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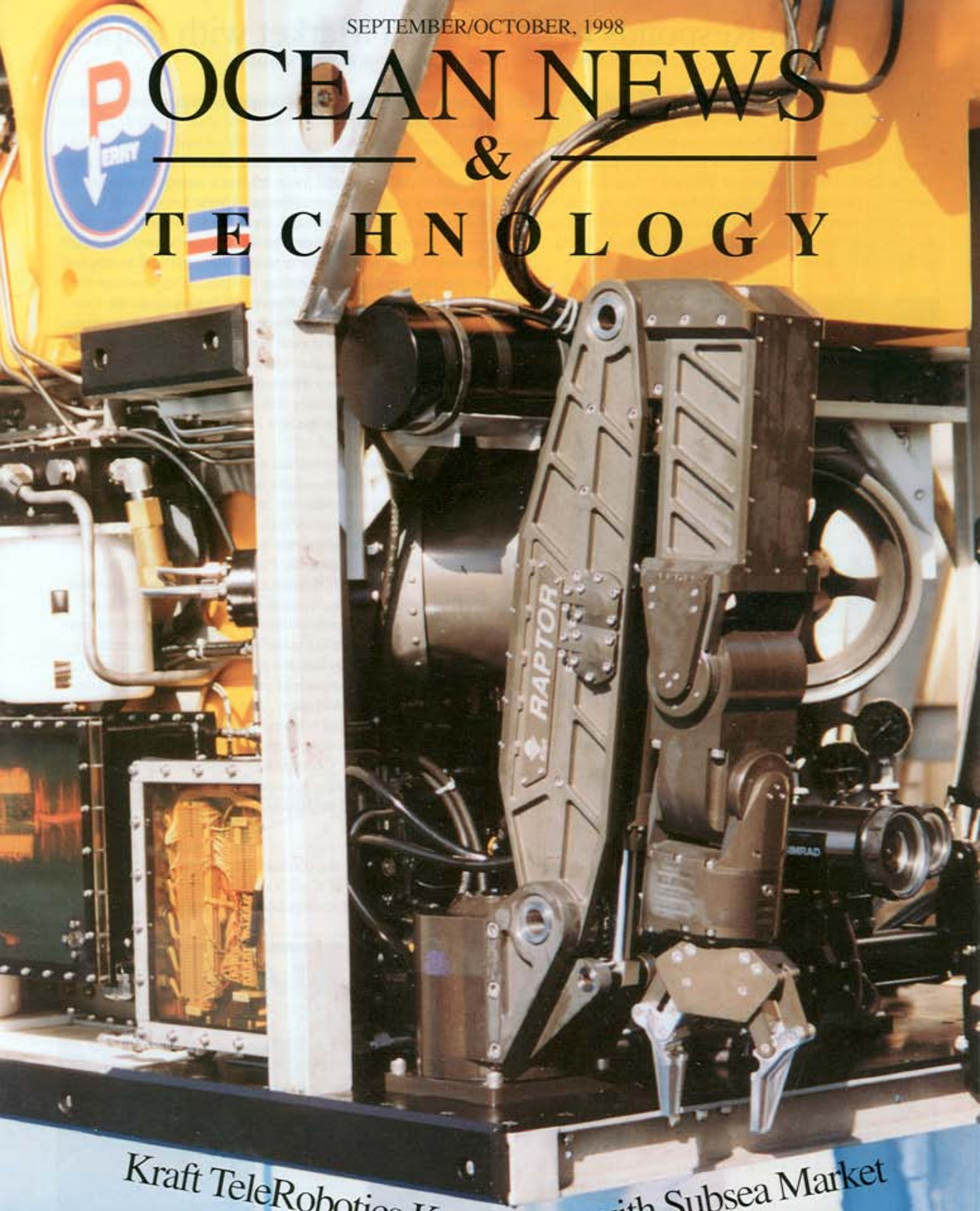


Kraft TeleRobotics Keeps Pace with Subsea Market

News for the Ocean Industry Professional

Cover Story

Kraft Responds to the Subsea Market with Raptor

by Steve Harbur, Kraft Telerobotics Inc., Overland Park, Kansas

Kraft TeleRobotics is not just another new company entering the offshore oil and gas industry, but rather a well established leader in the field of undersea manipulator technology with a tradition of technological innovation. In the early 1980s, Kraft introduced one of the first 7-function position controlled manipulator systems for use offshore. Called *Grips*, this unique manipulator system was used on a large number of ROVs including the famous Ametek Straza SCORPIO vehicle.

Predator Arm on Canyon Offshore ROV

With the downturn of the offshore industry in the mid 1980s, Kraft shifted its focus to inland market opportunities and pursued the sale of products to other industries. For over 15 years Kraft has been building and delivering underwater manipulator arms to a wide variety of international customers within the nuclear and aerospace industries, and to a large number of electric utility companies worldwide for the robotic maintenance of power lines.

