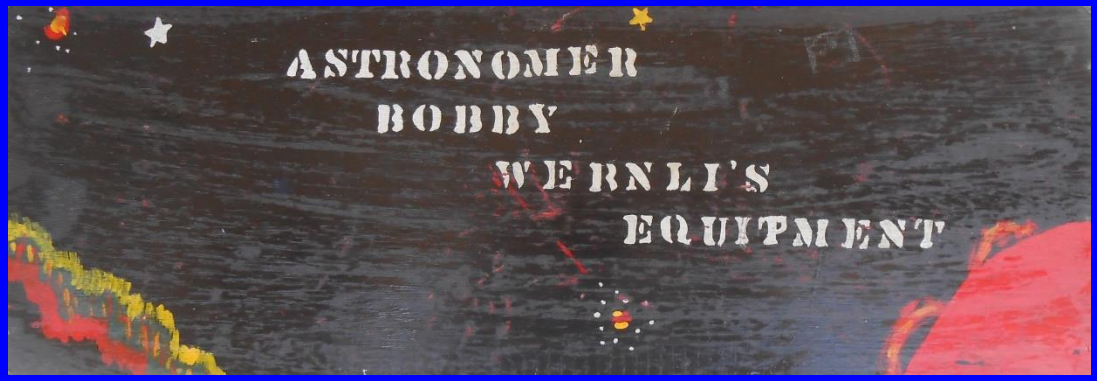
THE ROV MANUAL…
AND HOW I GOT THERE

Robert L. Wernli

First Centurion Enterprises

www.wernlibooks.com

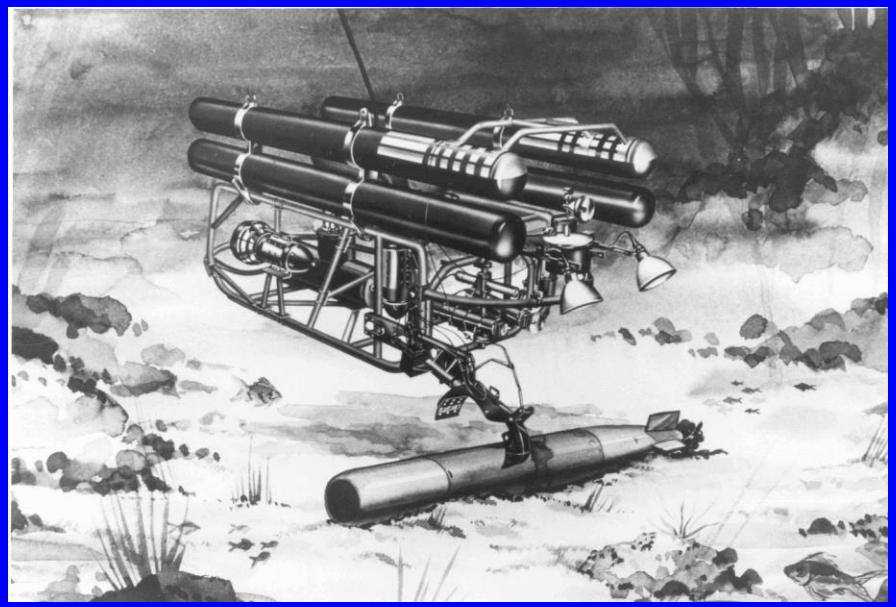
AN OUTER-SPACE CAREER???



SPACE….THE FINAL FRONTIER!!

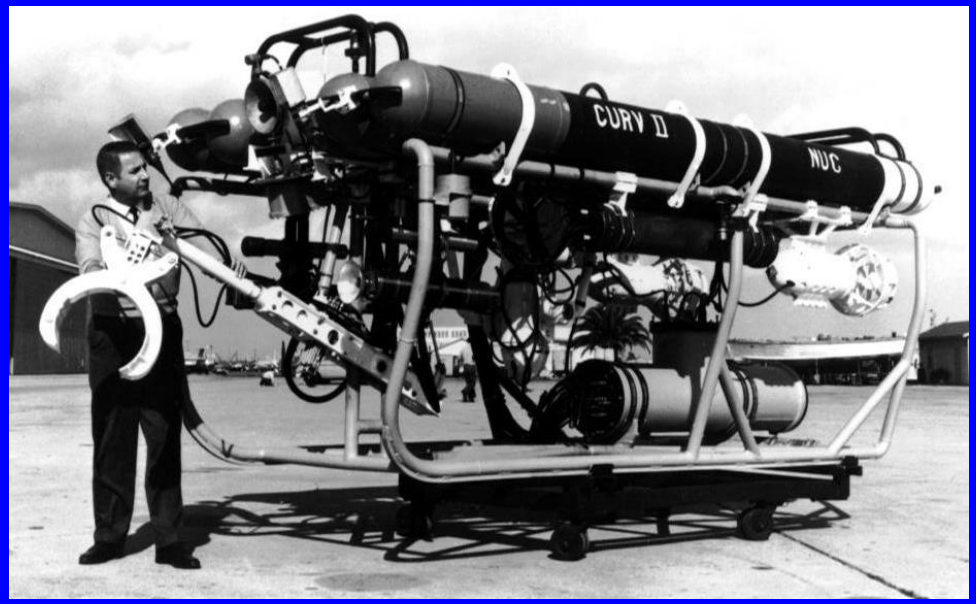
…WELL, MAYBE NOT.

A NAVY LAB RECRUITER TOLD ME ABOUT THESE ROBOTS



CIRCA 1961

…THE US NAVY CREATED THE CURV



THE U.S. NAVY HAD A NEED

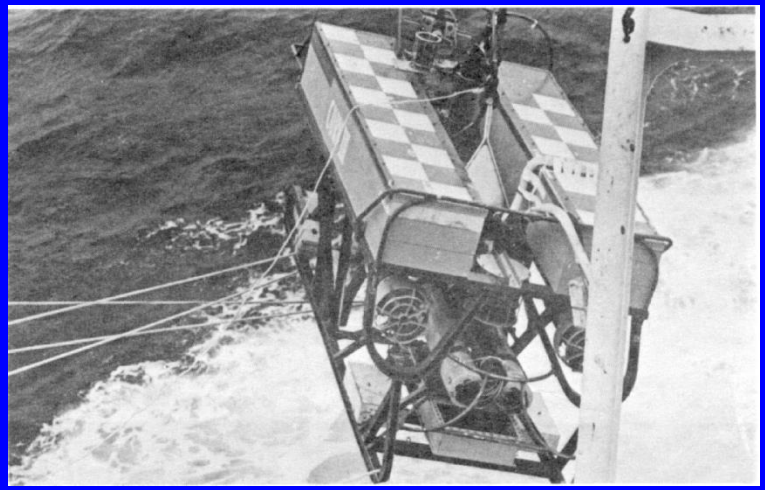
ATOMIC BOMB RECOVERY OFF PALOMARES SPAIN IN 1966 AT 869 METERS

CURV III WAS "FLY AWAY"

