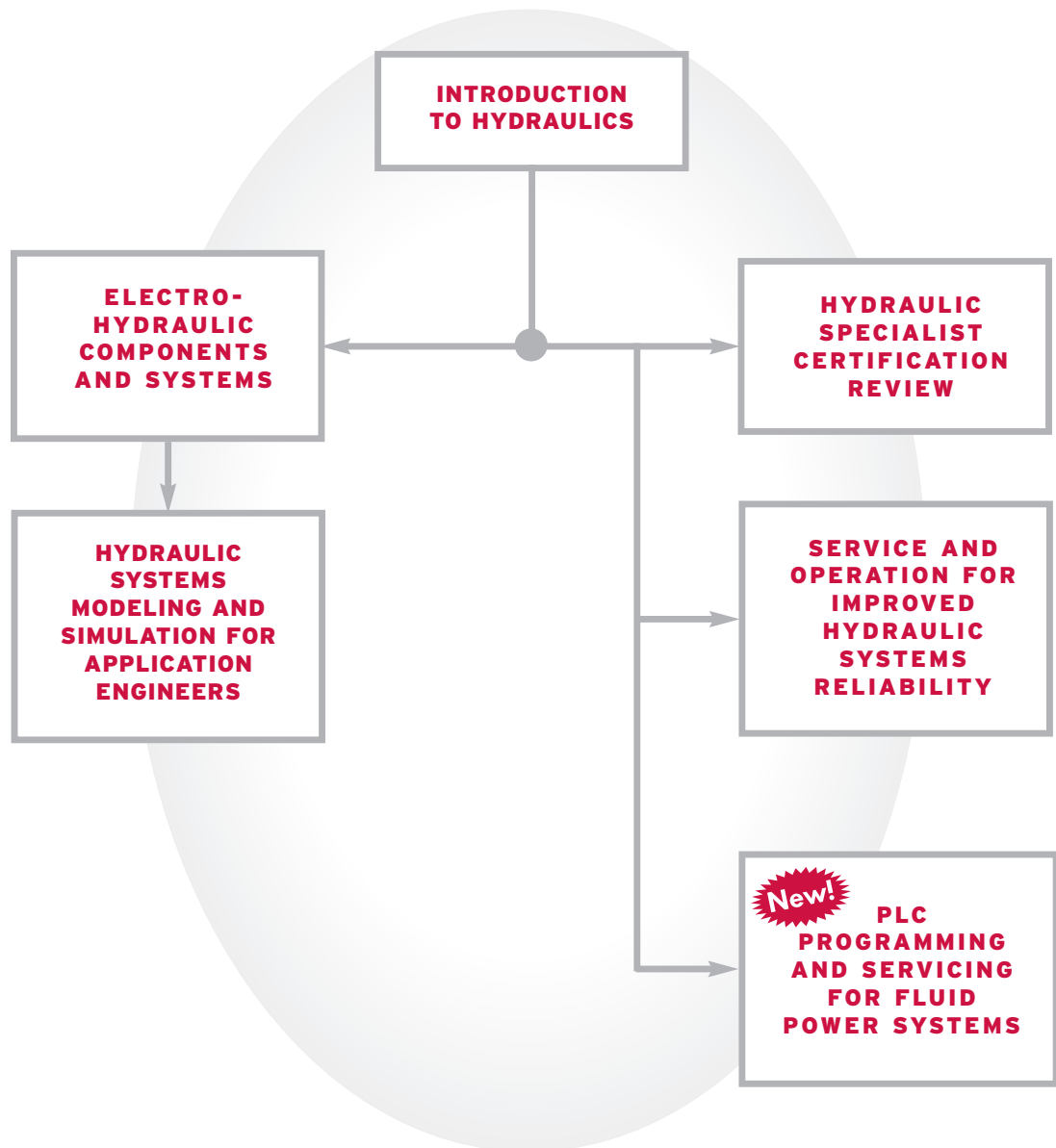
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Registration*



## SEMINAR MATRIX

- ✖ The matrix shown here suggests the sequence or paths to follow to master topics in the fluid power field, depending on your background and career plans.
- ✖ The left path is more advanced topics leading up to design of electrohydraulic feedback control systems that require basic hydraulics and a higher level of mathematics background.



