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Logan River First Dam

Logan First Dam is a small concrete dam and powerhouse.

Historical HIghlights of the UWRL

Contributors

Mr. John Fitch - USU Facilities
Abedalrazq Khalil - Ph.D. Student, USU, CEE Department
Jan Urroz - Historical Highlight and Graduate Students 1967 and 1968 - UWRL Administrative Assistant
Ivonne Harris - UWRL Publications Coordinator and Webmaster

Director's Corner

Graduate Students 1967-1968

Degrees offered by College of Engineering in 1967

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Spotlight

Abedalrazq Khalil

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Director's Corner

Dr. Ronald C. Sims, UWRL Director

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Infrastructure rehabilitation is a current major theme in water systems throughout the U.S. Logan River First Dam is representative of a multitude of small dams in the western U.S. both in its operation and in its infrastructure rehabilitation needs. Rehabilitation construction of the dam was done in two phases. The first phase was completed in 1993, and the second phase work was done during the winter of 2002. This issue of the UWJ addresses the infrastructure needs of Logan River First Dam and what was done.

During the current sustained drought conditions in the Western U.S. there is a critical need to develop improved management systems for making decisions concerning water allocation and use based on the amount of water available. This issue of the UWJ describes Artificial Neural Networks (ANNs) and their application to the problem of water scarcity in the Sevier River Basin. An ANN is an information processing system that roughly replicates the behavior of an organic brain by emulating the operations and connectivity of biological neurons. Our graduate student research "spotlight" in this issue of the UWJ features Abedalrazq Khalil, a Ph.D. student working under the direction of Dr. Mac McKee in the Department of Civil and Environmental Engineering, who is investigating how ANNs may play a critical role in canal management in Utah.

Students who graduated in 1967 and 1968 with M.S. and Ph.D. degrees and who were affiliated with the UWRL as part of their professional education are listed in this issue of the UWJ. In the previous issue we listed names of students who graduated with M.S. and Ph.D. degrees in 1965 and 1966. If you are on this list or know of someone on the lists, we would like to hear from you. In future issues of the UWJ we plan to identify graduates in succeeding years in an effort to locate and communicate with our graduates, to update them about current USU/UWRL programs and initiatives, and to connect our previous graduates with our current students for potential job opportunities and for professional advice.

We continue to profile the history of the UWRL over the 35+ year period since it's dedication and occupancy in September, 1965. This issue of the UWJ covers the activities, events, deans, directors, and research support from private and federal government sources during the years from 1956 through the present. The previous issue addressed the conceptualization and "birth" of the UWRL.

I hope that you enjoy reading this issue of the Utah Water Journal. Please send us your comments, ideas, or feedback.

The UWJ is sponsored and supported by the Utah Water Research Laboratory (UWRL) at Utah State University (USU).

Utah Water Journal staff

Dr. Ronald C. Sims, UWRL Director (ronsims@cc.usu.edu)

Ms. Ivonne Harris, Information Dissemination Coordinator (iharr@cc.usu.edu)

Ms. Jan Urroz, Features Contributor (janurroz@cc.usu.edu)

Logan River First Dam

July 25, 2002

by John Fitch, USU Facilities

Logan First Dam is a small concrete dam and powerhouse. Originally built between 1911 and 1914, the dam is located at the base of Logan Canyon, on the east side of Logan, Utah. It has a maximum height of about 30 feet and a crest length of about 250 feet. The dam is owned and operated by Utah State University. First Dam supplies water to the Utah Water Research Laboratory (UWRL) and local irrigation companies, in addition to providing power for USU. Logan River First Dam is classified by the Division of Water Resources as a hazardous dam.

Long before the recent construction project of 2001-2002 started, several independent Engineering companies documented the condition of the dam. Between 1980 and 1990 the following observations were documented with regard to the condition of the dam:

- No misalignment, settlement, or offsets
- Deterioration and spalling of the concrete on the upstream face near the waterline
- Several large open continuous cracks through the crest slab
- Significant cracking and leaching of some of the arch bays and buttresses
- Severe concrete deterioration and erosion on the downstream face and training walls of the spillway
- Few signs of high stresses caused by settlement or horizontal movement
- Cracking, seepage, and poor concrete in the upstream training walls for the spillway
- Left downstream training wall for spillway was in poor condition
- Deterioration of the concrete on the upstream face at the waterline
- Severe honeycombed concrete in the interior buttresses of the spillway
- A horizontal crack from Bay 8 to Bay 11

The State Engineer issued official notice to USU in 1993 that the dam did not meet state standards, and it was ranked among the highest priority dams in the state in need of rehabilitation. After years of planning and design, construction work started on First Dam in August 2001 to bring the dam up to current State and Federal dam safety guidelines. In addition to the deficiencies mentioned above it was determined that the spillway capacity could only pass about 10 percent of the probable maximum flood, and a larger flood would overtop and fail the dam. The structure would probably fail during the maximum credible earthquake.

