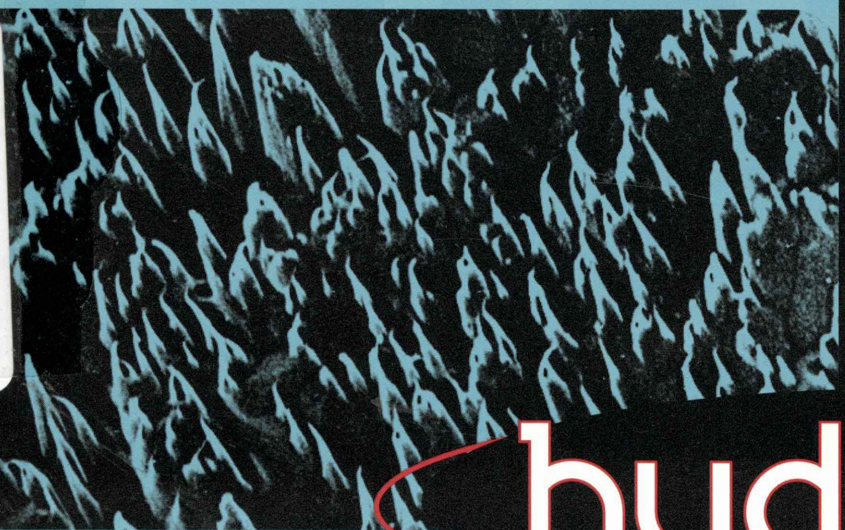
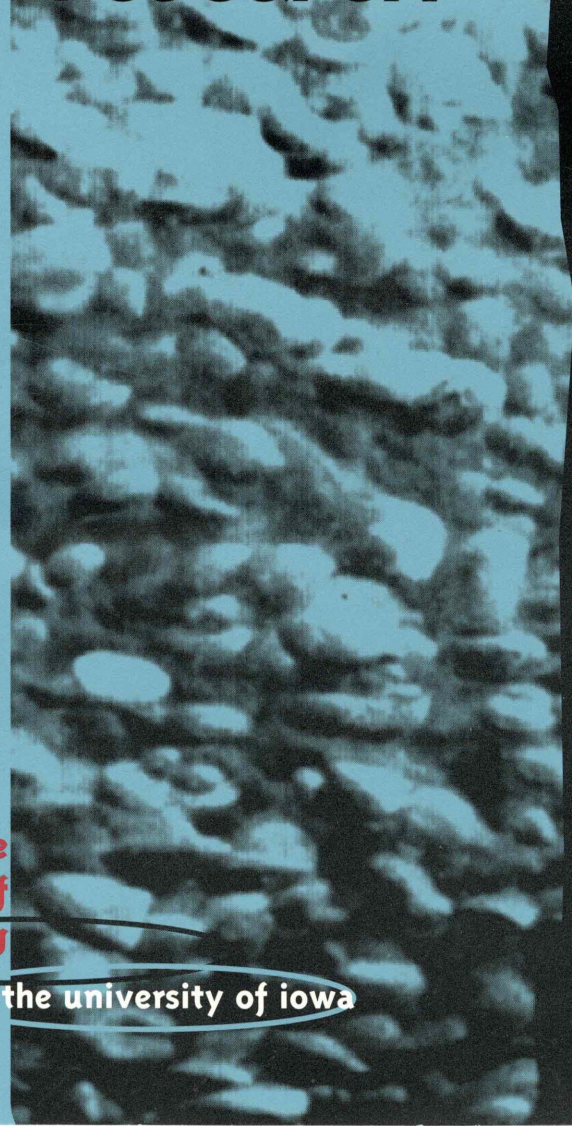


iowa institute of hydraulic research



college of engineering

the university of iowa

The University of Iowa

The central campus of The University of Iowa (UI) is in Iowa City, a community with a metropolitan-area population of approximately 70,000 people located on the Iowa River in east-central Iowa. **UI,** founded in 1847, is Iowa's oldest institution of higher education and the first public university in the United States to admit women and men on an equal basis. Disciplines of educational testing and speech pathology were begun at UI. **It also** was among the first to award graduate credit for creative work and is home of the famous Writers' Workshop, International Writing Program, and Playwrights' Workshop. **Among** UI's strongest programs, besides those listed above, are space science, hydraulics research, computer-aided design, and human medicine. **The** UI Health Center includes University of Iowa Hospitals and Clinics, one of the naton's largest university-owned teaching hospital complexes. **Currently** about 27,000 students, representing all 50 states and some 90 foreign countries, are enrolled in its ten colleges. **Students** are served by a 3.3-million-volume library which is considered to have one of the best research/academic reference collections in the country. **The** University of Iowa and the Iowa City community offer many recreational and cultural opportunities through their several parks and playing fields, recreation centers, museums, and theaters, including the 2,680-seat Hancher Auditorium, which has received critical acclaim as one of the finest multipurpose theaters in the nation.

iihr

The Iowa Institute of Hydraulic Research

Iowa Institute of Hydraulic Research (IIHR), a unit of The University of Iowa's (UI) College of Engineering and one of the nation's premier and oldest fluids research and engineering laboratories, is situated on the Iowa River in Iowa City, Iowa. IIHR historically has been closely involved in the study and development of the Mississippi and Missouri rivers, which together form one of the world's largest drainage basins; however, the research activities of IIHR extend well beyond the Midwest into the international domain. These activities include several international cooperative research and education exchange agreements and encompass the broad spectrum of hydraulics and fluid mechanics. In recent years, IIHR has conducted programs of teaching, together with basic and applied research, in the following areas:

Fluid Mechanics
- Turbulent Shear Flows
- Vortex Dynamics
- Ship Hydrodynamics
- Computational Fluid Dynamics

Hydraulics
- River Hydraulics
- Computational Hydraulics
- Hydraulic Structures
- Environmental Hydraulics

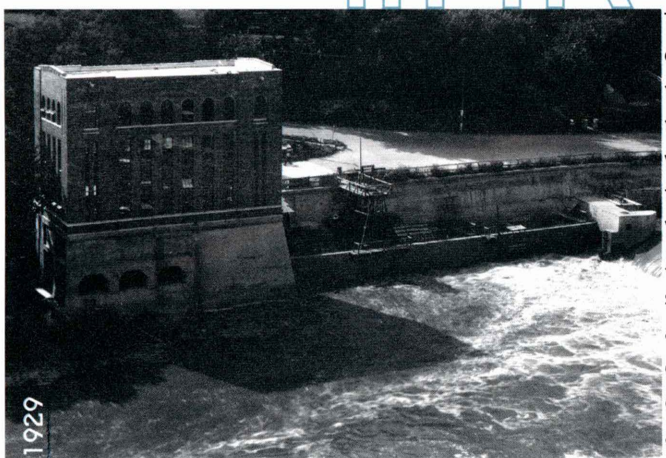
Cold-Regions Engineering
- Ice-Related River Hydraulics
- Ice Mechanics
- Winter Highway Maintenance
- Ice Modeling

Water Resources
- Hydrometeorology
- Integrated Watershed Processes

History
- Hydraulics
- Fluid Mechanics

IIHR has extensive research facilities, and professional and support staff, to respond in timely fashion to research opportunities and special requirements of engineering projects. Research facilities and staff and student offices are housed in six buildings located on UI's campus, which are linked by a high-speed local area network bridged directly to the University and the Internet.