## FACULTY BIOGRAPHIES



**Dr. Medhat K. Khalil** is the director of professional education. He has a bachelor's degree in mechanical engineering and a master's degree in fluid power

engineering from Military Technical College and Cairo University, respectively, of Cairo, Egypt. He earned his Ph.D. in mechanical engineering from Concordia University, Montreal, Canada. Khalil has more than 20 years of experience in fluid power control. Prior to joining MSOE, he was employed as a hydraulic system simulation software developer for CAE Inc. and an adjunct professor for Concordia University, Montreal, Canada. Khalil worked for five years as the technical officer and training manager for Mannesmann Rexroth in Egypt. His current interest is in developing universal fluid power software and hardware controllers. Khalil is a member of education outreach of the Center for Compact and Efficient Fluid Power, has extensive experience in modeling and simulation of hydraulic systems and designing electro-hydraulic systems. He is a listed consultant by the NFPA.



**Thomas Labus, P.E.,** is a professor in MSOE's Mechanical Engineering Department. He earned a bachelor's degree in aeronautical engineering from Purdue University

and a master's degree in theoretical and applied mechanics from the University of Illinois.



**Paul Michael, C.L.S.,** is a research chemist in MSOE's Fluid Power Institute. He earned his B.S. in chemistry at the University of Wisconsin-Milwaukee and graduated with distinction from

Keller Graduate School of Management. He has more than 30 years of experience in the formulation and testing of hydraulic fluids and lubricants. Paul is an STLE Certified Lubrication Specialist and chairs the NFPA Fluids Committee. In addition to his research in contamination analysis, he is currently investigating energy efficient hydraulic fluids in the NSF funded multi-university Center for Compact and Efficient Fluid Power.



**Thomas Wanke '78, '96, C.F.P.E.,** is the director of MSOE's Fluid Power Institute, America's leader in fluid power technology research and education. He has more than 40

years of experience in fluid power technology, 38 of which have been at MSOE. Wanke has a bachelor's degree in mechanical engineering technology and a master's degree in engineering with a fluid power specialty option, both from MSOE. He has worked on projects in the following areas: component and system design; development and evaluation; field troubleshooting and failure analysis; and fluids, filtration and contamination control. Wanke is a member of SAE and FPS. He is chairman of the NFPA Technical Board and was Educational Program Co-chairman for IFPE 2011.



**Rob Arbouw - Senior Trainer**

Born in the Netherlands, Arbouw started working for Applied Tech Systems (ATS) more than 12 years ago. He is a graduate of

the University of Amsterdam with a bachelor's degree in mechanical engineering and a specialization in flexible production automation. Arbouw started working with PLC in Europe, and continued after moving to the United States in 2003. In 2004, he began providing PLC training to many ATS customers throughout the U.S. All this contributed to his wide knowledge of different PLC platforms used around the world and resulted in a clear understanding of the need of standard program techniques. As an ATS trainer, Arbouw maintains the highest customer satisfaction rating of all U.S. trainers.



To speak with a seminar instructor call (414) 277-7269.



## SEMINAR INFORMATION

### How to Register

MSOE offers four convenient ways to register: mail, phone, fax or website. To ensure maximum seminar quality, enrollment is limited. Please note the discount applicable for registering early and for multiple registrations from the same company. Advance registration is required and may be accomplished by:

### Mail Registration Form and Seminar Fee to:

Applied Technology Center  
Milwaukee School of Engineering  
1025 North Broadway  
Milwaukee, WI 53202-3109

### Phone

(414) 277-2492 or (800) 332-6763 x2492

### Fax

Attn: Professional Education Office  
Fax: (414) 277-7470

### Website

[www.msoe.edu/seminars](http://www.msoe.edu/seminars)

### Seminar Fees Include

The seminar fees include a customized seminar manual and/or textbooks, handout materials, daily continental breakfast, break refreshments and lunch reception.

### Location and Parking

The Applied Technology Center - Professional Education Office is located in Room S-140 in the Allen-Bradley Hall of Science, 432 E. Kilbourn Avenue. Access the building from the State Street side.

Upon receipt of your registration, you will be mailed a confirmation letter with specific location information. Parking is available on campus in the MSOE Milwaukee Street Lot A on the northwest corner of State and Milwaukee Streets (see map on last page).