Rehabilitation construction of the dam was done in two phases. The first phase was completed in 1993 and consisted of filling the hollow spillway bays with concrete. Second phase work was done during the winter of 2002, which was one of Cache Valley's coldest winters on record. Progress could not be delayed because April's spring run-off demanded all river work be completed on time. Work completed in the second phase included:

- Buttressing the entire dam including the spillway and powerhouse with 28 feet of mass concrete
- Installation of new pneumatic crest gates
- Rebuilding the spillway
- Adding a stilling basin directly below the spillway
- Removal and replacement of the old power plant
- Installation of a new turbine/generator with fully integrated program logic control system
- Installation of a valved construction diversion pipe which could later be converted to a future hydro intake pipe
- Raising the non-overflow dam and powerhouse segments by 4.0 feet
- Removal of existing spillway apron and training walls and replacement with redesigned stilling basin, training walls, and riprap

The new low head turbine generator will produce 350 kilowatts, which will be fed directly into the campus power grid. The Federal Energy Regulator Commission (FERC) licensing requirements mandated that the new turbine generator's electrical output be close to the 1911 generator, but it will out-produce the old generator because of its ability to be efficient at low water levels. The 2002 Campus-wide power load is in the range of 5 megawatts at night to 13-15 megawatts during the day. The 350 kw produced by the First Dam turbine generator is a small but profitable contribution to USU's overall power requirement.

Construction facts:

- Owner: Utah State University
- Project construction cost: $2,509,252
- Construction time: August 2001 to August 2002
- General Contractor: Spindler Construction, Logan, Utah
- Engineering Firm: DMJM/ECI, Salt Lake City, Utah

First Dam prior to 2002 rehabilitation (Fall 2001)

First Dam after 2002 Rehabilitation (Summer 2002)

Historical Highlights of the Utah Water Research Laboratory

1956
Congressman H. Aldous Dixon (former president of USU) introduced H.R. 10663, a bill which proposed that the Secretary of Agriculture be: "…authorized and directed to establish, maintain, and operate at such location as he deems desirable a regional water laboratory for the purpose of conducting research and study with respect to the physical laws, principles, and dominant variables affecting the source, supply and use of water…"

1957
The first research actually done on the laboratory site was by Cy Lauritzen who installed a pipe outlet to bring water from First Dam and conducted experiments on the hydraulics of flexible tubing.

1958
Dean F. Peterson, Dean of the College of Engineering at USU, and P.K. Mohanty, a student, initiated flume studies using large bed elements at the present laboratory site with hopes that continuing research at the site would increase the chances of getting a funded water research laboratory at Utah State.

October 14, 1958
Dean F. Peterson, dean of the College of Engineering at USU, presented a University proposal for a federal water research laboratory to be located in Cache Valley to USDA at a public hearing on Soil and Water Research Facilities, held in Salt Lake City. The result was that the USDA put an irrigation hydraulics laboratory on their list of desired facilities.

1959
The Utah legislature authorized the establishment of a water resources research laboratory at USU and initiated architectural planning.

1961
The Utah legislature entertained a bill legislation providing that there be: "…appropriated to the State Building Board $1,200,000.00 or so much thereof, as may be necessary, from the General Fund for constructing the Utah Water Research Laboratory, on the Logan River, on property already acquired by the State of Utah for such purpose, the preliminary plans for which Research Laboratory have already been prepared by the Building Board…."
Subsequently, the building appropriation for USU for the 1961-63 biennium included $200,000 for a "Hydraulics Laboratory".

1961
U.S. Senator Wallace F. Bennett introduced a bill to authorize the Secretary of Agriculture to: "…establish, equip, and maintain a regional research laboratory to be located at or near the Utah State University…."