the history of IIHR



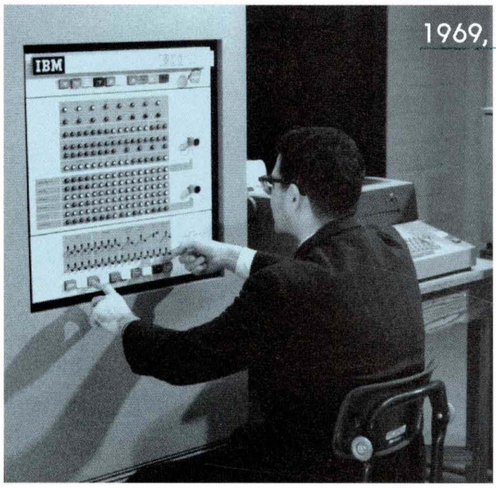
hydraulics laboratory, 1929

mississippi river lock and dam model, 1934
sponsor: u.s. army corps of engineers

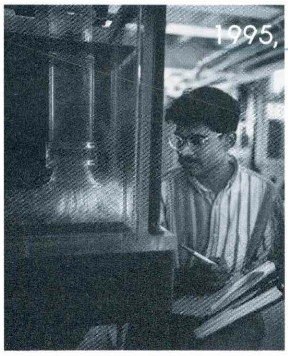
The original structure for the hydraulics laboratory essentially was a small machine room and workshop at the end of a 40-meter-long, 3-meter-wide open channel, which extended south from the west end of the Burlington Street dam on the Iowa River. Visionaries on UI's faculty foresaw the possibility of a hydraulics research facility at the site when the dam was constructed in 1904 and left a 3-meter opening to provide an entrance to an experimental channel. The original laboratory was completed in 1919 and became part of the Department of Mechanics and Hydraulics of the UI's College of Engineering. The hydraulics laboratory building was expanded twice, once in 1929 and again in 1932. It appeared then much as it does today.

The broadening scope and complexity of projects in the laboratory led to the formal organization of IIHR, in 1931, to allow the coordination of talent, facilities, and resources of the University for the solution of problems in fluid mechanics, hydrology, and hydraulic engineering. Although an integral part of the College of Engineering, IIHR has since then functioned as a separate entity in the negotiation and fulfillment of agreements and contracts with a variety of private organizations and governmental agencies.

During World War II, IIHR conducted research in the areas of ship resistance; fog dispersal for military airfields; diffusion of smoke and gas in urban districts;



1969, IBM 1801 used for on-line data acquisition and control



1995, flow-diagnosis with laser doppler and particle-image velocimeters

wind structure over mountainous terrain; investigations of cavitation around undersea bodies; and the development of fire monitors for naval vessels. After the war, an era of renewed emphasis on basic research in fluid motion, graduate study, and writing of textbooks in fluid mechanics and hydraulics began.

Beginning in the mid-1960's IIHR's research scope was broadened to maintain a fertile balance of basic and applied research. Major new research initiatives during the ensuing 25 years included thermal pollution of water bodies, ice engineering, design of hydraulic structures, and hydrometeorology. Five new laboratory buildings were constructed to house such facilities as an environmental flume, an ice-towing tank and laboratories, a low turbulence wind tunnel, and large-scale hydraulic models. Advanced flow-diagnostics equipment, including laser-velocimetry, and data-processing computers were acquired, and research in computational fluid dynamics and hydraulics was promoted.

IIHR continues its tradition of ongoing modernization of its facilities and capabilities to remain on the cutting edge of fluid and hydroscience research and education.

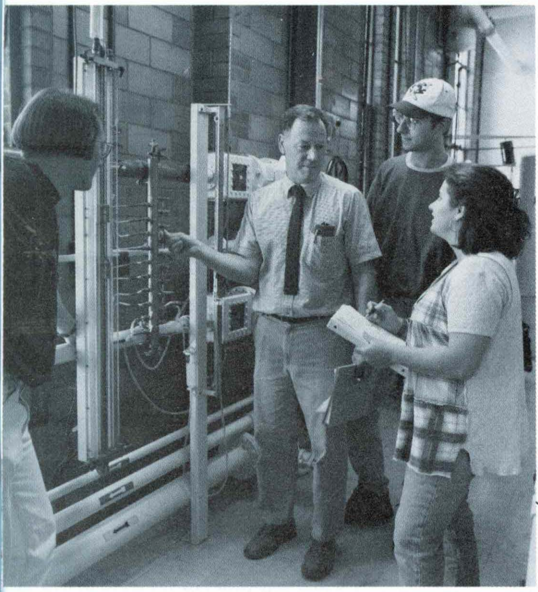
The following pages of this brochure provide a glimpse of the diverse educational and research activities of IIHR.

education, research, and engineering investigations

IIHR's mission is to educate and conduct research in the broad fields of fluid mechanics, hydraulics and the hydrosciences.

IIHR educates its students primarily through classroom and laboratory teaching, although its many site-specific investigations provide students with unique educational opportunities for hands-on experience and training. Most of IIHR's senior staff hold joint faculty appointments in the Department of Civil and Environmental Engineering or Department of Mechanical Engineering. Other staff are affiliated with the Geography and Geology departments. In their dual academic/research roles, senior staff teach courses at all levels, advise undergraduate and graduate students, and supervise thesis research. Faculty also serve on department, college, and University committees. Students working with IIHR-affiliated faculty have ready access to all IIHR facilities, as well as technical and support personnel. Weekly seminars are held at IIHR with speakers drawn from the IIHR staff and student body and from visitors to IIHR from other academic and research institutions and engineering firms throughout the world. IIHR's research ranges from studies on fundamental aspects of engineering science to diverse engineering practice, or applied-research, projects.

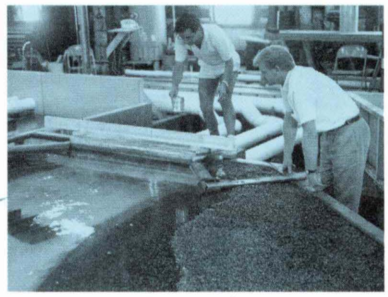
All of these activities contribute to the unique "triple-point" environment of IIHR, where academic instruction, basic research, and engineering investigation and practice not only coexist in one organization but complement each other and proceed in unison.



undergraduate fluids lab at IIHR

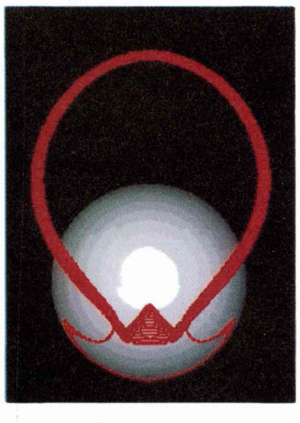
students working with faculty in engineering projects

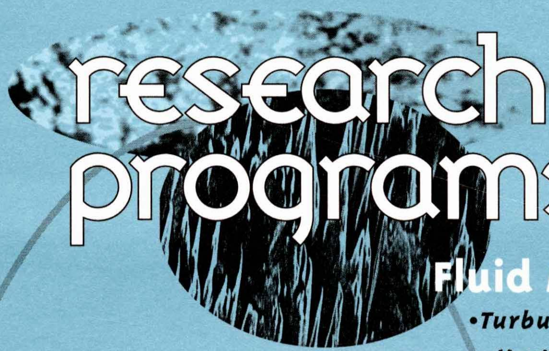
sponsor: city of leclaire, iowa



evolution of a vortex behind a sphere (back view)

sponsor: u.s. office of naval research





research programs:

page(s)