### Seminar Room S-100

Classroom/lab dedicated for professional education, especially fluid power.

### Cancellation Policy

MSOE reserves the right to cancel a seminar if minimum enrollment is not met. Please be informed that payment is due three weeks before the seminar, by credit card or by check. If payment is not received by the due date, your registration is not guaranteed. Cancellations before payment due date will be fully refunded.

Cancellations three weeks before the seminar are subject to a \$200 cancellation fee with a refund of the remainder. Cancellations two weeks before the seminar date are subject to a \$400 cancellation fee with a refund of the remainder. Cancellations one week before the seminar are subject to a \$600 cancellation fee and the remaining funds will be used as a credit towards any future seminar (subject to availability).

### Payment

Payment may be made via check (payable to MSOE), MasterCard, VISA or by forwarding a purchase order, from which MSOE will invoice. A discount is applicable for each registrant if two or more individuals from the same company register at the same time or for early registration.

### Continuing Education Unit

A certificate of participation will be awarded documenting the number of continuing education units (CEUs) earned for participating in the seminar. One CEU is awarded for 10 contact hours. The CEU is a nationally recognized standard unit of measurement awarded for participation in a continuing education experience under responsible sponsorship, defined objective and qualified instruction.

### What to Wear

Dress casual and comfortable. Look up Milwaukee weather forecast to plan your trip. [www.weather.com](http://www.weather.com), zip code 53202.

### What to Bring

Scientific Calculator

### Questions?

**Phone:** (414) 277-2492

**Fax:** (414) 277-7470

**Email:** [learn@msoe.edu](mailto:learn@msoe.edu)

**Website:** [www.msoe.edu/seminars](http://www.msoe.edu/seminars)



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Registration

Register Online at  
[www.msOE.edu/seminars](http://www.msOE.edu/seminars)

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**Date** \_\_\_\_\_

**Phone:** (414) 277-2492  
**Fax:** (414) 277-7470  
**Email:** [learn@msOE.edu](mailto:learn@msOE.edu)

**Please enroll the individual(s) listed below in:****Fee:**☐ **Introduction to Hydraulics**

☐ March 19-23, 2012 ☐ Sept. 17-21, 2012

☐ **Hydraulic Specialist Certification Review**

☐ April 2-5, 2012

☐ **Hydraulic Systems Modeling and Simulation for Application Engineers**

☐ April, 23-27, 2012

☐ **Electro-Hydraulics Components and Systems**

☐ Aug. 27-31, 2012

☐ **PLC Programming and Servicing for Fluid Power Systems**

☐ Sept. 10-14, 2012

☐ **Service and Operation for Improved Hydraulic Systems Reliability**

☐ Dec. 10-14, 2012

**For free seminars please go to [www.msOE.edu/seminars](http://www.msOE.edu/seminars)**

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Name (Dr./Mr./Mrs./Ms.)

\_\_\_\_\_  
Title Email

2. \_\_\_\_\_  
Name (Dr./Mr./Mrs./Ms.)

\_\_\_\_\_  
Title Email

\_\_\_\_\_  
Company

\_\_\_\_\_  
Company address

\_\_\_\_\_  
City/State/Zip

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Company telephone Fax

Seminar fee(s) of \_\_\_\_\_ are enclosed. (Make check payable to MSOE)

☐ Company purchase order enclosed. Please invoice accordingly. PO# \_\_\_\_\_

☐ Charge seminar fee(s) of \$ \_\_\_\_\_ to ☐ MasterCard ☐ VISA

Account number \_\_\_\_\_ Expiration date \_\_\_\_\_

\_\_\_\_\_  
Signature

**Register early or enroll multiple registrants for discounted fees. (Additional registration form on back. For more participants or future registrations, please make copies.)**

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Title Email

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Signature

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## CENTER FOR COMPACT AND EFFICIENT



The Center for Compact and Efficient Fluid Power (CCEFP) is a National Science Foundation (NSF) Engineering Research Center, funded for a five-year period with \$17.5 million from NSF, \$3.5 million in membership dues from participating companies, and \$3 million from participating universities.

Our Center is a network of researchers, educators, and industry working together to transform the fluid power industry—how it is studied, applied and taught. Fluid power is used in a wide range of industries, including manufacturing, transportation, aerospace, construction, agriculture and medical devices. Nearly all U.S. manufacturing plants rely on fluid power in their production of goods.