1962/1963
Although nothing came of Bennett's 1961 bill, a bill was drafted and introduced by Senator Clinton Anderson of New Mexico in 1962 to establish water resources research centers at selected universities. Then in 1963, the bill was revised and introduced again. The legislation was enacted the following year and became known as the Water Resources Research Act of 1964. The program was administered by the Office of Water Resources Research (OWRR), U.S. Department of the Interior.

November 1963
Groundbreaking ceremonies were held, and building the Utah "hydraulics" laboratory began.

July 12, 1964
The USU Board of Trustees approved the appointment of Vaughn E. Hansen as the first Director of the Utah Water Research Laboratory.

November 21, 1964
An official Charter for the Utah Center for Water Resources Research at Utah State University was approved by the Board of Trustees of Utah State University to coordinate the Utah portion of the OWRR program.

February 2, 1965
The UCWRR responsibility for the Utah water research program was officially designated to the Office of Water Resources Research.

December 6-7, 1965
The completed Utah Water Research Laboratory facility was dedicated.

June 30, 1966
Dr. Vaughn Hansen resigned his position as Director, and was replaced by Dr. Jay M. Bagley in July 1966.

March-April 1968
A memorandum of agreement between Utah State University and the U.S. Department of the Interior for executing a portion of this program was signed April 8, 1968, by D.F. Peterson and March 26, 1968, by the Director of the Office of Water Resources Research.

June 12, 1970
An Advisory Panel was created to work with campus water leaders and programs in assuring a program of research that is coordinated with the state's needs. June 12 was the date of their first meeting.

1971
Total federal and private sponsorship of projects exceeded $1 million.

July 1974
The Universities Council on Water Resources held their annual meeting on the Utah State campus at which Director Warren Hall of OWRR announced a name change to the Office of Water Research and Technology (OWRT), and the water center directors of the respective states organized the National Association of Water Institute Directors (NAWID).

July 1975
Dr. Bagley resigned his position as Director. Calvin G. Clyde was named Acting Director.

July 1, 1976
Dr. L. Douglas James became director of the Utah Water Research Laboratory.

March 1978
Funds were authorized for adding modern water quality research laboratory facilities and student project space within the UWRL building.

March 1979
UWRL remodeling project was approved and the contract signed. Construction began in April.

December 4, 1980
UWRL building addition dedication was held.

August 6, 1982
The building that houses the Utah Water Research Laboratory was named the "George Dewey Clyde building" in official ceremonies. The naming honored the former Governor of Utah, George Dewey Clyde, for his contributions to water research and development in Utah. His support of the Water Laboratory concept while he was governor made the enterprise possible.

1982
E. Joe Middlebrooks resigned as Dean; Russell M. Holdredge was appointed Acting Dean of the College of Engineering.

1983
Dr. A. Bruce Bishop was appointed Dean of the College of Engineering.

September 24, 1985
The research program had been shifted in the Department of the Interior to the U.S. Geological Survey. Official certification was made as required by the provision of 30 CFR 401.6 of the establishment of the Utah Center for Water Resources Research at Utah State University to conduct the Utah water research program cooperatively with the U.S. Department of the Interior through the Office of Water Resources Research (1964), Office of Water Research and Technology (1974), Office of Water Policy (1982), the U.S. Geological Survey (1984), and any successor agencies. (Letter from Stanford Cazier, USU President, to Dr. Dallas L. Peck, Director U.S. Geological Survey, U.S. Department of the Interior, Reston VA.)

1988
Total federal and private sponsorship of projects exceeded $2 million.

1990
Total federal and private sponsorship of projects exceeded $3 million.

December 1991
Dr. L. Douglas James resigned as Director. Dr. David S. Bowles was appointed Acting Director.

September 1992
Dr. David S. Bowles was appointed Director of the UWRL.

June 1996
Dr. David S. Bowles resigned as Director. Dr. R. Ryan Dupont was appointed Acting Director.

November 1996
Dr. Ronald C. Sims was named Director of the UWRL.

January 1998
The Utah On-Site Wastewater Treatment Training Center was established to assist the local health departments and the Utah Department of Environmental Quality by providing technology transfer, training, and information dissemination in on-site wastewater treatment.