Fluid Mechanics 6-9
- *Turbulent Shear Flows*
- *Vortex Dynamics*
- *Ship Hydrodynamics*
- *Computational Fluid Dynamics*

Hydraulics 10-13
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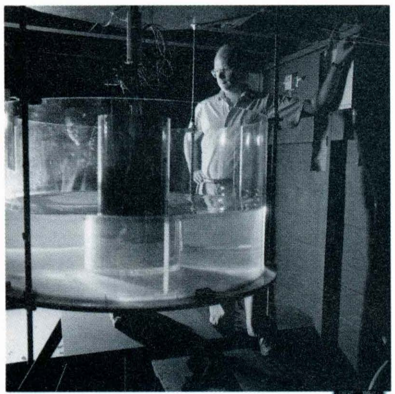
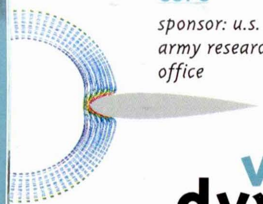
rotating tank to study geophysical flows

sponsor: u.s. army research office



numerical simulation of blade penetrating a vortex core

sponsor: u.s. army research office



vortex dynamics

Experimental and computational work is performed on a variety of aspects of vortex dynamics, with application to problems in aerodynamics, ship hydrodynamics, geophysics, and hydraulics.

Ongoing research includes investigation of the dynamics of coherent vortices and general issues involving the transport and generation of vorticity in incompressible flows. Experiments using high-resolution particle-image velocimetry (PIV) clarify the unsteady aspects of vortices. Computations are performed using a variety of algorithms, ranging from conventional primitive-variable formulations to discrete vortex-element formulations.

Studies on the dynamics of vortices are used as an idealization for improved design of certain vortex-related devices and for understanding of the physics of turbulent flows. Recent topics of investigation include evolution and breakup of vortices subjected to straining and shearing flows, vortex evolution in density stratified flow, stability of three-dimensional vortex configurations, and vortex processes in the far wake of blunt bodies.

The dynamics of vortex-body interaction is of importance for predicting unsteady forces and associated noise generation in rotorcraft aerodynamics and marine-propulsor hydrodynamics and for sediment entrainment by vortices in river bends, at the base of pilings, and in rolling ocean waves on a beach.

vortex breakdown following cut with a thin blade *sponsor: u.s. army research office*

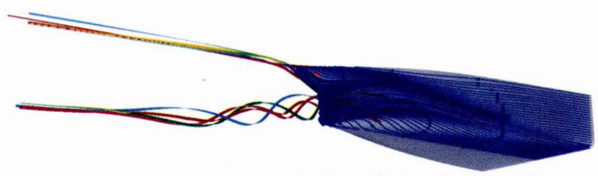
turbulent shear flows

The five wind tunnels in the Wind Tunnel Annex are dedicated to the study of complex turbulent shear flows. Experiments are conducted in turbulent boundary layers and wakes of bodies and structures, in jets, and in combinations of such flows, to elucidate the physics of phenomena such as flow separation, vortex formation and decay, and evolution of coherent structures or large eddies in turbulence. Measurements are made with multi-component hot-wire and laser velocimetry (LDV), along with state-of-the-art data acquisition computers and data processing software.

Detailed measurements in the flow around bodies at angle of attack, airfoils, wings, ship hulls and propellers have provided new insights into the flow physics and the central problem of turbulence modeling, and have served to develop and assess modern methods of computational fluid dynamics (CFD). Indeed, data gathered at IIHR were employed in international CFD workshops as test cases to gauge the success with which numerical models predict complex turbulent flows.

IIHR wind tunnels are occasionally employed in applied research projects to calibrate probes, measure wind loads on buildings and structures, and study the flow around automobile and truck models.

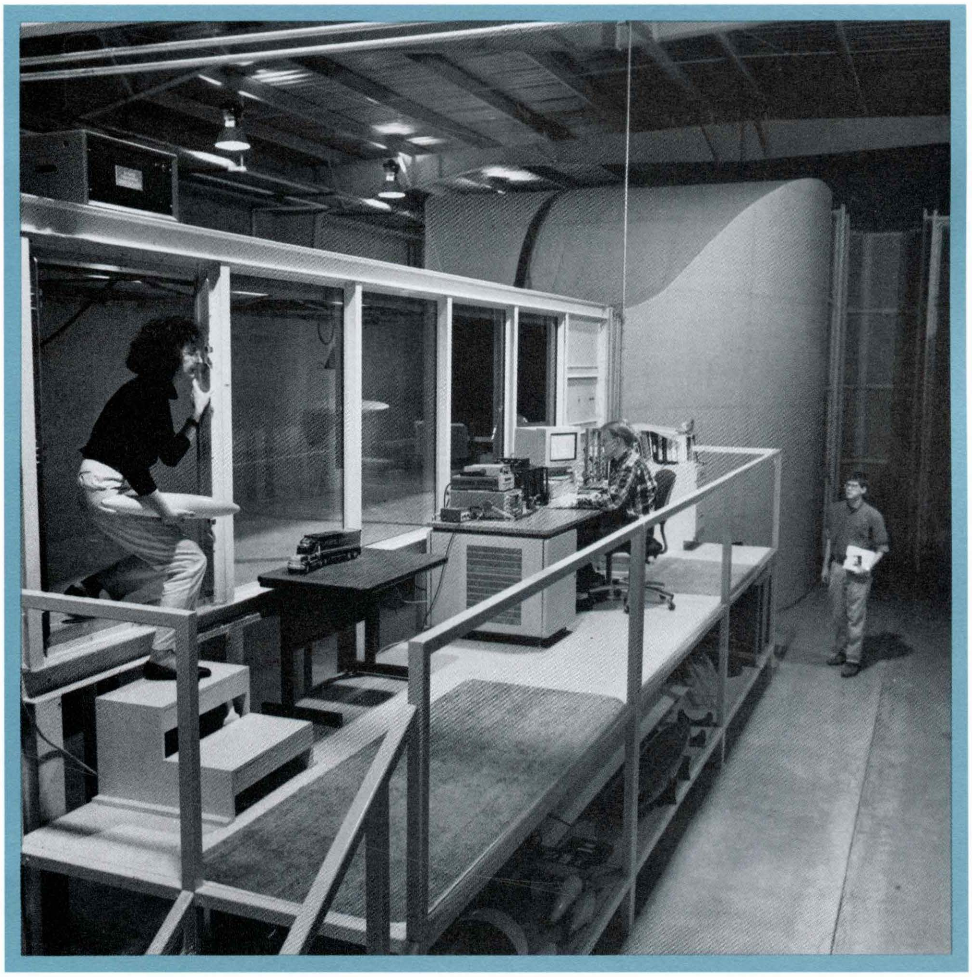
Development of turbulence models, ranging from two-equation to full Reynolds-stress models, to simulate complex, three-dimensional, shear flows have been the subject of intense research. Calculations have been carried out for a wide range of internal and external flows, with emphasis on three-dimensional separation and vortex formation. Current research focuses on modeling roughness, effects of rotation and swirl, and turbulence in unsteady flows.



computational simulation of the stern and near-wake regions of turbulent flow past a ship hull

sponsor: office of naval research

fluid mechanics



the 1.8 meter x 1.6 meter low turbulence wind tunnel

fluid mechanics

the 100 meter x 3 meter x 3 meter ship towing tank

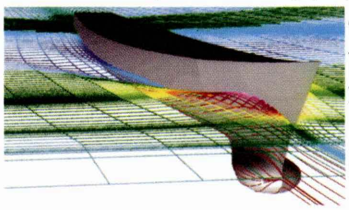
ship hydro-dynamics

Research related to ship resistance and motion has been conducted at IIHR for over four decades. Experiments on ship hulls and related shapes are conducted in the towing tank, which is equipped with a state-of-the-art fiber-optics laser-Doppler velocimeter (LDV), and in other IIHR facilities, such as the low-turbulence wind tunnel, the ice towing tank and hydraulic flumes. Computational research is carried out using local workstations and off-campus supercomputers. A hallmark of IIHR research is that computations are often supported and guided by concurrent physical experiments.