The work of the Center will have profound societal impact, bringing dramatic change to fluid power applications now found in a broad spectrum of industries. Examples of innovative technology that will result from Center research include devices that improve mobility for the ailing and elderly, autonomous rescue and service robots and fluid-powered portable hand tools.

### Research

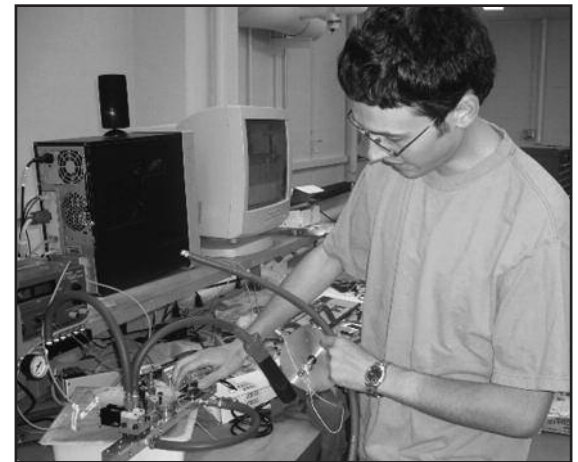
The CCEFP has four research goals: to dramatically improve the energy efficiency of fluid power in current applications; to improve the efficiency of transportation by developing fuel efficient hydraulic hybrid vehicles; to develop untethered portable human-scale fluid power devices; and to make fluid power clean, quiet, safe and easy to use. The research needed to realize these goals is being conducted in three coordinated thrust areas and demonstrated in five test beds. Thrust areas include Thrust 1 - Efficiency, Thrust 2 - Compactness, and Thrust 3 - Effectiveness. Center research is demonstrated in five test beds: an excavator, SUV (small Urban Vehicle),

compact rescue crawler, fluid power-assisted portable hand tools, and fluid power-assisted orthoses.

### Education

The Center's network and research enable the development and delivery of innovative education and outreach programs relevant to fluid power to middle and high school students, undergraduate and graduate students, engineers, industry practitioners, and the general public. Some highlights:

- ✖ Working with Project Lead The Way to add fluid power content to PLTW's engineering curriculum for middle and high schools, now taught nationwide.
- ✖ Revising undergraduate curriculum so all mechanical engineers understand fluid power.
- ✖ Developing specialized fluid power courses for graduate and advanced undergraduate students.
- ✖ Building an industrial internship program for undergraduate and graduate students.
- ✖ Collaborating with the Science Museum of Minnesota in the development of permanent and traveling fluid power exhibits.
- ✖ Producing a documentary on fluid power, in conjunction with Twin Cities Public Television.
- ✖ Working with tribal colleges in Minnesota and Wisconsin to promote engineering among Native American students and to provide mentoring services.



### Industrial Collaboration/Technology Transfer

More than 60 fluid power manufacturers, distributors, and suppliers have become supporting members of the Center—an unprecedented demonstration of industry support. In addition, many of these companies contribute equipment and provide project champions who actively work with universities on project and test bed research.

### Participating Institutions

- ✖ University of Minnesota (lead institution)
- ✖ Georgia Institute of Technology (GT)
- ✖ Milwaukee School of Engineering (MSOE)
- ✖ North Carolina Agricultural and Technical State University (NCAT)
- ✖ Purdue University (PU)
- ✖ University of Illinois at Urbana-Champaign (UIUC)
- ✖ Vanderbilt University (VU)

### Outreach Institutions

Science Museum of Minnesota  
National Fluid Power Association  
Project Lead the Way

Visit [www.ccefp.org](http://www.ccefp.org) for more information.