2000
Total federal and private sponsorship of projects exceeded $4 million.

2001
Total federal and private sponsorship of projects exceeded $5 million.

August 2001
Upon relocation of the EMRC and associated personnel from the CEE Department, seven centers were based at the UWRL: Environmental Management Research Center (EMRC), Institute for Dam Safety Risk Management (IDSRM), Institute for Natural Systems Engineering (INSE), International Office for Water Education (IOWE), Substitute Teaching Institute (STI), Utah Center for Water Resources Research (UCWRR), and the Utah On-Site Wastewater Treatment Training Center.

September 2001
Establishment of the Huntsman On-Site Wastewater Treatment Physical Demonstration Facility. The facility was established to enable the UWRL to provide hands-on training for on-site wastewater treatment.

July 2002
Dr. Bruce Bishop, Dean of the College of Engineering, resigned after twenty years as Dean of the College. He rejoined the faculty at the UWRL to continue research and teaching.

August 2002
Professor H. Scott Hinton was appointed Dean of the College of Engineering.

Use of Artificial Neural Networks in Canal Management

by Abedalrazq Khalil

akhalil@cc.usu.edu

Water scarcity in the Sevier River Basin has lead water managers to seek methods for identifying optimal real-time control strategies for operating reservoirs and irrigation canals. Management and control of flows in a canal require adequate data on current and recent historical flow conditions, information on required water deliveries, and an understanding of the nonlinear behavior of the canal system. The Sevier River Water Users Association and the US Bureau of Reclamation have installed an automated data collection system to monitor storage conditions in the reservoirs and flows in the canals (see Figure 1) in the basin.

The Sevier Valley/Piute Canal is a particularly difficult canal to manage. Since the canal is 65 miles in length, travel times in the canal vary from one to three days depending upon flow conditions. This, together with seepage losses, generates a high degree of uncertainty for canal operations. In the face of this uncertainty, the canal manager must decide on a near real-time basis how much water to divert into the canal in order to meet water orders along the entire length of the canal over the next few days, while at the same time minimizing the volume of spill that will eventually occur at the end of the canal. Traditional engineering approaches for modeling flows in the canal and thereby gaining useful real-time information to guide decisions about optimal diversions require channel hydraulic data that are expensive to obtain, and would not lend themselves to use by canal managers who are not technically trained for this.

However, given sufficient data on the behavior of the Sevier Valley/Piute Canal, data-driven predictive models that are not based on traditional physically-based modeling approaches might produce accurate predictions for required total water diversions to the canal. The most widely used type of data-driven model is the approach embodied in Artificial Neural Networks (ANNs).

An ANN is an information processing system that roughly replicates the behavior of a organic brain by emulating the operations and connectivity of biological neurons. Research in this area started in the 1950s, but really useful applications were first reported in the mid-1980s when methods for properly training ANNs were discovered. From a mathematical point of view, an ANN is a complex non-linear function with many parameters that are adjusted (calibrated, or "trained") in such a way that the ANN output becomes similar to the measured output of the real system for a known data set. This research represents the first application of ANNs to real-time management of a long irrigation canal.

The results of the ANN modeling effort thus far are shown in Figures 2 and 3. Figure 2 compares actual observed diversions into the canal against model predictions, and Figure 3 shows the same information in a time-series format for the irrigation season of 2001.

The beneficial products of this research in using ANNs are:

- They provide a means to complement, or even to replace, traditional (physically-based) methods
- They represent an inexpensive tool that could be used to improve irrigation water use efficiency through more accurate anticipation of the total quantity of water to be diverted into the canal to satisfy irrigation needs
- They provide a potential contribution to computer-controlled canal automation in the Sevier River Basin, which might reduce the cost of canal management and more fully exploit the canal flow database available for the basin
- They advance the state-of-the-art in use of ANNs in water resources engineering through the first practical application of ANNs in canal flow modeling