Active research projects include the study of free-surface effects on ship boundary layers and wakes and propulsor-body interactions and detailed propulsor-blade flow. This work involves the design and implementation of a particle image velocimetry (PIV) system in the towing tank and the development of computational fluid dynamics (CFD) methods for surface-piercing bodies with free-surface gravity waves and marine propulsors.

The present program of free-surface research focuses on development of unsteady three-dimensional Navier-Stokes (NS), Reynolds-averaged Navier-Stokes (RANS), and large-eddy simulation (LES) methods for such flows.

The propulsor research focuses on development of the NS and RANS methods for applications to practical geometries. Important issues include: steady and unsteady propulsor blade and wake flows at design and off-design conditions; propulsor-body interactions; turbulence modeling for unsteady flows; and flow at full-scale Reynolds numbers.



RANS simulation of a surface combatant

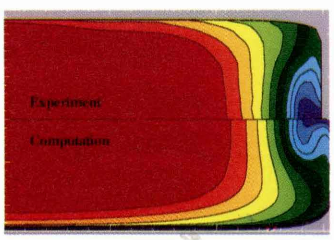
sponsor: office of naval research

computational fluid dynamics

Research in computational fluid dynamics (CFD) at IIHR cuts across many disciplinary boundaries and is closely coordinated with efforts in computational hydraulics. CFD research at IIHR is supported by a computer laboratory comprising several state-of-the-art superscalar workstations with advanced graphics capabilities. The laboratory is also linked to leading supercomputer centers around the country. In most projects, physical experiments and numerical modeling proceed simultaneously in a complementary manner. Finite-difference and finite-volume methods are being developed for application to a wide range of three-dimensional flows including ship and submarine hydrodynamics, low-speed aerodynamics, human voice production, and river and power-plant hydraulics. These methods solve the time-dependent, Reynolds-averaged, Navier-Stokes (RANS) equations in generalized, non-orthogonal, curvilinear coordinates in conjunction with advanced turbulence models. IIHR methods have been tested over a range of flow conditions defined at international workshops.

Areas of current research include multi-domain grid generation techniques, high resolution discretization schemes, convergence acceleration methods such as multigrid and preconditioning strategies, and time-accurate algorithms.

Algorithms based on the velocity-vorticity formulation have also been developed for viscous diffusion of the vorticity field, in two- and three-dimensional unsteady flows about bodies, and for prediction of pressure on the surface of immersed bodies and within the fluid.



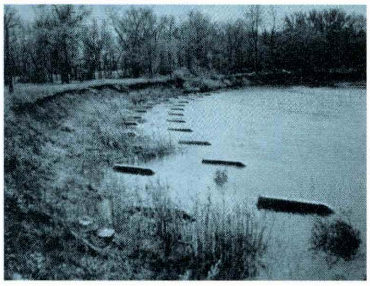
velocity contours in flow through a transition duct

sponsors: office of naval research and tennessee valley authority

river hydraulics

For over one-half century, IIHR has been heavily involved in the field of river engineering, including research in sediment transport, sediment transport in ice-covered streams, fluid-sediment interaction, flow and bed characteristics in meandering channels, and nonequilibrium river processes. Research has comprised both experimental and theoretical study, with increasing emphasis on use of field and experimental data to develop and verify computer-based simulation models. In the area of nonequilibrium river processes, for instance, numerical experiments, involving computer-based simulation models and laboratory experiments, are used to determine the characteristic times of river responses to imposed changes in sediment and hydrologic regimes, channel slope, and geometry, such as occur following installation of dams.

IIHR staff developed and patented the "Iowa Vanes" for bank-erosion control. These are short, vertical submerged vanes that are installed at a slight angle to the flow in the outer half of an alluvial river bend. These vanes significantly reduce the secondary currents and attendant undercutting and flow attack on concave banks. Prototype applications have proven their effectiveness in holding banks that previously had been severely eroding. The vanes also are effective as general sediment control structures, for example, for maintenance of required navigation depths and flood-flow conveyances and for alleviating sediment deposition at riverine pump-intake sites. Research continues to establish design criteria for use of vanes in these diverse applications.



iowa vane installation in the east nishnabotna river

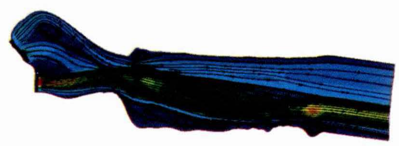
sponsors: iowa department of transportation

computational hydraulics

Computational hydraulics is the application of numerical techniques for computer-based simulations of large-scale hydraulic processes both in natural waterways and engineered systems. This mathematical modeling is complementary to physical hydraulic modeling with its application being ideal for simulation of flow conditions over large distances and for extended time periods. Research in computational hydraulics at IIHR deals with unsteady flow processes in mobile-bed and fixed-bed waterways with emphasis on developing efficient, robust numerical techniques and implementing them. IIHR actively collaborates with other laboratories in developing and distributing computational-hydraulics software for use in engineering practice.

Areas of investigation in one-, two-, and three-dimensional contents include mobile-bed modeling for the study of contaminated-sediment fate and transport, fixed-bed modeling for riverine thermal regime and optimal control of power-plant effluents, unsteady modeling with application to reservoir sedimentation and channel stability, unsteady mobile-bed modeling for cohesive and noncohesive sediments, expert-system simulation of regulated irrigation canals (CanalCAD program), contaminant transport in porous media, and conveyance of ice in natural channels.

A major undertaking has been the ongoing development of a series of three-dimensional CFD models for simulating flow through hydropower plant installations, including the forebay, the turbine, and the tailrace. When fully developed and validated, the models may be used to provide guidance for all aspects of powerplant operation, including applications such as evaluation of fish passage devices and enhancement of dissolved oxygen.