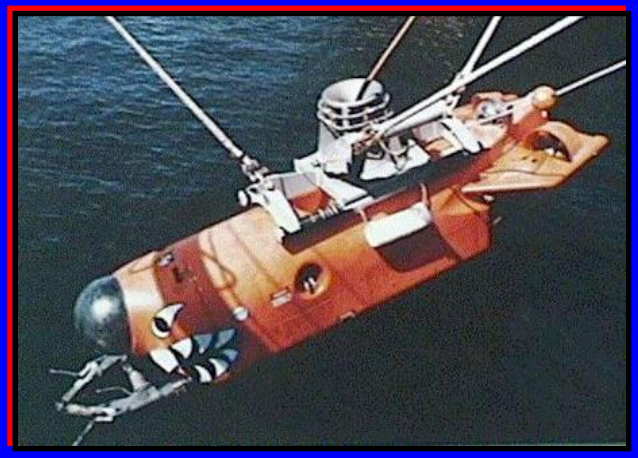
…WHICH MADE ROGER CHAPMAN A VERY HAPPY PILOT

***PISCES III* OFF CORK IRELAND IN 480 METERS**

1973

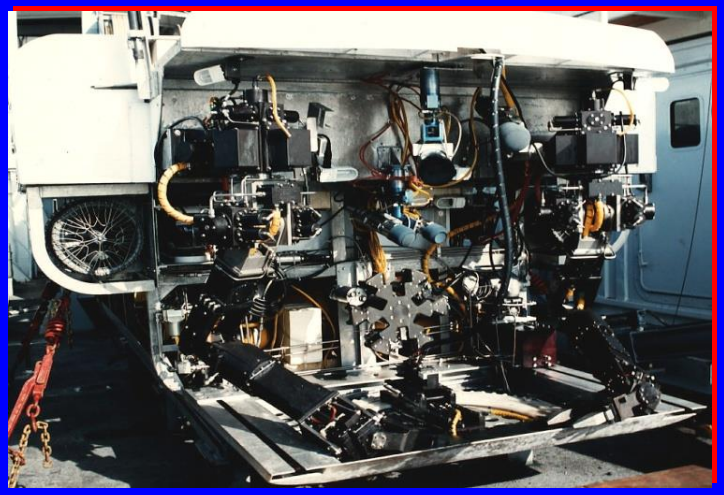


DEEP OCEAN TECHNOLOGY PROGRAM AT US NAVY LAB – SAN DIEGO

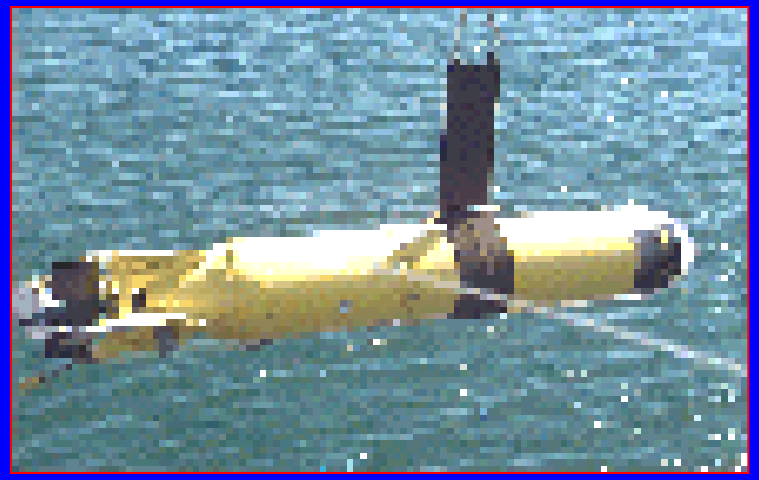


Mine Neutralization System

Advanced Unmanned Search System



Advanced Tethered Vehicle



Flying Plug

VEHICLES DEVELOPED AT NAVY LAB IN SAN DIEGO

Remotely Operated Vehicles

	Year Completed
CURV I	1963
CURV IIA	1966
CURV IIB	1967
CURV IIIA	1969
CURV IIIB	1970
CURV IIIC	1971
SNOOPY	1973
ELECTRIC SNOOPY	1974
NAVFAC SNOOPY	1975
SCAT I	1973
SCAT II	1984
MNV	1977
RUWS	1975
FOCUS	1980
ATV	1992
NOZZLE PLUG	1979

Manned Vehicles

	Year Completed
MORAY	1964
DEEPJEEP	1965
HIKINO	1966
DEEPVIEW	1972
MAKAKAI	1972
BTV	1970

Autonomous Underwater Vehicles (AUVs)

	Year Completed
AUSS I	1983
AUSS II	1990
FREE SWIMMER I	1978
FREE SWIMMER II	1983
MNV (AUSD)	1989
FLYING PLUG	1996

MY BIGGEST TOY!

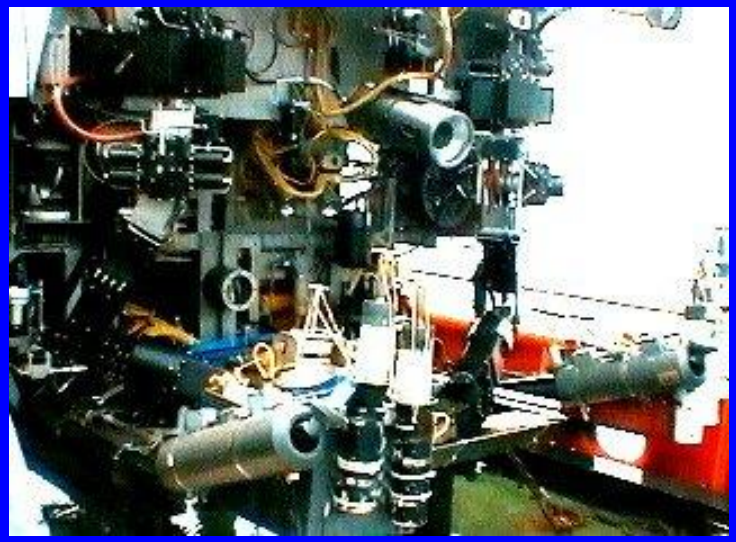
CURV TRANSFERRED TO INDUSTRY

- **1990 – *CURV*, OEPRATED BY EASTPORT INTERNATIONAL, BREAKS THE 20K BARRIER WITH A RECORD DIVE TO 20,105 FEET**
- **29 YEARS IN THE MAKING!**