Figure 1. An Automated Gage on the Sevier Valley/ Piute Canal

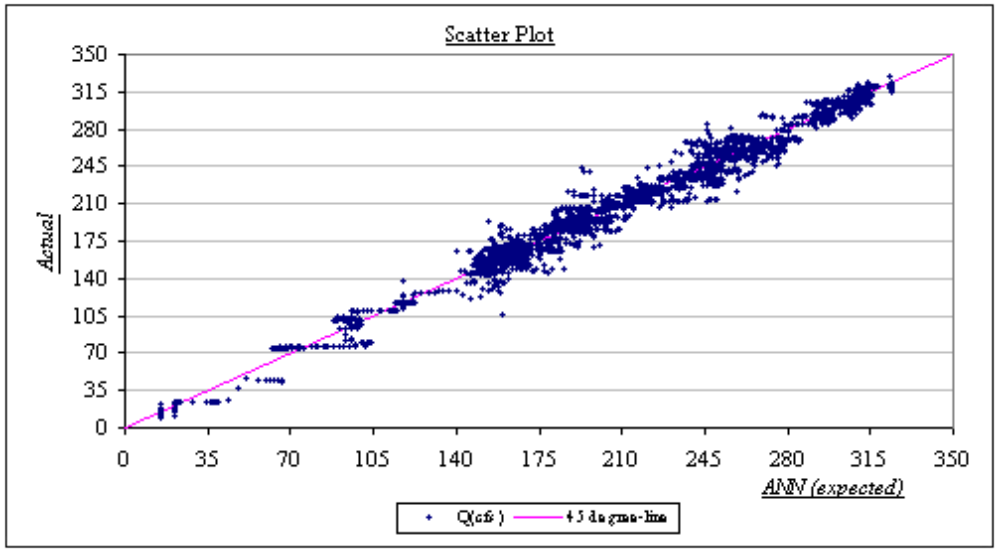

Figure 2: Scatter of the ANN Model Forecasts about the 45° line

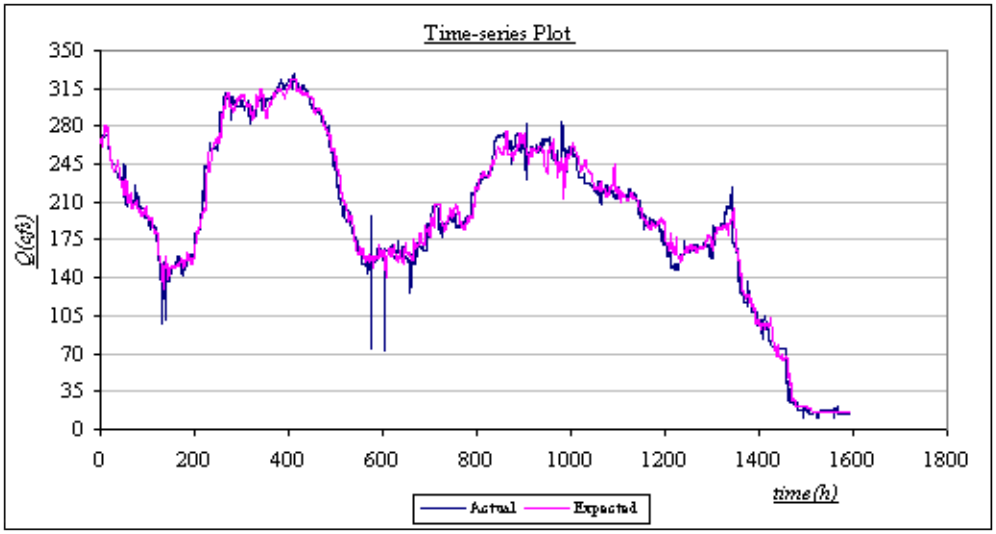

Figure 3: Time-series Graph of the Actual Diversions versus the ANN Forecast Diversion for 2001

1967 Degrees from the College of Engineering

Doctorate Degrees 1967:

AAbaza, Mohamed M. Ismail
Dessuk, U. A. R.
MS: Utah State University, 1964
Major: Civil Engineering
Major Professor: Dr. Calvin G. Clyde
Dissertation: Streaming potential and Current induced by flow through porous media and their relations to the flow.

Peck, Eugene Lincoln
Bountiful, Utah
MS: University of Utah, 1951
Major: Civil Engineering
Major Professor: Dr. Jay M. Bagley
Dissertation: Influences of Exposures on Pan Evaporation in Mountainous Area.

Riley, John Paul
Logan, Utah
MS: Utah State University, 1953
Major: Civil Engineering (Hydrology)
Major Professor: Dr. Jay M. Bagley
Dissertation: Application of an Electronic Analogy Computer to the Solution of Hydrologic and River-Basin-Planning Problems.