Today, however, since the introduction of Kraft's *Predator* and *Raptor* manipulator systems, Kraft sales within the offshore oil and gas industry have increased dramatically and the owner/operators of these systems have expressed their enthusiasm and high level of satisfaction regarding the performance and operational characteristics of these arms. Available with force feedback control, these two new Kraft manipulators have set a new standard for manipulator performance and durability. By year's end, Kraft plans to introduce a simple grabber arm called *Talon*, a powerful 5-function rate controlled arm. *Talon* will provide the necessary heavy lift capability to perform a wide range of subsea tasks, including the anchoring of a ROV to a subsea structure.

Force Feedback Technology

When mounted on the front of an ROV, conventional rate controlled and position controlled manipulator arms are often severely damaged by powerful dynamic forces that are generated by the relative motion between the ROV and the work site. The individual joints in these arms are essentially locked in place awaiting the next operator command, and as a rigid hydraulic device, each arm must deal with external forces acting on it.

Unlike a rate controlled or position controlled hydraulic arm, a hydraulically powered force feedback manipulator arm has the ability to move in compliance to these forces. All the joints in a force feedback arm are inherently compliant (can move) to keep the arm from breaking under severe dynamic loading. The ability of the manipulator arm itself to respond to force, as opposed to resisting it, dramatically reduces the risk of damage to the arm when mounted on the front of an ROV. Hydraulic force feedback arms and standard position controlled hydraulic arms are very much alike. Both types are typically powerful, providing long reach and heavy lift capability. The primary difference between a standard position controlled manipulator and a force feedback manipulator is the way in which the arm is controlled.

A standard position controlled manipulator responds directly to the operator's commands as he or she moves the controller. Moving the controller at one end makes the manipulator arm move at the other end. When the controller is not being moved, the manipulator arm remains rigidly in place awaiting the next command. Pushing or pulling on the manipulator itself will not make anything happen. The arm will only respond to movement of the controller. This is called unilateral control. A force feedback manipulator system works very much the same way, but in both directions. If you move the controller, the manipulator arm will move, however, if you move push or pull on the manipulator arm itself, the controller will move, and the two will move together. This is called bilateral control. Bilateral control is accomplished by placing electric actuators on the individual joints of the operator's controller. These actuators respond to forces acting upon the manipulator to provide movement of the controller, and in the process convey force feedback to the operator.

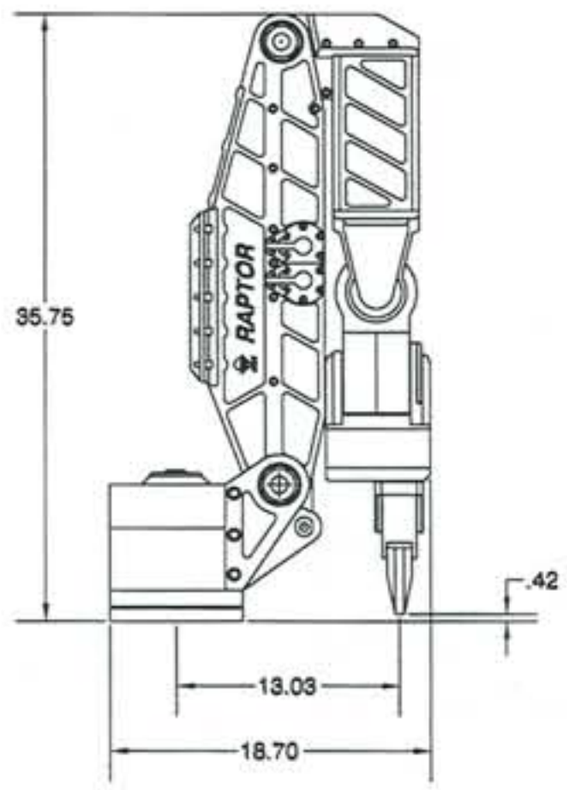
With the upswing in the offshore ROV activity and the successful introduction of Kraft's unique force feedback control technology, offshore manipulator sales are once again very

Cal Dive ROV operating with the Predator Arm

strong. The popularity of Kraft's new manipulator systems is also due in part to their low cost. In fact, owning and operating a Kraft force feedback *Predator* or *Raptor* manipulator system is often less costly than the competitor's arms, without the force feedback control.

