The Official Publication of the U. S. Water Jet Technology Association

U.S. Water Jet Technology Association

JET NEWS

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International Journal of Water Jet Technology

At the International Water Jet Symposium held in September of 1987, in Beijing, China, a decision was made to publish a quarterly international journal on water jet technology. The major objective of this journal is to provide an opportunity for authors to publish their findings, apart from national and international symposia, in a journal dedicated exclusively to water jet technology.

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Water Jet Instructor Training Workshop

The U.S. Water Jet Technology Association has scheduled a workshop designed specifically for individuals who are engaged in training personnel in the use of water jets. The workshop will be held March 13-14, 1989, in St. Louis, Missouri at the Stouffer Inn by the airport. Written and visual prop materials and volunteers for presentations are still needed. For more information, please contact Dr. David Summers at the University of Missouri-Rolla (314)341-4311.

Water Jet Cutting: An Interview With Dr. Norman Franz

The following is a transcript of an interview conducted by telephone with Dr. Norman Franz. Dr. Franz, formerly at the University of Michigan and the University of British Columbia, is one of the pioneers of water jet cutting.

JET NEWS: What led to your realization that high-pressure water could be used as a cutting medium?

DR. FRANZ: Jet cutting was the spinoff of a continuing research program that I was conducting on the machining of wood. We were seeking new and potentially better ways of cutting wood with less waste. Exploration included a wide array of new devices, such as lasers and ion beam guns, which were coming along in the late fifties. Water jet cutting really grew from the casual remark of a Navy man who indicated they tested for leaks in the very high pressure boiler systems with a broom handle. The steam jet escaping from these leaks would actually cut the broom handle off, which was rather surprising. We did explore steam jets, but there are obvious limitations because of the gas pressures involved. We then theorized that the water jet perhaps would be an alternative approach, using the same general principles. We experimented with water jet cutting around 1960 using a homemade, single-action pressure intensifier developing over 50,000 psi. It was exciting to be able to actually cut wood and other materials with ordinary water.

JET NEWS: How did you link up with Ingersoll-Rand to develop the equipment necessary to test your water cutting theory?

DR. FRANZ: Initially I was searching for a high-pressure pumping source that would continuously produce high pressures to sustain a jet. We had found that synthetic sapphire orifice jewels could be used for high-pressure nozzles and appeared to be very long lasting. However, our homemade system did not provide a practical way to determine if durability was adequate for industrial applications. We needed a means for running continuously, so I contacted known makers of high-pressure devices and, armed with samples of our laboratory results, visited several manufacturers. I was surprised to find that none had considered the possibility that high-pressure water might be a cutting device. I was able to spark the interest of Wally Walstad, of McCartney Manufacturing, an Ingersoll-Rand subsidiary. After a visit to my laboratory, he arranged to lend me one of their high-pressure pumps used for catalyst injection in the manufacture of polyethylene. After many modifications to cope with the difficulties of pumping water at extreme pressure, we proved to have a reliable system. This was later duplicated for installation at Alton Boxboard Company as the world's first industrial high-pressure jet cutting operation, and solved a cutting problem that could not be handled by conventional methods.

JET NEWS: How was Alton Boxboard Company cutting their materials before using water jet cutting?

DR. FRANZ: Initially, the rather complex three-dimensional parts were cut by a hand-held sabresaw following a pencil-drawn pattern. As demand grew, bandsaws were used, but were costly, slow, inaccurate, and wasteful. Alton was producing furniture components from kraft-paper-laminated tubes up to 5/8-inch thick, roughly rectangular in cross section, with a diameter of about 40 inches, and height of 7 feet. Since cuts had to be perpendicular to the curved surface of the tubes, it was a challenging problem. Through a friend, aware of my machining research, Alton's problem was brought to my attention and samples of their laminate were sent for jet cutting trials. Happily, the samples could be cut cleanly with virtually no wetting, and at a high speed. We had found a unique solution to a unique production problem. All we needed was a

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From the President's Desk...

We know a lot about water jets, but a telephone call from a prospective member reminded me that we need more knowledge about our technology. The caller wanted to use water jets to clean the outside of a rock-faced church. He wanted to know if anyone has measured the adhesive strength of various contaminants on rock. I had to reluctantly admit that I didn't know the answer to his question.

It seems to me that there are a lot of areas, such as this, where more information would be helpful. For instance, when can we expect a high-pressure hose to fail? It seems to me that this important safety problem is still a guessing game. Why can't we develop practical use of pulse jets? Fast, repetitive firing of slugs of water are a good way of introducing tensile stress in material. Solids are much weaker in tension than in compression and, thus, would be cut much easier by pulse jets as compared with continuous jets. Why can't we use scaling laws to predict the jet cutting behavior of large jets from data gathered from laboratory-size jets? The present state of the art of hydraulic mining is that it is practically impossible to predict production rates in a hydraulic mine from experiments on laboratory samples. Will sparks from abrasive water jet cutting ignite a flammable atmosphere? This is an important safety problem for those who wish to cut steel pipelines with an abrasive jet.