## GROHMANN MUSEUM

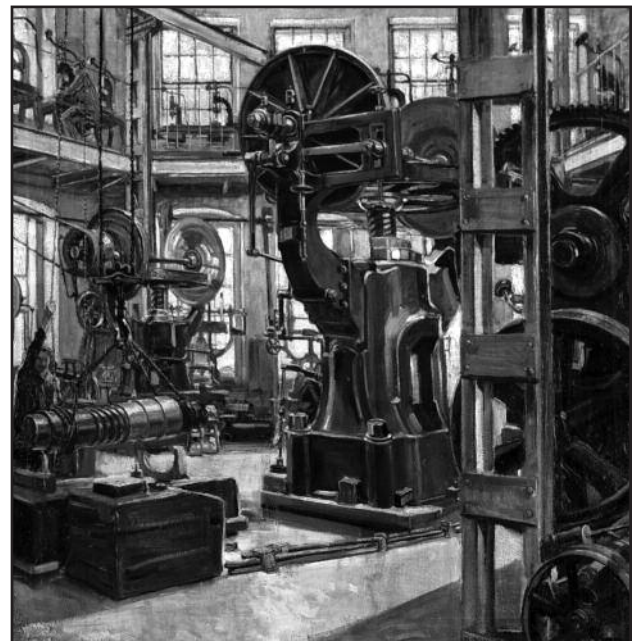
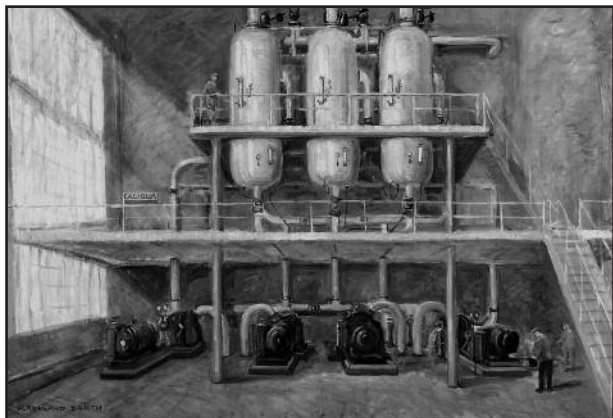
While your on campus, visit the Grohmann Museum, home to the world's most comprehensive art collection dedicated to the evolution of human work. The museum has three floors of galleries where the art collection is displayed, as well as a spectacular rooftop sculpture garden.

The collection comprises more than 800 paintings and sculptures from 1580 to the present. They reflect a variety of artistic styles and subjects that document the evolution of organized work. The museum also presents three to four special exhibitions per year.

The museum is named in honor of Dr. Eckhart Grohmann, an MSOE Regent, Milwaukee businessman and avid art collector who donated his collection to MSOE in 2001 and subsequently the funds to purchase, renovate and operate the museum.



[www.msoe.edu/museum](http://www.msoe.edu/museum)



## DIRECTIONS TO MSOE

### Air Travel to Milwaukee

Book your own flight to Mitchell International Airport (Airport Code: MKE), it is a 15-minute taxi ride to downtown Milwaukee.

### Driving Directions to MSOE

#### From the north

Take I-43 south to downtown Milwaukee. Then take Hwy 145 east/McKinley Avenue exit (exit # 73 A). Turn left (east) on McKinley; proceed for six blocks. Turn right on Broadway to the specific building or parking lot on campus.

#### From the south

Take I-94 west/I-43 north to downtown Milwaukee. Continue north on I-43, then take Hwy 145 east/McKinley Avenue exit (exit # 73 A). Proceed on McKinley for six blocks. Turn right on Broadway to the specific building or parking lot on campus.

### From the west

Take I-94 east to downtown Milwaukee; then take I-794; exit Jackson/Van Buren (exit # 1 E). Proceed north on Van Buren Street seven blocks to State Street; turn left. Follow State Street to the specific building or parking lot on campus.

Look for signs at parking lot entrances for a campus map.

### Exciting Metropolitan Setting

Milwaukee is one of the largest cities in the country with a metropolitan population of approximately 1.7 million residents, yet maintains the intimacy of a smaller community. MSOE's 15-acre campus, located in historic East Town, a vibrant downtown community, is just blocks from beautiful Lake Michigan, the theater district, museums, sports and music venues, parks and shopping. The city also stages more than 50 major festivals and other public gatherings annually.

### Where to Stay

We recommend the following hotels within a ten-minute walking distance to the seminar location. Mention MSOE when making reservations to receive a reduced rate. These hotels are served by airport shuttles from Milwaukee's Mitchell International Airport.