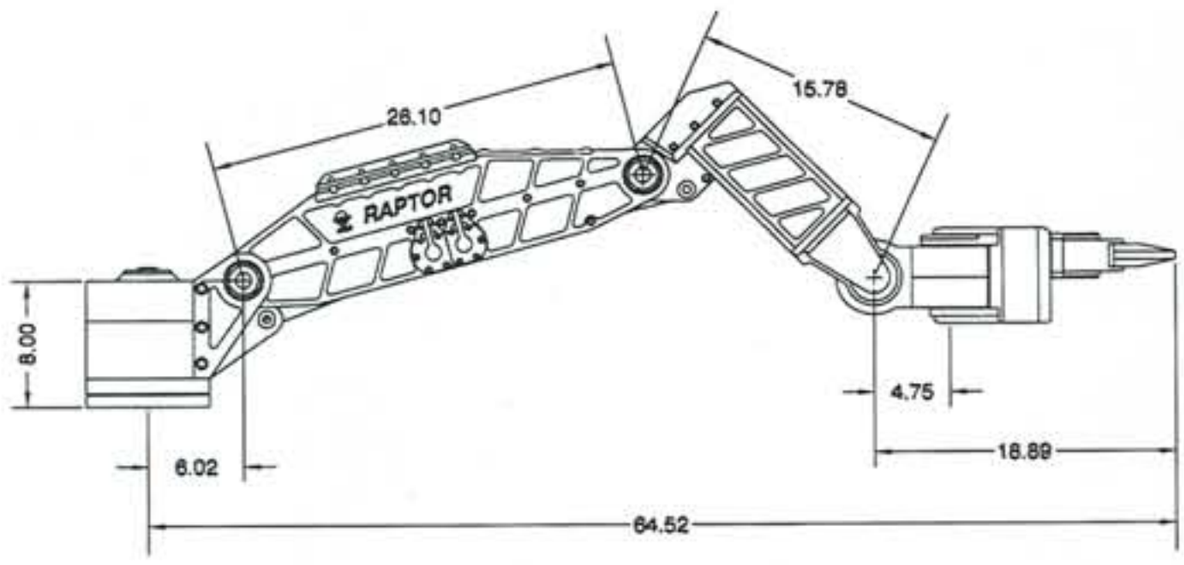
Kraft's Latest Manipulator - *Raptor*

Raptor is a very rugged, powerful, high-dexterity manipulator for applications where both size and weight as well as lift and reach are important. *Raptor* incorporates field proven bilateral force feed back control which greatly enhances the ability of the arm to survive extreme forces and heavy work loads. In its stowed position, *Raptor* is less than 36-inches tall with an in water weight of only 89 pounds. Fully extended, *Raptor* can reach 64-inches and lift 200 pounds.



Raptor Slave Arm

The *Raptor* manipulator is a microprocessor controlled electrohydraulic device with a total of seven actuated functions. The manipulator's performance envelope allows for either left or right hand operation. The slave's basic structure is anodized 6061-T6 aluminum with an impregnated teflon protective coating. All non-aluminum hardware is corrosion resistant metal or composite material.



The manipulator is divided into two basic sections - an upper arm section that provides the primary motions of shoulder azimuth, shoulder elevation and elbow pivot, and a forearm section that provides wrist pitch, wrist yaw and wrist rotate motions. In addition to these six degrees-of-freedom, a parallel jaw-type gripper with force control is provided as the standard end effector. Kraft's unique proportionally variable control of gripper force has proven superior to the typical constant rate type of jaw. Motive force is supplied by seven hydraulic actuators, all designed and manufactured by Kraft. Each actuator is controlled by a hydraulic servo valve, packaged as an integral part of the manipulator. The wrist and gripper actuators are internally ported, eliminating the need for hydraulic hoses.

For more information call Steve Harbur at (913) 894 9022

Force Feedback Raptor on Ceanic's New Triton ST. Ceanic Currently Has 7 Force Feedback Raptor Arms on Order

Specifications

General Specifications	
Degrees of Freedon	6 plus gripper
Maximum Reach	64 inches
Lift at full Extension	200 lb.
Jaw closure force	300 lb.
Wrist torque	100 ft.-lb.
Dry weight	160 lb.
Weight in sea water	89 lb.
Hydraulic Requirements	
Operating pressure	1500-3000 PSI
Flow requirement	5 GPM
Filtration	25 micron absolute
Joint Motion	**Total Angular Degrees**
Shoulder azimuth	275
Shoulder elevation	120
Elbow Pivot	120
Wrist Pitch	200
Wrist Yaw	200
Wrist Rotate	
Mode 1 (Slaved)	340
Mode 2 (Continuous)	55 RPM max

RAPTOR

7-Function Subsea Manipulator System

FEATURES

- Strong – Rugged Heavy Duty Construction
- Powerful – 200 Lbs. of Lift at Full Extension (64 inches)
- Compact – Stowed Height Less Than 36 inches
- High Dexterity – 200 Degrees of Wrist Pitch & Yaw Motion
- Low Cost – Complete System $115,000
- Bilateral Force Feedback Control (Optional)

The New Standard in Subsea Manipulator Performance

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