LESS THAN A WEEK LATER

ATV, DEVELOPED BY THE US NAVY ("NOSC") INCLUDING KEVLAR CABLE WITH FIBER OPTICS

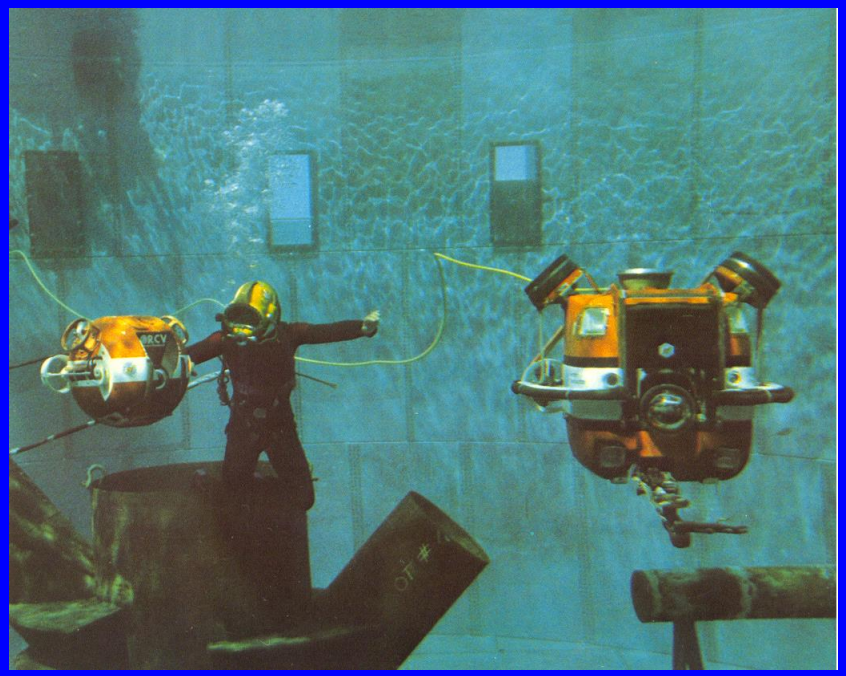
THE ADVANCED TETHERED VEHICLE BREAKS RECORD AGAIN, REACHING A DEPTH OF 20,600 FEET



SAN DIEGO WAS THE "ROV CAPITAL OF THE WORLD"

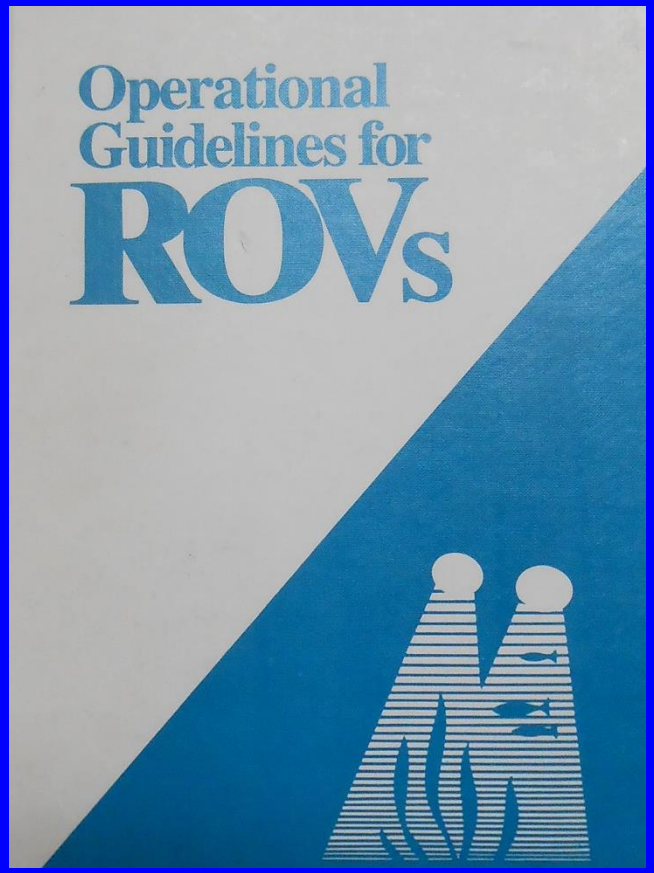
30+ YEARS AGO…

SAN DIEGO RULED



HYDRO PRODUCTS, NAVY LAB, AMETEK STRAZA AND ALL THE SUPPORTING TECHNOLOGIES

THE MTS ROV COMMITTEE AND THE SAN DIEGO SECTION TOOK CONTROL



40+ YRS AND STILL GOING STRONG

KEVIN

JACK

JACK AND I PRODUCED THE OEUUS FOR THE ROV COM.