I wish I had the answer to these questions.

Administration

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An Interview With Dr. Franz, continued from page 1

means of obtaining relative motion between the jet and the tube. The first cost quotation for this missing link came in at a stunning $750,000 and might easily have crushed anyone less determined. A second supplier managed to offer a control system for $75,000, which was still far out of reach. Finally, I drew upon my furniture industry experience and built a cardboard-and-wood model of a device using the concepts found in the old automatic routers. I sent the model to McCartney, who then built a working unit for the grand cost of only $7,000 --- 99 percent less than the first quote! The completed jet-cutting system was soon the first in industrial use, and has operated successfully for many years.

JET NEWS: Did you ever expect that the technology would grow and reach the level of sophistication it has? Or penetrate the industries it has?

DR. FRANZ: I guess it is the hope of every researcher that he's going to have an earthshaking idea. Very rarely do you have the opportunity to see something grow from a concept, through a laboratory experiment, and actually into use.

JET NEWS: New applications for water jet cutting are constantly being discovered and implemented. As the technology continues to develop, what new applications do you foresee for water jets?

DR. FRANZ: New applications might be found in areas we have not yet even imagined. I feel there are many opportunities being overlooked because the general public does not realize that jet cutting is a viable and unique alternative to conventional methods. Jet cutting has not enjoyed the glamor and publicity of lasers, for instance, in part due to its limited attraction to the military and medical science. Water jets are primarily valued as a machining method. We used a laser to drill pinholes in a piece of wood at about the same time as we looked at high-pressure jets. Since that time, lasers have had enormous effort and money spent on development. Water jets have struggled by comparison.

JET NEWS: Regarding lasers, how would you compare laser cutting to water jet cutting? Do you see them as being competitive, compatible?

DR. FRANZ: I feel they're complementary. The two are similar in that they are essentially point sources of energy. The laser has its place, very definitely, along with its very significant limitations. The water jet similarly has its specific applications where it will do the job better than a laser. It has its limitations as well. One picks the better tool for a given application.

JET NEWS: Backtracking a bit to applications, what experimental water jet applications are currently taking place that you are aware of?

DR. FRANZ: I think the cutting of new man-made materials, such as Kevlar, carbon-fiber composites, and laminates, has attracted recent attention. These materials are often extremely difficult to cut with conventional methods. There is renewed research and interest in the use of water jets for cutting wood. In fact, I'm currently consulting for the U.S. Forest Service on a program for the automated lumber processing systems that they have developed. The question there is, whether the laser or the jet is the better way to go. They've asked me to evaluate the potential of water jets as opposed to the use of the current high-powered lasers.

JET NEWS: Please address the issue that water jet technology offers many advantages in dealing with difficult to machine materials.

DR. FRANZ: As with most applications, a major advantage of water jets is that they are virtually a point source of energy. This allows freedom to cut in any direction, sharp corners, blind cutouts, and three-dimensional cutting paths. Although pressures are very high, jet forces axially and laterally are quite small, providing for easy and rapid movement during cutting, as well as light-weight supporting structures. Advantages in safety arise from the small forces present. Workpiece damage is reduced by low forces and the minimal heat generated at the cut. Wetting is normally not a problem if cutting parameters are correctly selected. The working jet is ordinarily relatively quiet, and can be widely separated from the pumping system. The very small kerf made by jets reduces or eliminates possible polluting waste material. There is little danger from the extreme liquid pressures used, since, unlike pressurized gases, little energy is stored.

JET NEWS: Were environmental advantages in the workplace a concern when you developed water jet cutting?

DR. FRANZ: I must admit, at that time, environmental considerations were

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An Interview With Dr. Franz, continued from page 2

secondary. We were looking for a new method of cutting. But as I say, it turns out that environmentally it's very favorable, particularly for cutting materials that are hazardous. Asbestos being one example, breakshoe material.

JET NEWS: The innovation of the addition of abrasive to water has greatly expanded water jet technology to machine the more difficult, denser materials. What refinements do you see in the technology for the future?

DR. FRANZ: We did experiments on the introduction of abrasives into water jets back in the early days of water jet cutting, long before my association with McCartney. At the time, there were a number of cleaning operations using abrasives and water pressures in the neighborhood of 5,000 psi. So the use of abrasives is not really a new development at all. It's really a renewed interest in the concept to extend the application of water jet technology as it is today. It has a lot of advantages. It has the added disadvantages of increasing the costs of operation considerably and it also produces a waste product of abrasive material that has to be taken care of. For specific applications, it's great. But, it's not something that one would use unless you absolutely had to.

JET NEWS: Do you see any further refinements of the water jet?