Masters Degrees 1967:

Chou, Nory Tsung-Te
Taiwan, China
MS: Waseda University, 1964
Major: Civil Engineering
Major Professor: Dr. Irving D. Dunn
Thesis: Soaking Period and Preloading Effects on Shearing Strength of Cohesive Soil.

Chu, Frederick Fudan
Taipei, China
BS: National Taiwan University, 1963
Major: Civil Engineering
Major Professor: Dr. Cary K.K. Mak
Plan B Report

Cliff, John Oliver
Pocatello, Idaho
BS: Utah State University, 1964
Major: Civil Engineering
Major Professor: Dr. William A. Cordon
Thesis Director: Professor Norman B. Jones
Thesis: Effects of the Sand/Cement Ratio on the Cracking Tendency of Concrete.

Eggleston, Keith Otis
Grover, Wyoming
BS: Utah State University, 1966
Major: Civil Engineering (Hydraulics)
Major Professor: Dr. G. V. Skogerboe
Thesis: Effects of Boundary Geometry on Critical and Subcritical Flow Through Measuring Flumes.

Hau, Teh-Hong
Taiwan, China
BS: National Taiwan University, 1958
Major: Civil Engineering
Major Professor: Dr. Jerald E. Christiansen
Thesis: Evaluation of Earth Lining for Seepage Control.

Israelsen, Eugene Kay
Logan, Utah
BS: Utah State University, 1962
Major: Civil Engineering
Major Professor: Dr. Cheng-Lung Chen
Thesis: Effect of the Free Surface on the Resistance to Flow over Schematic Dunes in Open Channels.

Kau, Wen-Terng
Taiwan, China
BS: National Taiwan University, 1960
Major: Civil Engineering
Major Professor: Dr. Cary K.K. Mak
Thesis: Some Basic Mechanical Properties of Polyvinyl Chloride thermoplastic Sheet.

Lee, Jinn Jen
Taiwan, China
BS: National Taiwan University, 1962
Major: Civil Engineering
Major Professor: Dr. G. Z. Waters
Thesis: A Preliminary Experimental Study of a Hemisphere in Free Surface Flow.

Li, Chen-Hai
Taiwan, China
BS: National Taiwan University, 1963
Major: Civil Engineering (Structures)Major Professor: Dr. Cary K. K. Mak
Thesis: An Experimental Investigation of Buckling Behavior of Cylindrical Shells.

Lin, Tzyy Iang
Taiwan, China
BS: National Taiwan University, 1961
Major: Civil Engineering
Major Professor: Dr. Winfred O. Carter
Thesis: A Study of Movement-Curvature Relationship of the Rectangular, Inelastic Beam-Column.

Luong, Moc
Taiwan, China
BS: National Taiwan University, 1964
Major: Civil Engineering
Major Professor: Dr. Cary K. K. Mak
Thesis: A Numerical Method of Analysis for Plates with Variable Thickness.

Narayana, Dhruva VV
Guntur, India
BS: Indian Inst. of Technology, 1955
Major: Civil Engineering
Major Professor: Dr. J. M. Bagley
Plan B Report

Packer, Murland Ray
Ririe, Idaho
BS: Utah State University, 1965
Major: Civil Engineering
Major Professor: Dr. Gaylord Skogerboe
Thesis: Summary and Evaluation of Hydrologic Data for
Water Resources Management Decisions in the Grouse Creek Drainage.

Robinson, Lawrence R.
Ogden, Utah
BS: Utah State University, 1965
Major: Civil Engineering
Major Professor: Professor Norman B. Jones
Thesis: Hydrologic and Water Quality Study of the Logan City Sewage Outfall System.

Smedley, Weston B.
Syracuse, Utah
BS: Utah State University, 1965
Major: Civil Engineering
Major Professor: Dr. Winfred O. Carter
Thesis: The Structural Analysis of Three-Dimensional, Orthogonally Intersecting, Pin-Connected truss Systems by the Displacement Method.

Wang, Leei-Luoh
Taiwan, China
BS: National Taiwan University, 1958
Major: Civil Engineering
Major Professor: Dr. Jay M. Bagley
Thesis Director: Dr. A. Leon Huber
Thesis: Application of Multivariate Analysis in Predicting the Water Yield for Watersheds in the State of Utah.