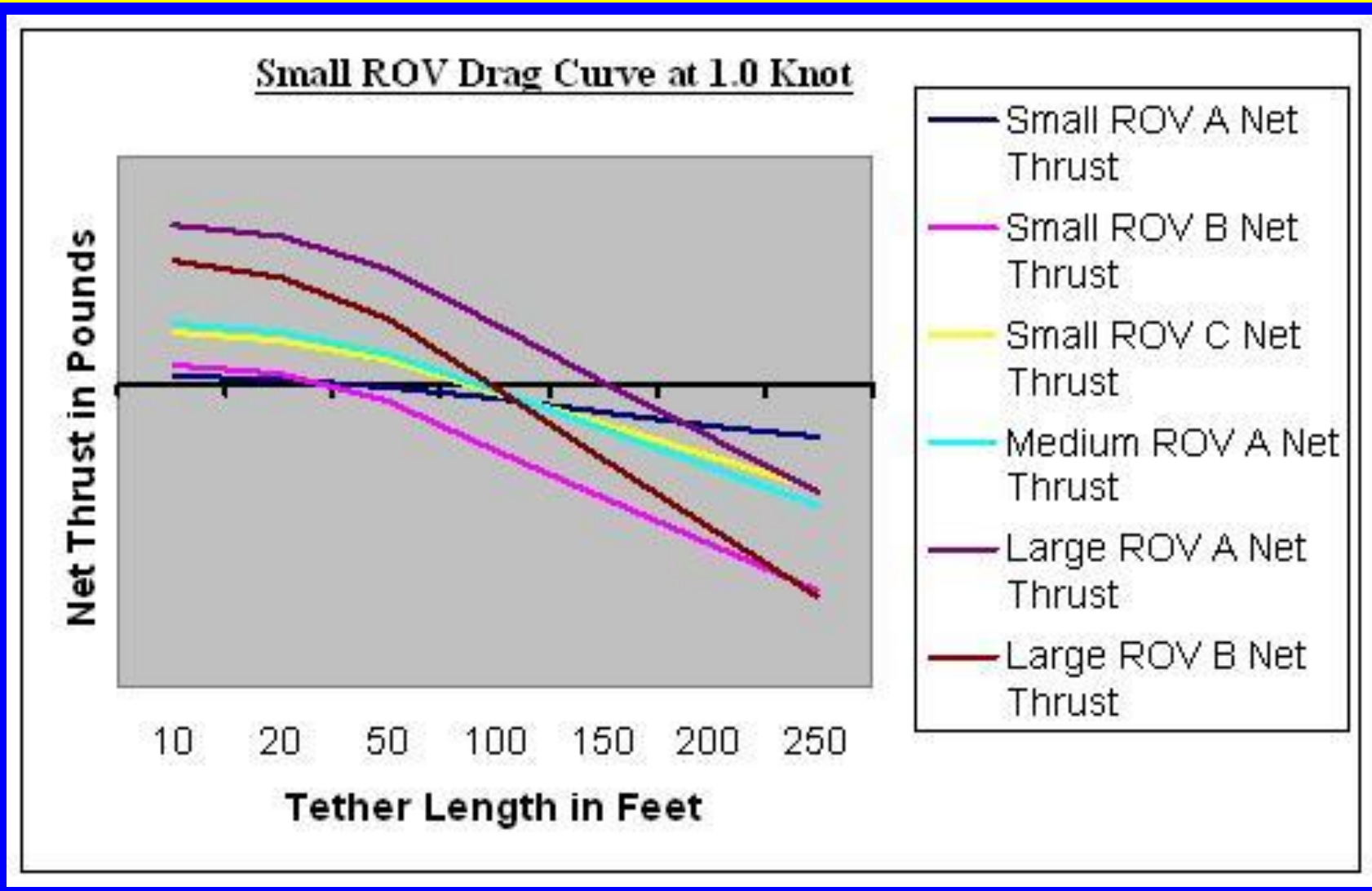
ROBERT D. CHRIST WANTED TO WRITE A BOOK

BASED ON A COAST GUARD CONTRACT EVALUATING OCROVS

Observation Class ROVs

Portable ROVs that weigh less than 200 lbs (91 kg)

OPERATIONAL CAPABILITY ANALYZED

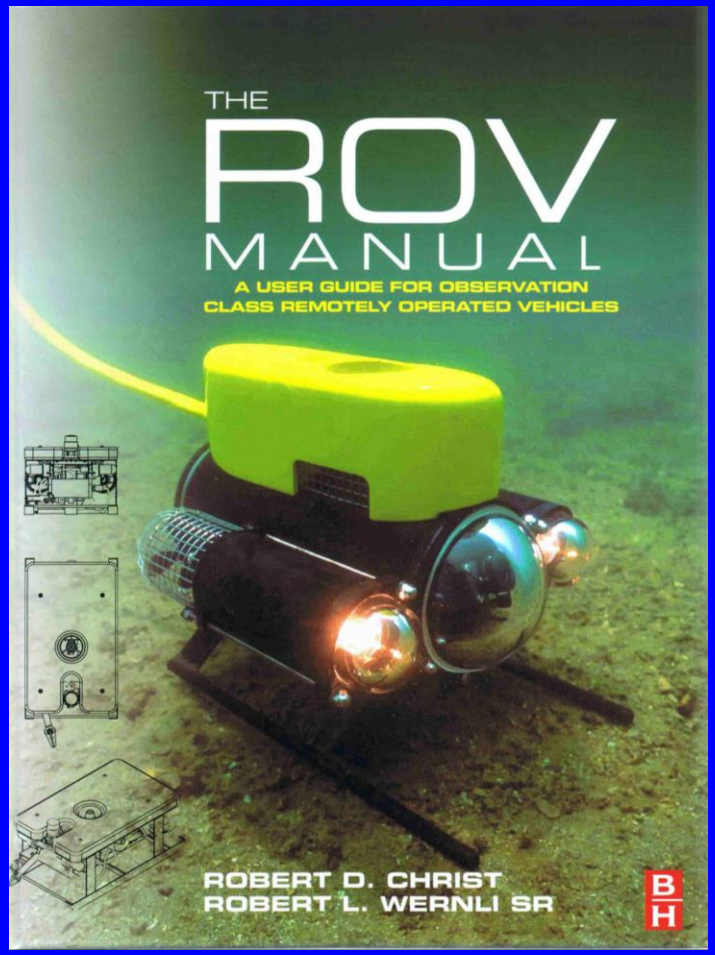


REPRESENTATIVE OCROV SPECIFICATIONS (2007-2014)

NAME	COMPANY	WT. (KG) IN AIR	DEPTH (M)	BUILT (2007)	SHIPPED (2014)
Little Benthic Vehicle (LBV)	SeaBotix, Inc., US	10-15	150-1500	642	1,150
Outland 1000	Outland Technology Inc., US	17.7	152	93	??
300F ROV	Seamor Marine	16	300	40+	??
RTV Series	Mitsui, Japan	42	150	310+	??
VideoRay* Series	VideoRay LLC, US	4-4.85	0-305	1250	3,500

THANKS TO:

- **Imagenex Technology Corp.**
  (Fort Coquitlam, British Columbia, Canada)
- **JW Fishers Mfg.**
  (East Taunton, Massachusetts, USA)
- **Mitsui Engineering and Shipbuilding Co.**
  (Tokyo, Japan)
- **Outland Technology, Inc.**
  (Slidell, Louisiana, USA)
- **Reliant Subsea, Inc**
  (Santa Barbara, California, USA)
- **SeaBotix Inc.**
  (San Diego, California, USA)
- **Seamor Marine Ltd.**
  (Nanaimo, British Columbia, Canada)
- **Submersible Systems, Inc.**
  (Patterson, Louisiana, USA)
- **VideoRay LLC**
  (Phoenixville, Pennsylvania, USA)