DR. FRANZ: Yes, I think the primary refinement that's needed is better and cheaper initial capital cost equipment. This is one of the greatest limitations. We also need an expansion of the range of equipment, both of the smaller and larger pumping systems. Right now, most of the pumping systems fall within a fairly narrow range of capability. For mining applications, you need much bigger and heavier equipment. For some of the more sophisticated industrial applications, smaller equipment is preferred. I think continued improvement in the actual hardware and functioning of the system is required. There are many problems that still have to be solved requiring better knowledge of water systems. Nozzle development could be carried further, as well.

JET NEWS: Ingersoll-Rand recently introduced a family of robot-controlled water jet cutting systems to provide a turnkey solution to transforming assembly lines and expanding job shops. Had you ever imagined that water jet cutting would join forces with robotics?

DR. FRANZ: Oh yes, in fact this was one of the very early concepts when we began to get involved in the process of lumber cutting. Computerized numerical control systems, including what is now called robotics, are a natural and ideal way to fully utilize the unique characteristics of high-pressure water jet cutters. Our early activity in this area was handicapped in large part by the fact that early control devices were too slow and heavy, having been designed for metal cutting requirements. My work with the Forest Service is closely related to an elaborate computer imaging and control system.

JET NEWS: Do you feel that this can revolutionize the production line workforce?

DR. FRANZ: Yes, and I think, in many cases, it probably already has.

JET NEWS: In what ways?

DR. FRANZ: In many instances, water jets have been able to perform cutting operations impossible or impractical by any other means. They have opened the path to novel automated operations while improving the safety of working environments.

JET NEWS: Ingersoll-Rand designed a water jet cutter specifically for the printed circuit board industry. Do you see this tailorization as a trend for other industries ?

DR. FRANZ: I think that this has been one of the areas that has been neglected in the development of water jets generally. Most people, particularly when they're dealing with a new technology, don't have the capability, in many cases, or the desire, to build all the auxiliary equipment to make use of the jet. In other words, just selling a jet-cutting device is not enough, in most cases. People want a package turnkey type of operation that's been tested, proved, and ready to work. I would say that these turnkey operations are probably the way that water jet cutting should and will go.

JET NEWS: You're still with the university?

DR. FRANZ: No, I've retired from academia, but keeping extremely busy with an ever increasing number of interesting projects. I'm still very much interested in water jets, and as I indicated earlier, I am involved in consulting work with various people. Watching jet cutting develop through the years is much like watching your child grow. It has been a rewarding experience that has been filled with many fine, interesting people, and fascinating cutting problems. We have cut everything from cakes to space shuttle tiles, but have scarcely begun to realize the full potential of jet cutting.

Recommended Practices For The Use Of Manually Operated High Pressure Water Jetting Equipment

Copies of the U.S. Water Jet Technology Association publication, "Recommended Practices" developed by industry, government, and university representatives to the Standards Committee of the U.S. Water Jet Technology Association are available for purchase. The publication includes personnel requirements, operator training, operating procedures, equipment care and maintenance, protective clothing, personnel protection, freeze precautions, and accident precautions for manually operated high pressure water jetting equipment commonly used by industries involved with construction, maintenance, repair, cleaning and demolition work. Attention is drawn to the relevant or proposed OSHA, ASTM, and ANSI standards.

Copies are available at the following prices (excluding shipping and handling): 1-10, $5.00 each; 11-99, $4.00 each; 100 or more, $3.00 each. To order, please complete the form on page 5.

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– James Stephen

Fifth American Water Jet Conference Set For August 29-31, 1989

The Fifth American (formerly U.S.) Water Jet Conference will be held August 29-31, 1989, at the Inn on the Park in Toronto, Ontario, Canada. A short course on water jet cutting will be held on August 28 at the Inn on the Park.

The conference is being sponsored by the U.S. Water Jet Technology Association and the National Research Council of Canada.

The conference will be designed as a forum in which researchers and practitioners can make contacts, exchange ideas, and review advances in this rapidly developing technology.

There will be an exhibition hall at the Inn on the Park. Exhibitors are reminded that there is room for 25 booths and to date, five have been reserved. Firms or organizations wishing to exhibit their products or literature at the Conference should reserve a booth now by paying the fee of $375.00 (Canadian) per booth immediately. Please contact:

Mrs. H. Lacoste, Conference Coordinator
Conference Services
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In addition to the table top exhibition at the Inn on the Park, a technical tour will be held on the afternoon of August 30. This tour will include stops at firms in the Toronto area which specialize in water jetting and at the grounds of the Atomic Energy of Canada at Mississauga, Ontario, for a demonstration of equipment. Firms wishing to demonstrate the operation of their equipment should contact Mr. A.D. (Doug) Hink at the following address to inform him of their requirements:

Mr. A.D. (Doug) Hink, General Manager
Advanced Systems Applications
Atomic Energy of Canada, Ltd.
2251 Speakman Drive
Mississauga, Ontario, Canada L5K 1B2
Telephone: (416) 823-9040
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The fee for participating in the equipment demonstration is $500.00 (Canadian) payable immediately after requesting a place. The checks should be made payable to: "NRC - Fifth American Water Jet Conference" and mailed to Mrs. H. Lacoste, the Conference Coordinator.

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