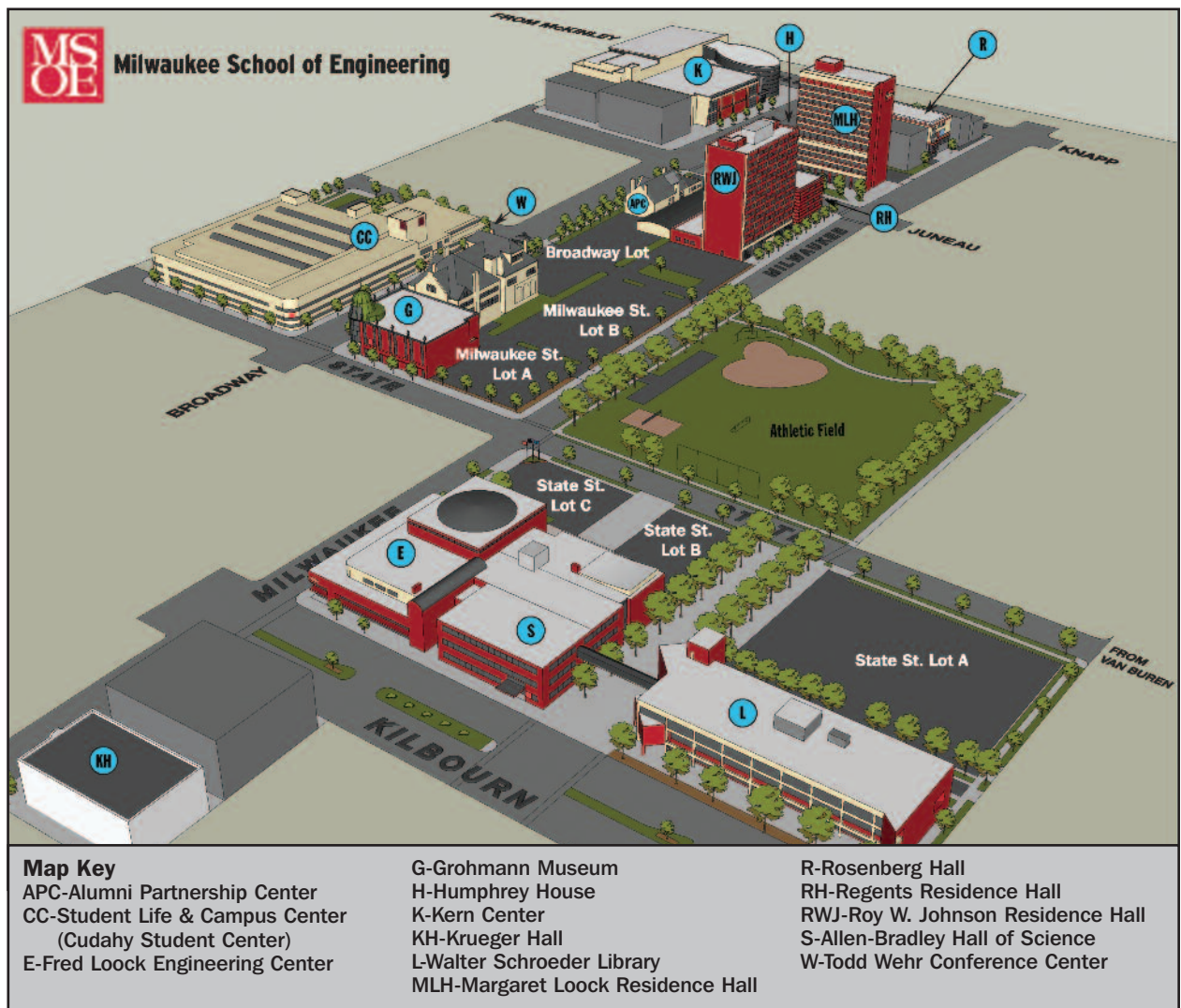
#### Hyatt Regency Milwaukee

(414) 276-1234  
(800) 233-1234  
333 W. Kilbourn Ave.  
\$109 plus tax per night  
[www.hyatt.com/hyatt/index.jsp](http://www.hyatt.com/hyatt/index.jsp)

#### The Astor Hotel

(414) 271-4220  
924 E. Juneau Ave.  
\$69 per week night plus tax

More information,  
visit: [www.msoe.edu/seminars](http://www.msoe.edu/seminars)







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