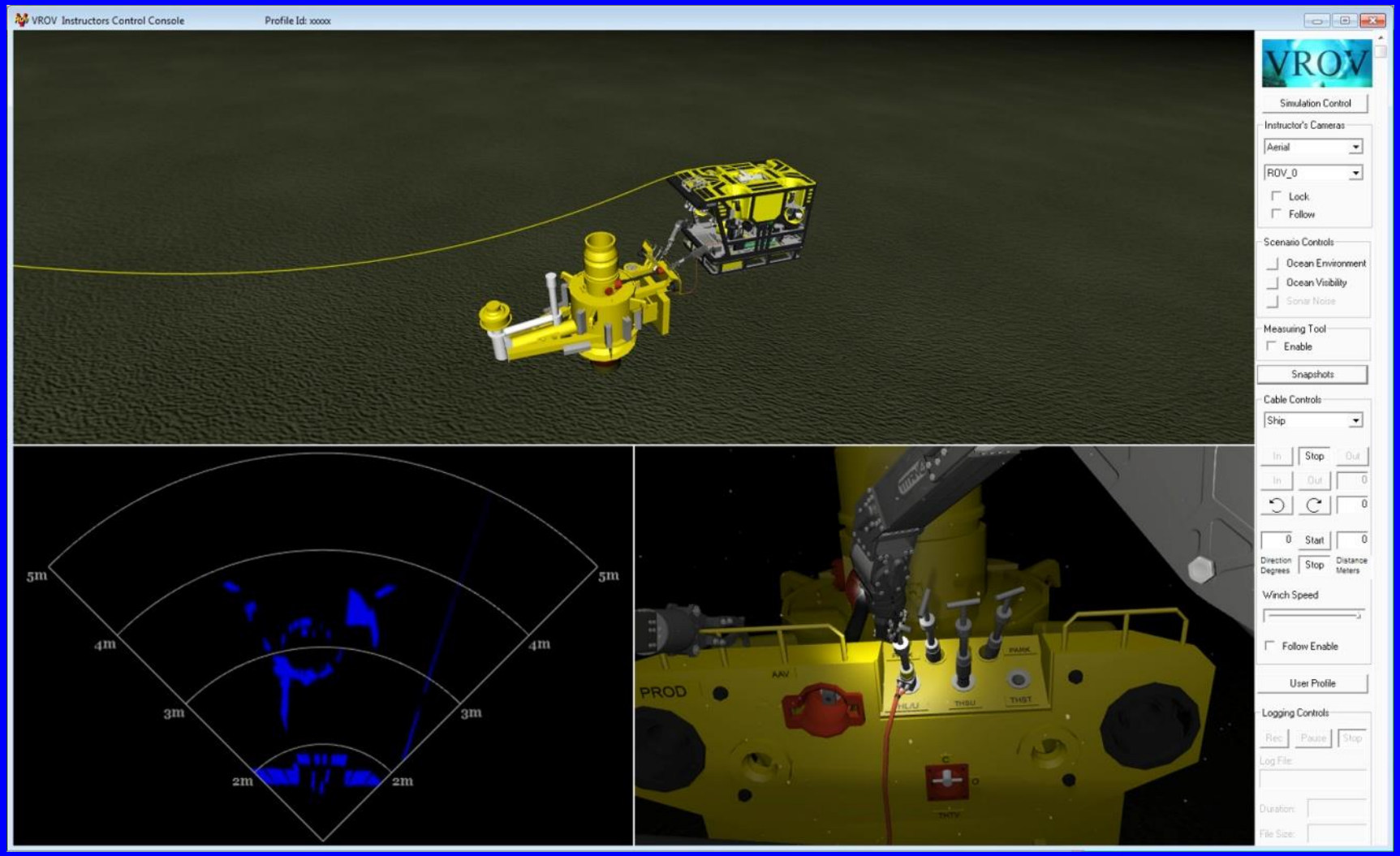


LET'S DO A 2ND EDITION!

- **SO…BOB CHRIST PROPOSED THAT WE UPDATE THE 1ST EDITION AND ADD A "COUPLE" CHAPTERS:**
  - **1ST ED – 14 CHAPTERS, 308 PAGES**
- **TWO YEARS LATER….**
  - **2ND ED – 23 CHAPTERS**
  - **679 PAGES**
- **NOW…SOME HIGHLIGHTS**