computational model of wanapum dam tailrace

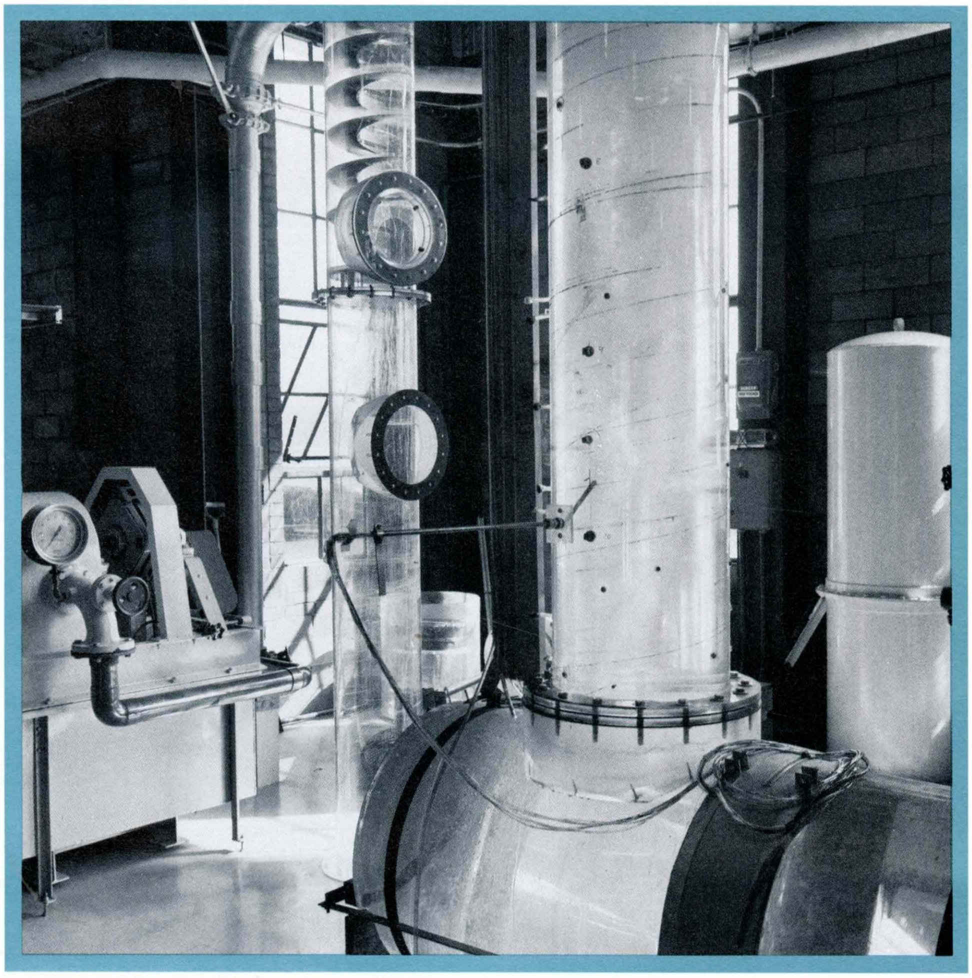
sponsor: public utility district no.2 of grant county, washington

hydraulics

rock island dam forebay model under construction in oakdale annex

sponsor: public utility district no. 1 of chelan county, washington

hydraulics



test facilities to investigate drop-shaft designs

sponsor: japan institute of construction

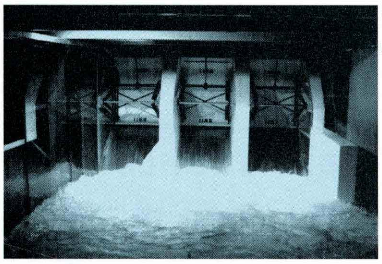
hydraulic structures

IIHR has a long tradition of working closely with engineering practitioners to design and test many types of hydraulic structures, including with those who developed the Mississippi River lock and dam system. Over the years IIHR researchers have designed or modified and tested water intakes/outlets, spillways, closed-conduit dropshafts, cooling towers, power-plant outfall diffusers, sediment-control structures, and fish-passage facilities.

For over a decade, IIHR has combined expert knowledge of fish behavior with its expertise in hydraulic modeling to design and test structures that protect downstream-migrating juvenile fish from passing through hydro turbines. New fish friendly passages are being tested for existing installations but also will be used at new sites.

Numerous (over 55 in the last 20 years) model studies of pump- and turbine-intake structures have been completed at IIHR. These have focused on diagnosing the cause of poor pump and turbine performance and devising corrective measures, which have included techniques for uniformly distributing pump-approach flows and suppressing free-surface and boundary-attached vortices. IIHR design recommendations have been successfully implemented in many locations around the world.

environmental hydraulics



dam spillway model to investigate reduction of nitrogen gas supersaturation
sponsor: public utility district no.2 of grant county, washington

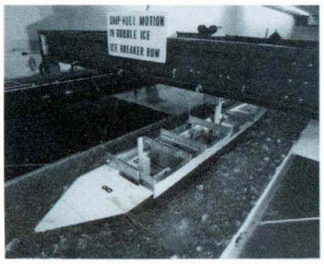
IIHR entered the field of environmental hydraulics and fluid mechanics in the late 1960's and has conducted a wide variety of ecological and environmental studies. These include water-quality monitoring, hydrogeological studies of contaminant transport and modeling, and environmental impact assessments. IIHR's environmental laboratory facilities are capable of conducting complete water, wastewater, and limnological analyses. IIHR staff have access to a complete wet-chemistry laboratory for the processing, extraction, derivation, digestion, or synthesis of liquid and solid samples.

IIHR's Environmental Flow Facility has been used extensively to study the dispersion characteristics of thermal and contaminant plumes and for evaluating fish-diversion devices. Fish holding facilities, which include provisions for heating or cooling as well as oxygenation and filtration of water and its complete quality monitoring, have been used in the studies that utilize live fish in laboratory-model flows.

Mathematical models and numerical algorithms have been used to investigate a variety of environmental problems, including suspended solids and chemical transport from dredged material disposal, chemical speciation and transport in groundwater flows, and pesticide fate and transport in rivers and reservoirs.

cold-regions engineering

ice-related river hydraulics



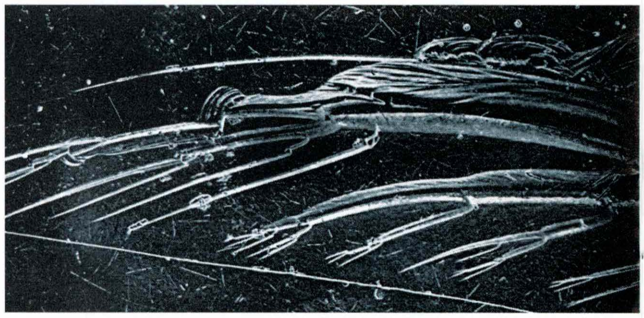
model of ship moving through rubble ice

sponsor: hitachi-zosen corporation

IIHR has been at the forefront of cold-regions engineering, as it relates to river hydraulics since the early 1970's, when it constructed a refrigerated laboratory, with a tilting flume, to study the formation of ripples on the underside of river ice covers. IIHR researchers have combined the fundamental processes of hydraulics and ice mechanics for investigations relating to waterways in cold regions. These include problems of sediment transport in ice-covered alluvial rivers; thermal regimes of rivers under frigid conditions; development, properties and effects of river ice jams; and ice-control structures; and ship hull and barge motion through sheet and broken ice.

ice mechanics

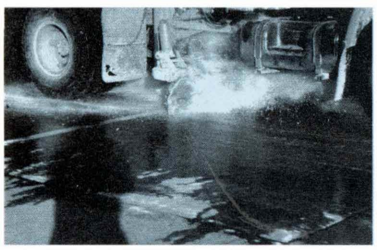
The extensive ice-testing and research facilities of IIHR provide unique opportunities to conduct research aimed at understanding the basic mechanisms that control the failure of ice. Recent studies have focused on adhesion, compression, creep, fatigue, and fracture-toughness properties of freshwater ice. Laboratory facilities are available to grow a variety of freshwater or saline ice types (single-crystal, columnar, or granular). Mechanical testing is performed in a refrigerated laboratory on a Low-Temperature Mechanical Test System, and detailed analysis of fracture surfaces is accomplished using scanning electron microscopy.