1968 Degrees from the College of Engineering

Doctorate Degrees 1968:

Adamek, James Conrad
Powers, Oregon
MS: Stanford University, 1965
Major: Civil Engineering
Major Professor: Dr. Gary Z. Watters
Dissertation: Lift and Drag Forces on a Cube on a Boundary in a Finite,Three-Dimensional Flow-Field with Free Surface Effects.

Anderson, Julian B.
Seattle, Washington
BS: Utah State University, 1961
Major: Civil Engineering
Major Professor: Dr. D. F. Peterson
Dissertation: A Study of Free Surface and Vicous Effects on Simulated
Rough Open Channel Beds.

Bittinger, Morton Wayne
Fort Collins, Colorado
MS: Iowa State University, 1951
Major: Civil Engineering
Major Professor: Dr. Calvin G. Clyde
Dissertation: Simulation and Analysis of Stream-Aquifer Systems.

Owais, Talaat M.
Zagazig, Egypt UAR
MS: University of New Mexico, 1964
Major: Civil Engineering
Major Professor: Dr. Calvin Clyde
Dissertation: Hydrodynamic Forces and Pressure Fluctuations on a Hemisphere on a Boundary in Velocity Gradient Flow
Considering Free Surface Effects.

Masters Degrees 1968:

Chang, Chia Sheng
Taipei, Taiwan, China
BS: Chung Yun College of Science and Engineering, 1961
Major: Civil Engineering
Major Professor: Professor Vance T. Christiansen
Thesis: Plan B

Clark, Ralph Herbert
Cedar City, Utah
BS: Utah State University, 1966
Major: Civil Engineering
Major Professor: Professor Norman B. Jones
Thesis: Wastewater Stabilization Ponds: An Annotated Bibliography
and a Brief Discussion of the Anaerobic Environment.

Dixon, Neal Perry
Gooding, Idaho
BS: Utah State University, 1959
Major: Civil Engineering
Major Professor: Professor Norman B. Jones
Thesis: Plan B

Lin, Philip Hsiang-Huey
Pingtung, Taiwan, Republic of China
BS: Taiwan Christian College, 1962
Major: Civil Engineering
Major Professor: Dr. W. O. Carter
Thesis: Plan B

Mangelson, Kenneth A.
Salt Lake City, Utah
BS: Utah State University, 1967
Major: Civil Engineering
Major Professor: Professor Cleve H. Milligan
Thesis: Streamflow Forecasting for the Logan and Blacksmith
Fork Rivers in Northern Utah.

Mizue, Hiro Paul
Los Angeles, California
BS: University of California, 1967
Major: Civil Engineering
Major Professor: Professor Gaylord V. Skogerboe

Thesis: Irrigation Demand in the Utah Lake Drainage Area: The Role of Irrigation Efficiency.

NG, Chung Yin
Hong Kong
BS: Chu Hai College, 1965
Major: Civil Engineering
Major Professor: Dr. W. O. Carter
Thesis: Plan B

Rasheed, Muhammad Aslam
Lahore, Pakistan
Engineering University of Lahore, 1964
Major: Civil Engineering
Major Professor: Professor J. E. Christiansen
Thesis: Hydraulic Characteristics of a Modified Venturi Section

Rawal, Darshan Lal
Chandigarh, India
BS: Muslim University, India, 1957
Major: Civil Engineering
Major Professor: Dr. W. O. Carter
Thesis Director: Professor F. W. Kiefer
Thesis: Plan B

Sakhan, Kousoum South
Phnom Penh, Cambodia
BS: California State Polytechnic College, 1966
Major: Civil Engineering
Major Professor: Dr. Alvin Bishop
Thesis Director: Professor Gaylord Skogerboe
Thesis: Plan B

Saunders, Barry Collins
Brigham City, Utah
BS: St. Louis University, 1953
Major: Civil Engineering
Major Professor: Dr. Calvin Clyde
Thesis: A procedure for Determining the Feasibility of Planned
Conjunctive Use of Surface and Ground Water.

Shah, Rajendra Chimanlal
Karamsad, Gujarat, India
BS: S.V.V. University, India, 1966
Major: Civil Engineering
Major Professor: Professor Vance T. Christiansen
Thesis: Plan B

Uzcategui S., Jose Antonio
Merida, Venezuela
BS: Universidad Los Andes, 1965
Major: Civil EngineeringMajor Professor: Dr. Gary Z. Watters
Thesis: Plan B.