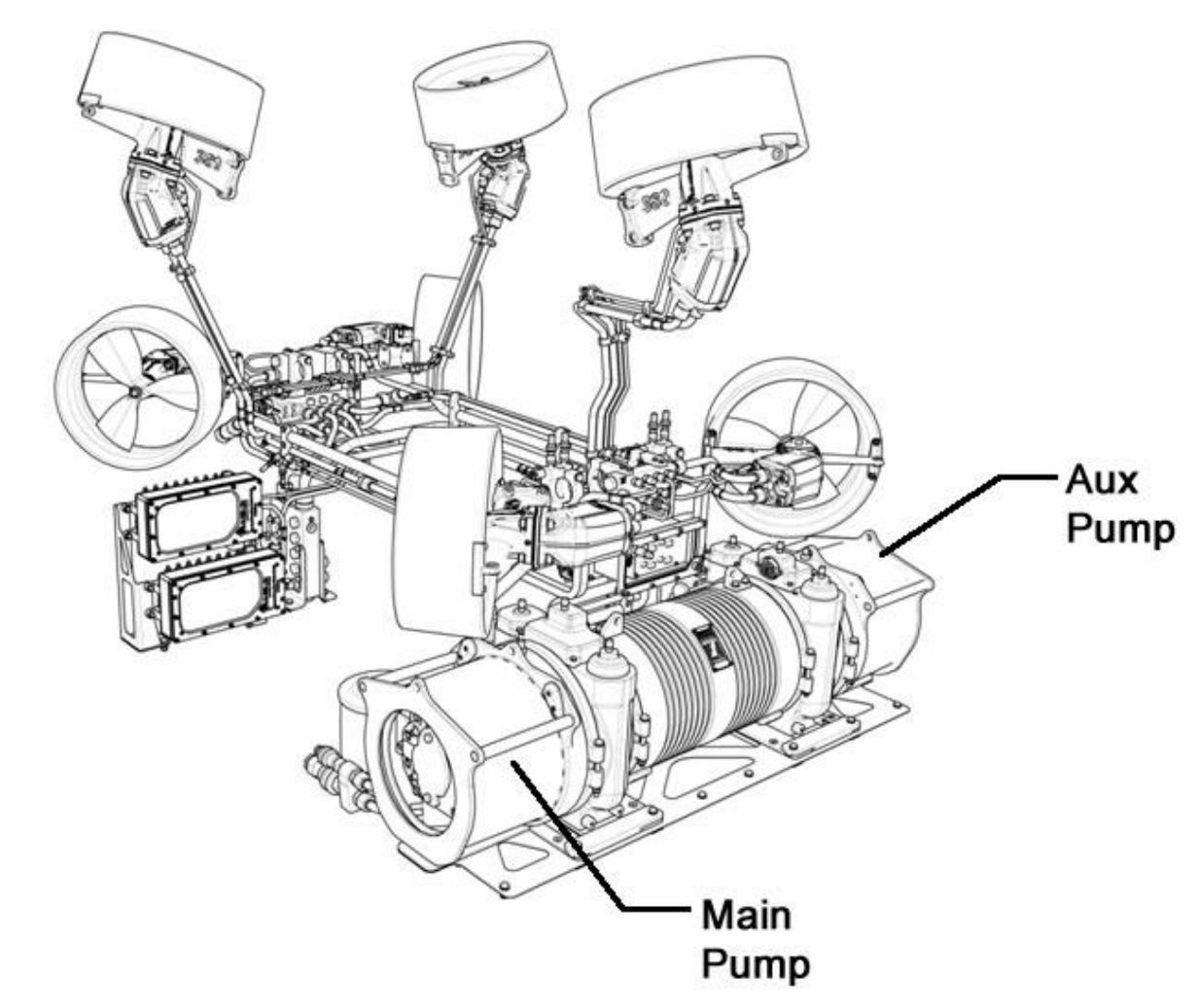
SIMULATORS ARE GREAT

(Courtesy GRI Simulations)



TAKING A PAGE FROM TOYOTA

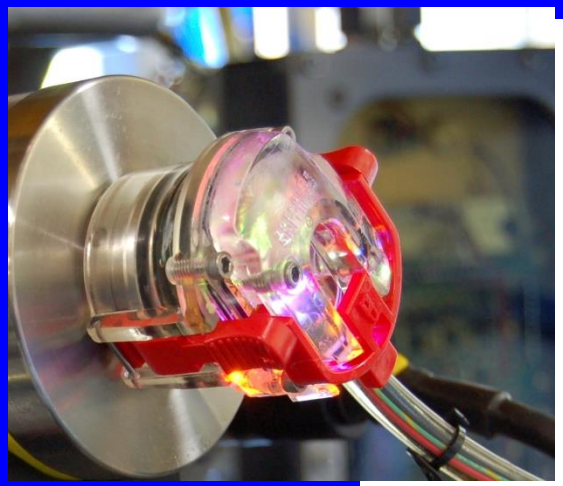
(Courtesy Schilling Robotics)



CABLES AND CONNECTORS

THANKS KEVIN, BROCK, CAL AND BRAD!!!

(Courtesy MacArtney)



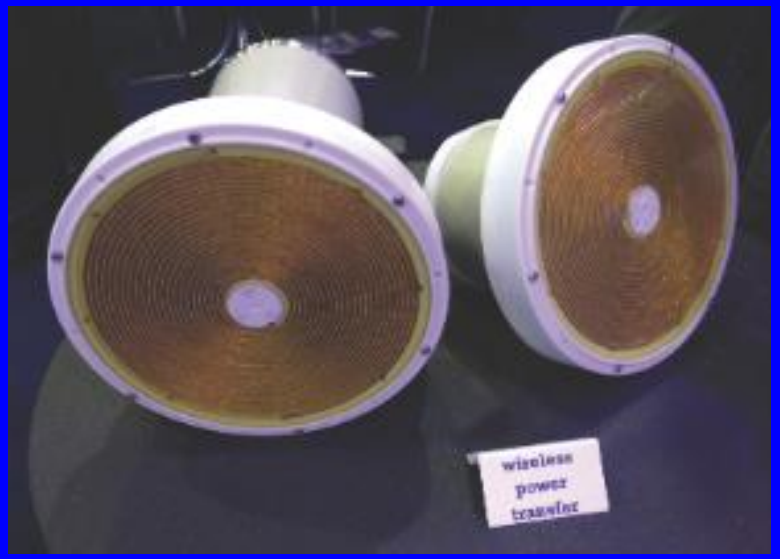
SeaNet Connector (Courtesy Schilling Robotics)

DO'S AND DON'TS

Courtesy Ocean Innovations

Courtesy the Internet!!

CONNECTORLESS POWER TRANSFER



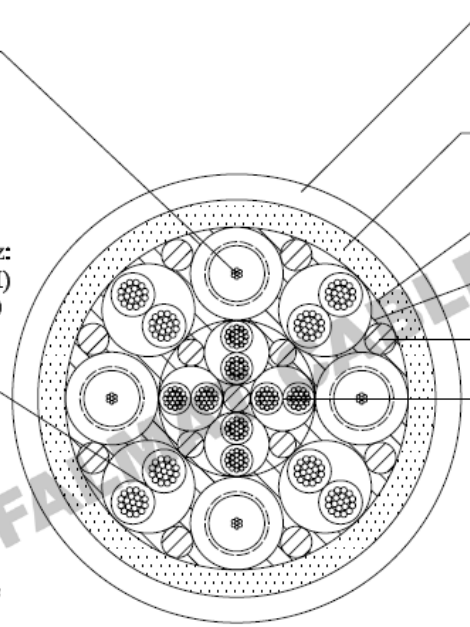
FAU “Flying Plug” Inductive Recharge System
(Courtesy FAU-OE)

WFS Technologies
Inductive Power Link
(Courtesy Ocean Innovations)

CABLES ARE COVERED

THANKS FALMAT!