fracture surface of ice viewed in a scanning electron microscope

sponsor: u.s. army research office

winter highway maintenance



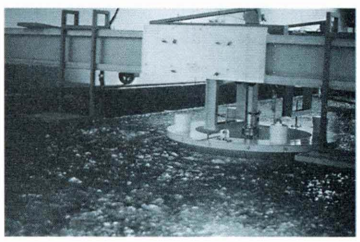
field test of ice removal

sponsor: iowa department of transportation

An increasingly important area of ice-related research has emerged from the need to make our nation's highway-transportation network safe during winter passage as well as to minimize the damage to roadways and maintenance vehicles from extensive use of chemicals for removal of ice and snow. Testing has been conducted both at laboratory and at field scales, using IIHR's computerized highway maintenance truck, to evaluate nonchemical removal of ice and snow from roads and runways to improve the design and efficiency of maintenance equipment.

ice modeling

IIHR also has been involved in numerous model studies, for a diverse clientele, of site-specific problems. These projects have been concerned with ice forces on structures such as bridges, port facilities, and offshore drilling platforms; and laboratory modeling of control mechanisms that prevent/suppress the effects of deleterious ice accumulation around structures.



ice forces on offshore drilling platforms

sponsors: minerals management service/mobil oil corporation

water resources

Hydrometeorology

Over the past decade, hydrometeorology has emerged as an important area for basic and applied research at IIHR. Research has focused on the application of physically based models for flood forecasting and water resources analysis, remote sensing of atmospheric and hydrologic processes, and assessment of hydrometeorological hazards. For example, meteorological and hydrological models have been merged to form a physically based hydrometeorological model for real-time-flood and flash-flood forecasting. Local quantitative precipitation-prediction models are coupled to land surface hydrology and channel routing models, and automatic updating is performed to provide real-time probabilistic forecasts of flood occurrence and magnitude. The system for real-time forecasting at various sites in the United States now is being implemented. Ongoing research investigates ways to incorporate remotely sensed data into hydrometeorological modeling systems. Research in remote sensing includes the development of algorithms to estimate hydrologic fluxes and storages using radar and satellite sensors, evaluation of uncertainty sources in remote-sensing-based estimates, and evaluation of the effects of uncertainty on predictions from hydrologic models. Research also is underway to assess the hazards posed by hydrometeorological extremes. This includes the analysis of rare floods, such as the 1993 Midwest flood, the estimation of drought probabilities using long records of streamflow reconstructed with tree-ring information, and the development of improved methods for flood frequency analysis and floodplain mapping in complex urban environments.

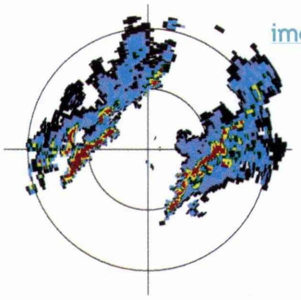


image produced with visualization software developed at IIHR to improve rainfall-estimation methods

sponsor: national oceanic and atmospheric administration

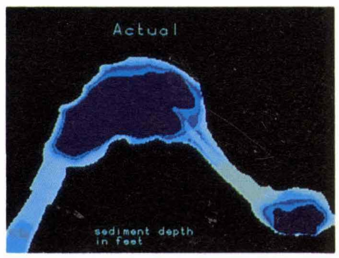
integrated watershed processes

Traditional IIHR strengths in hydraulics, hydrology, and sediment transport are combined with more recent capabilities in hydrometeorology and geomorphology to study complex physical processes using a combination of: integrated, multi-dimensional sensor arrays specifically designed for field monitoring, as well as for full-scale and in some cases watershed-level experimentation to capture details of process dynamics; GIS technologies for analyzing data; and dedicated parallel computing systems to model the complex physical dynamics at work. This methodology has been applied successfully in studies involving movement of turbidity currents in glacial lakes, complex fire/erosion/sediment transport dynamics associated with high-energy mountain environments, reservoir sedimentation and sluicing dynamics, and watershed runoff and sediment-yield modeling.

This approach also is being used as the basis of a broader effort to develop fully integrated flood-impact-response models which combine physical and socio-economic data bases to develop on-line emergency management and response systems.

a GIS-based study of the effect of riparian vegetation on sediment storage in rivers

sponsor: u.s. department of agriculture



history of hydraulics and fluid mechanics

hydraulics The history of hydraulics and fluid mechanics and of the people who pioneered research in these areas has been a focus of study throughout IIHR's own history. However, a true center of historical studies dates from the early 1950's when the staff began compiling a collection of rare books in hydraulics. This collection now comprises over 500 volumes and has been described by leading hydraulicians as "the finest collection known to exist on the history of hydraulics."

IIHR publishes its own series of history-related books and papers. Among these are *History of Hydraulics*, by Simon Ince and Hunter Rouse; *Hydraulics in the United States, 1776-1976* and *Historic Writings in Hydraulics*, both by Rouse; and *Hans Albert Einstein: Reminiscences of His Life and Our Life Together*, by Elizabeth Roboz Einstein. A scientific biography of H.A. Einstein, son of the famous physicist, soon will be published, and other works are planned.

albert and hans albert einstein in berlin, 1927

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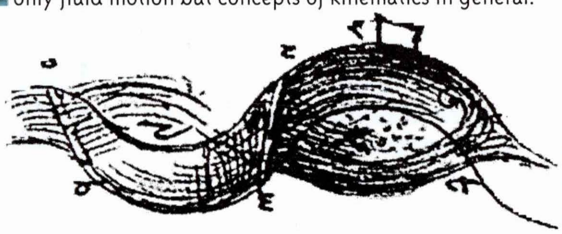
fluid mechanics A long-term, on-going project relating to the history of fluid mechanics involves interpretation, analysis, and synthesis of the codices and manuscripts of Leonardo da Vinci as they relate to fluid-flow phenomena. This work is enhanced by IIHR fluid mechanicians who can read and understand Leonardian script and who have the expertise to replicate his experiments, using IIHR facilities. Their work began with the Madrid Codices in 1974 and has continued with study and interpretation of several others, including the Codices Atlanticus, Forster, and Hammer. Other projects include studies of representation of water in art and science and a comprehensive history of kinematics, which includes not only fluid motion but concepts of kinematics in general.



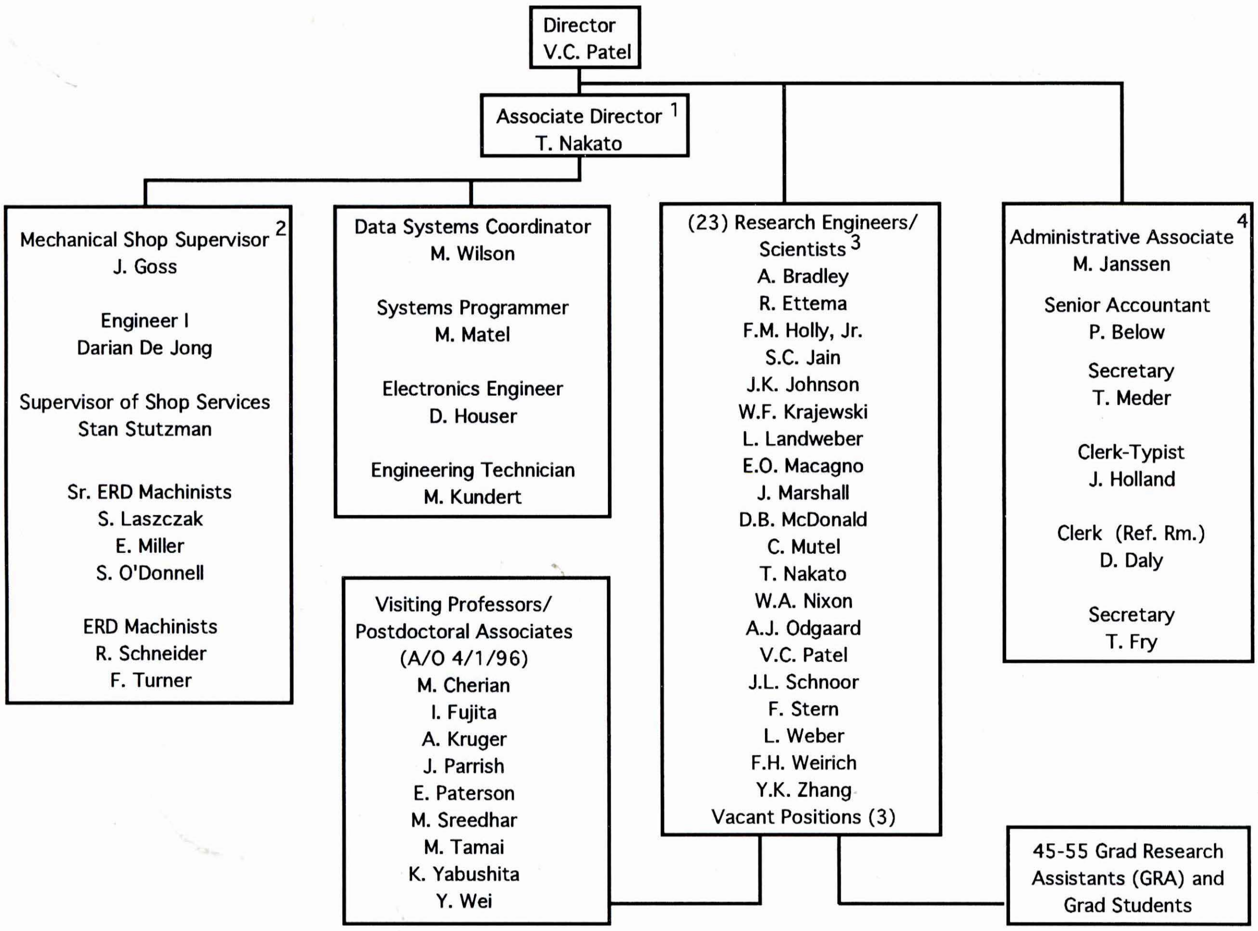
this river-meander modification sketch by leonardo da vinci experimentally was analyzed at IIHR

STAFF

The present organization of IIHR consists of a senior professional staff of 21 research engineers drawn from UI's departments of Mechanical and Civil and Environmental Engineering; 43 research associates and assistants, who are concurrently pursuing advanced degrees; and a support staff of 20 comprising administrators, office personnel, machinists, carpenters, instrumentation specialists, and electronics technicians. Several of IIHR's research engineers and all of its support staff have full-time commitments to IIHR, with no teaching or other academic responsibilities. This facilitates timely completion of projects on tight schedules.

IIHR is headed by its director, who is ultimately responsible for all of its endeavors, including staff activities, laboratory facilities, research procedures, and reports and finances. The director also pursues his own research and teaching interests. The IIHR director reports to the College of Engineering dean and the UI vice-president for research and ultimately to the UI president. Research engineers directly supervise the various projects and graduate-student investigations conducted at IIHR.

The responsibilities of IIHR staff are summarized in the organizational chart presented below; the areas of specialization of IIHR's senior research staff are listed on the reverse side of this insert.



[1] Responsible For
a. Coordinating Institute Projects
b. Maintaining and Developing Contact with Sponsors/Clients
c. Laboratory and Computer Facilities

[2] Responsible For
a. Supervision of Mechanical-shop Personnel
b. Assignment of Shop Personnel to Projects
c. Shop Equipment and Material Acquisition

[3] Responsible For
a. Serving as Project Engineer/Principal Investigators on Projects
b. Directing Laboratory Technicians and Postdoctoral Fellows
c. Supervising Graduate Research Assistants and Thesis Research

[4] Responsible For
a. Administering Nontechnical Activities and Fiscal Matters of the Institute
b. Administrative Matters Related to Research Proposals and Grants/Contracts
c. Direction of Office-related Activities

IIHR SENIOR RESEARCH STAFF/ AREAS OF SPECIALIZATION

Name of staff member, area of specialty, degree, school, degree year, title, primary department

A. Allen Bradley
Hydrology, Hydroclimatology, Watershed Modeling; Ph.D.; Wisconsin-Madison; 1992; assistant professor; Civil and Environmental Engineering

Robert Ettema
River Mechanics, Ice Engineering, Hydraulic Structures, Hydraulic Modeling; Ph.D.; Auckland (New Zealand); 1980; professor; Civil and Environmental Engineering

Forrest M. Holly, Jr.
Computational Hydraulics, River Mechanics, Dispersion Processes; Ph.D.; Colorado State; 1975; professor; Civil and Environmental Engineering

Subhash C. Jain
River Mechanics, Hydraulic Structures, Stratified Flows, Hydraulic Modeling; Ph.D.; Iowa; 1971; professor; Civil and Environmental Engineering

J. Kent Johnson
Aquatic Chemistry, Limnology, Fish Protection; Ph.D.; Iowa; 1986; adjunct assistant professor; Civil and Environmental Engineering

Witold F. Krajewski
Hydrometeorology, Remote Sensing, Water Resources Systems; Ph.D.; Technical University of Warsaw (Poland); 1980; associate professor; Civil and Environmental Engineering

Anton Kruger
Development and Application of Weather-related Instrumentation, Weather Radar and Image Processing, Particle Image Velocimetry; Ph.D.; Iowa; 1991; postdoctoral research associate; IIHR

Louis Landweber
Hydrodynamics, Ship Hydrodynamics, Wave Mechanics; Ph.D.; Maryland; 1951; professor emeritus; Mechanical Engineering

Enzo O. Macagno
Biological Flows, Fluid Mechanics, Rotating Flows, History of Fluid Mechanics; D.P.S.; Grenoble (France); 1953; professor emeritus; Mechanical Engineering

Jeffrey Marshall
Vortex Dynamics, Vortex Methods in Aerodynamics, Atmospheric and Oceanic Processes; Ph.D.; California-Berkeley; 1987; associate professor; Mechanical Engineering

Donald B. McDonald
Limnology, Water Quality, Environmental Impact; Ph.D. Utah; 1962; professor emeritus; Civil and Environmental Engineering

Cornelia Mutel
Program Associate II; M.S.; University of Colorado, Boulder; 1973; scientific historian, IIHR

Tatsuaki Nakato
River Mechanics, Experimental Hydraulics, Hydraulic Structures, Hydraulic Modeling; Ph.D.; Iowa; 1974; research scientist, IIHR

Wilfrid A. Nixon
Ice Engineering, Mechanical Properties of Materials at Low Temperatures; Ph.D.; Cambridge (England); 1984; associate professor; Civil and Environmental Engineering

A. Jacob Odgaard
River Mechanics, Hydraulic Structures, Coastal Engineering, Environmental Engineering; Ph.D. Technical University of Denmark; 1966; professor; Civil and Environmental Engineering

Virendra C. Patel
Boundary-Layer Theory, Viscous Flow, Turbulence, Ship Hydrodynamics; Ph.D.; Cambridge (England); 1965; professor; Mechanical Engineering

Eric Paterson
Computational Fluid Dynamics, Ship Hydrodynamics, Unsteady Viscous Flow; Ph.D.; Iowa; 1994; postdoctoral research associate; IIHR

Jerald L. Schnoor
Water-Quality Modeling, Dispersion Processes; Ph.D.; Texas; 1975; professor; Civil and Environmental Engineering