Example Synthetic strength-member



75+/-3 Ohm Coax, 4:
#22 AWG (7 x 0.010 in)
(0.355 sq-mm area)
Tin-plated copper with
Polyethylene dielectric
T/C Braid, 95% coverage
Polyethylene Jacket
Max Attenuation at 25 MHz:
20 dB/1,000 FT (66 dB/KM)
c/c: BRN, ORN, GRN, VIO

Twisted Pair, 4:
#13 AWG (19 x 0.016 in)
(2.43 sq-mm area)
Tin-plated copper with
Cross-Linked Polyethylene
Rated for 600 volts, 7 amps
Two conductors twisted
into pairs and each pressure
extruded with polyethylene
c/c: WHT+RED, WHT+YEL,
WHT+BLU, WHT+GRY

Outer Jacket:
Black polyurethane coated
with a talc-powder dusting

Kevlar(TM)Strength Member
Dual served layer, torque-
balanced, 15-20 degree angle

PVC/Mylar(TM) binder tapes

Water block compound

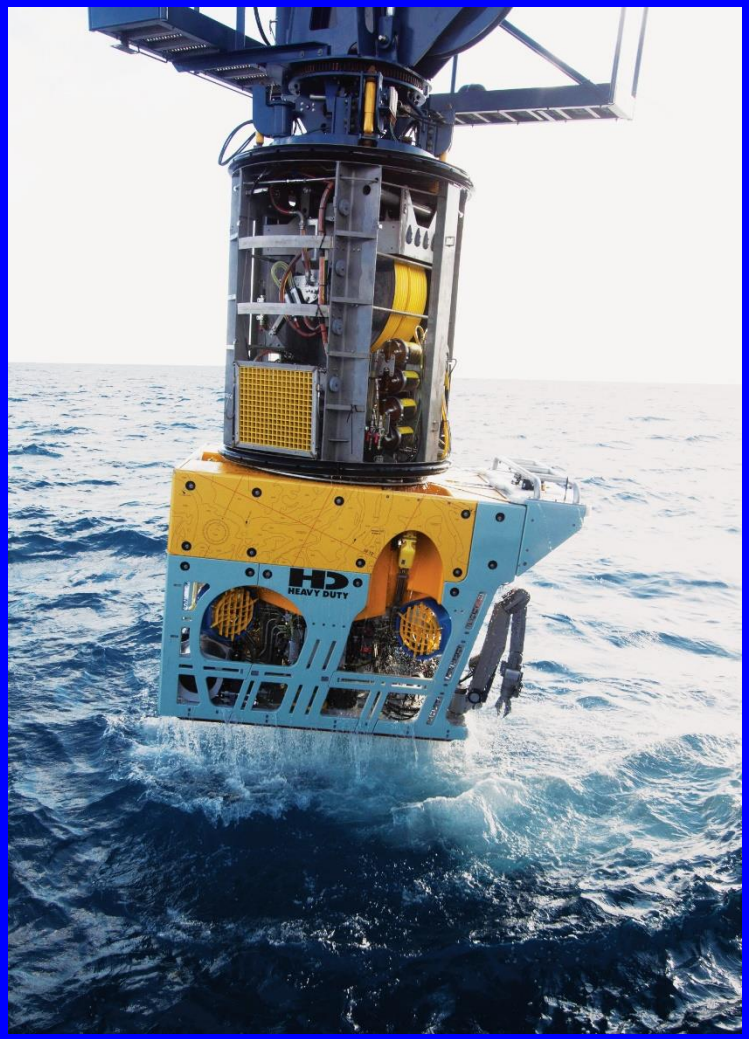
Plastic rod fillers

Twisted Pair, 4:
#15 AWG (19 x 0.0126 in)
(1.53 sq-mm area)
Tin-plated copper with
Cross-Linked Polyethylene
Rated for 600 volts, 5 amps
Two conductors twisted
into pairs and each pressure
extruded with polyethylene
c/c: WHT+BRN, WHT+RED
WHT+ORN, WHT+YEL

Overall Diameter = 1.170 +/- 0.06 in (29.7 +/- 1.5 mm)
Weight in Air = 756 lbs/1,000 feet (1125 KG/KM) nominal
Weight in Sea = 278 lbs/1,000 feet (414 KG/KM) nominal
Specific gravity = 1.62 +/- 0.1 gm/cc density
Breaking Strength = 31,000 lbs (14 Tonne) minimum
Peak Tension Load = 4,400 lbs (2 Tonne) maximum
Bend Diameter = 40 inch (1 M) minimum
Depth rating = 1,500 FT (450 M) = 650 PSI (4.5 Mpa)
Operating Temperature = 32 to 104 F (0 to 40 C)
Storage Temperature = -40 to +158 F (-40 to +70C)