Madhu Sreedhar
Computational Fluid Dynamics, Large Eddy Simulation; Ph.D.; Virginia Polytechnic Institute and State University; 1994; postdoctoral research associate; IIHR

Frederick Stern
Ship Hydrodynamics, Cavitation, Turbulent Boundary Layers; Ph.D.; Michigan; 1980; associate professor; Mechanical Engineering

Larry Weber
Hydraulic Structures, Data Acquisition Techniques, Ice Mechanics; Ph.D.; Iowa; 1993; assistant research scientist; IIHR

Yingchang Wei
Mechanics of Ice; Ph.D.; Clarkson University; 1991; postdoctoral research associate; IIHR

Frank H. Weirich
Geomorphology and Related Hydrologic Processes, Sediment Transport and Reservoir Sedimentation, Watershed Response to Environmental Changes; Ph.D.; Toronto; 1982; associate professor; Geography/Civil and Environmental Engineering

You-Kuwan Zhang
Hydrogeology and Groundwater Hydrology; Ph.D.; Arizona; 1990; assistant professor; Geology

SPECIAL-IZED FACILI-TIES

A strength of IIHR has been its continuing and visionary commitment to maintaining and enhancing its experimental facilities while at the same time pioneering efforts in high-speed computational analysis and . simulation of complex flow phenomena.

What perhaps **makes IIHR unique** among fluids research laboratories is its state-of-the-art, in-house capabilities for both computational and physical modeling and experimentation. This permits varying, yet complementary, approaches for investigation and solution of a wide variety of flow problems. Research **facilities of IIHR** include many hydraulics flumes, air- and water-flow units, and more routine experimental apparatus and instruments and the more specialized facilities described below.

Low-Turbulence Wind Tunnel

A closed-circuit wind tunnel with an 8-meter-long, 1.8-meter by 1.5-meter rectangular working section that has a maximum speed of 40 meters/sec, a high level of flow uniformity and a turbulence level of less than .05 percent. An automated three-component traverse facilitates rapid data acquisition.This tunnel has been specifically designed to accommodate the latest three-dimensional LDV equipment (see below).

Vortex Laboratory

The vortex laboratory includes a vortex cutting apparatus, a 1-meter-diameter rotating tow tank, a 4-meter-long flow visualization tow tank, and a number of facilities for study of pump intake vortices. All facilities utilize a high resolution particle-image velocimetery system for measuring an instantaneous velocity field over a planar section of the flow.

Ship-Model Towing Tank

A 100-meter-long, 3-meter-wide, 3-meter-deep towing tank, equipped with one 15HP drive carriage, two instrumented trailers and a wave maker. Trailer #1 is instrumented with a two-component LDV with an underwater optic probe. Trailer #2 is instrumented with five-hole probes, capacitance-wire probes, pressure transducers, and has four modulynx automated traverse systems. Both trailers use a 486 PC with a 16 channel A/D board for data acquistion.

Sediment Laboratory

A 6-meter by 3.5-meter sediment laboratory in the Model Annex is equipped with the basic instrumentation and equipment required for most sediment analyses. These include a vacuum-pump filtering system, electronic balances, chemical balances, constant-temperature ovens, sets of sieves, a complete system for the visual accumulation tube (VA) method, and an Iowa rapid sediment analyzer (currently under development).

Model-Test Basins

Three large model-test basins; one 30 meters by 27.5 meters, one 27.5 meters by 20 meters, and a third, which has been designed with special flow and metering capabilities, 39.5 meters by 15 meters.

Environmental Flow Facility

A 20-meter long, 3-meter-wide, 2.1-meter-deep recirculating flume with 9.75-meter-long glass-walled working section, equipped with two 500,000 BTU/hr gas-fired water heaters, a small cooling tower, and two 0.9-meter-diameter pumps to obtain variable discharge up to 4 cubic meters/second.

Specialized Laboratory Instrumentation

Computational Fluids/Hydraulics Lab

The IIHR Computational Fluids/Hydraulics Laboratory services expanding activities in experimental data acquisition and control as well as in high-performance computation and visualization. A high-speed TCP/IP local area network, which is tied to the University's fiber-optic backbone, binds IIHR's computational activities together.

Experiments undertaken at IIHR use state-of-the-art instrumentation and data acquisition systems. Major experimental sites have dedicated instrumentation and data-acquisition systems while other sites are instrumented individually, according to their requirements, from IIHR's pool of shared equipment.

The demanding computational requirements of IIHR research partially are met by 28 UNIX workstations, which are used for simulations and other intensive floating-point calculations, software development, debugging, and visualization. Links to supercomputers at various national supercomputing sites are utilized for large-scale runs. A mini-supercomputer currently is being acquired and a graphics facility, which features high-performance graphics and associated film and video editing systems for the production of still and animated images of experimental and computational results, is being developed.

Ice-Engineering Laboratories

The Ice-Engineering Laboratories of IIHR comprise five cold rooms capable of operating at temperatures as low as -45°C in which are located the ice towing tank/model basin and icing wind tunnel (described separately, below), as well as a 12.2-meter long, 0.6-meter-wide tilting flume; a custom-built ice-scraping machine; a 1-meter-wide, 0.75-meter-deep, 6-meter-long specimen tank; and a 50kN servo-hydraulic mechanical testing machine, with electronic feedback control and full-load, stroke, and strain control.

Ice Towing Tank/Model Ice Basin

Flume 20-meter long, 5-meter wide, 1.3-meter deep, located in a refrigerated room (minimum temperature -29°C) and equipped with a variable-speed motorized carriage.

Icing Wind Tunnel

Portable wind tunnel 11-meters long, with 0.6-meter-square working section, is equipped with a vaneaxial fan driven by 20-HP motor which produces wind speeds of up to 23 meters/second.

Hydrometeorological Laboratory (HML)

The computational facilities of the HML comprise several high-end engineering workstations with on-line as well as secondary mass storage capabilities; high-resolution printers; and other peripherals. The HML also operates the Surface Meteorological Station, a unique facility for rainfall research, combining high temporal resolution measurements of surface rainfall, a vertically pointing radar, and measurement of surface meteorological variables.

Particle Image Velocimeter (PIV)

The IIHR PIV system runs on a dedicated IBM RISC 6000 workstation and utilizes a double-pulsed Nd:YAG laser for generation of the laser sheet. Image acquisition can be performed either by a CCD video camera (with *1K* x *1K* pixel resolution) or by a still camera with electronically controlled shutter, which are synchronized with laser pulsing.

Laser Doppler Velocimeter (LDV)

IIHR's unique three-dimensional, fiber-optics-based LDV system is designed for remote measurement of all three components of the turbulent velocity vector in either air or water. For example, the fiber-optics probe can be traversed outside the large wind tunnel or the Environmental Flow Facility to measure the velocity at any point inside the test sections.

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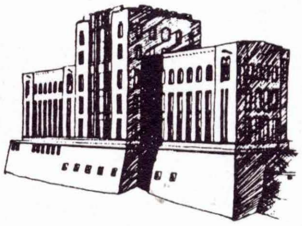

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THE UNIVERSITY OF IOWA
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how to obtain further information:

Parties interested in pursuing graduate education in a postdoctoral research assignment, or in soliciting a proposal for engineering study or research in any of IIHR's areas of endeavor, should address an inquiry to :

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Iowa City, Iowa 52242-1585 U.S.A. Telephone: 319-335-5237
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Web Server: http://www.iihr.uiowa.edu