L&R AND TMS – FROM A…

Courtesy Schilling, Caley Ocean Systems, VideoRay and SeaBotix

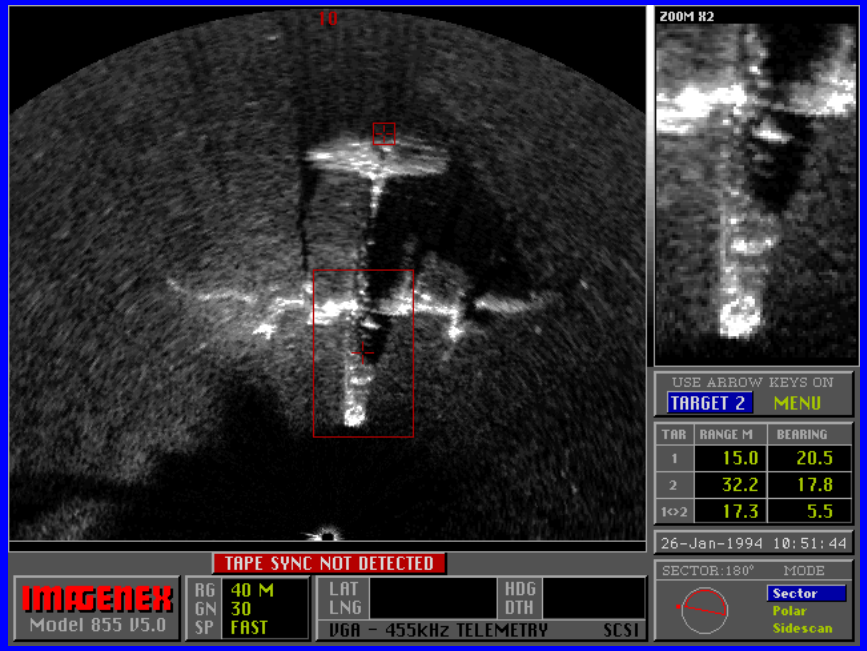


…TO Z

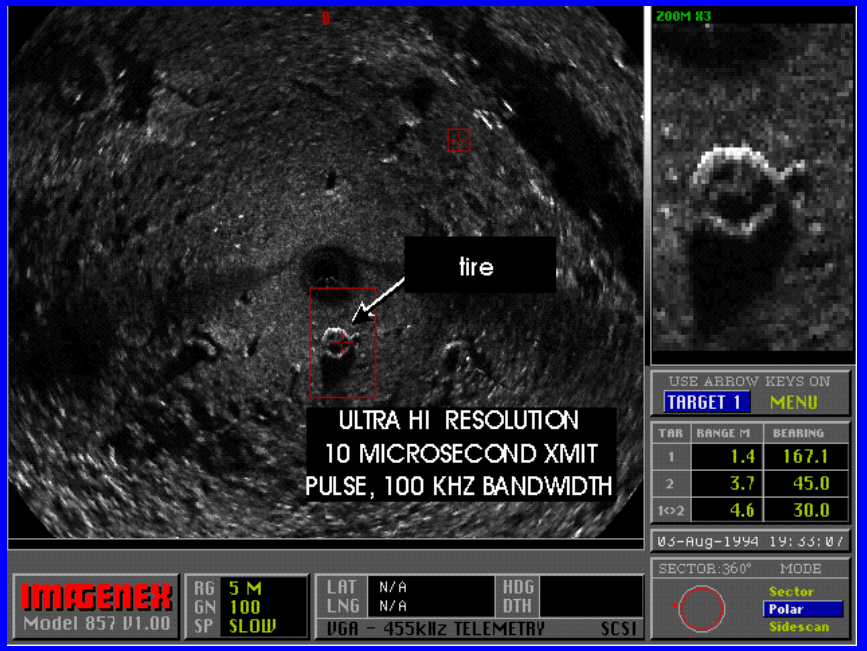
Courtesy Dynacon

Courtesy Cargotec

SONARS AND INTERPRETATION



Convair PB4Y-2 Privateer
in Lake Washington, WA

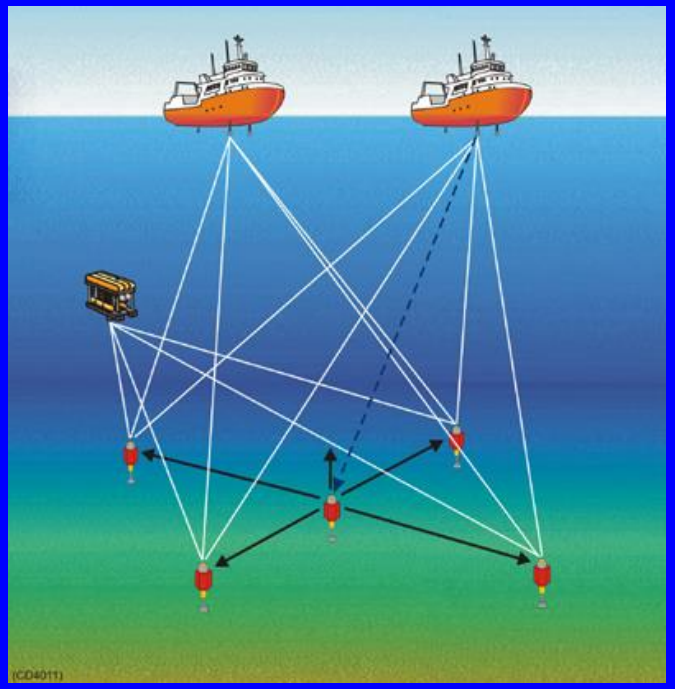


Ultra-High Resolution
Sonar Image

(Courtesy Imagenex Tech. Corp.)

WE KNOW WHERE WE ARE

The CDL MiniSense 3, a 2 degree magnetic Aided Altitude and Heading Reference System – Courtesy CDL



5 Transducer LBL Array – Courtesy Kongsberg Maritime

MANIPULATORS

The Early Days
(Courtesy Hydro-Products)

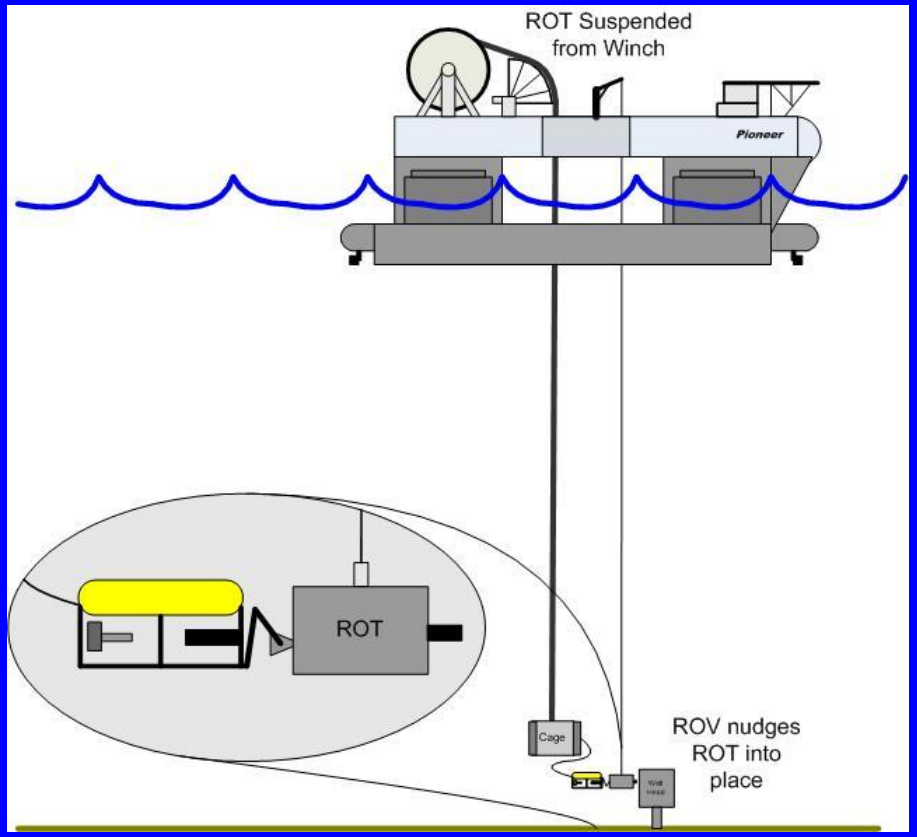
Today's Leaders of the Pack
(Courtesy Schilling Robotics)

MANIPULATORS – ALL SIZES

SeaBotix Vehicle with Grabber and Various End Effectors

SOME TOOLS GO BEYOND MANIPULATORS

Tool Deployment Unit
(Courtesy Forum Energy Tech.)

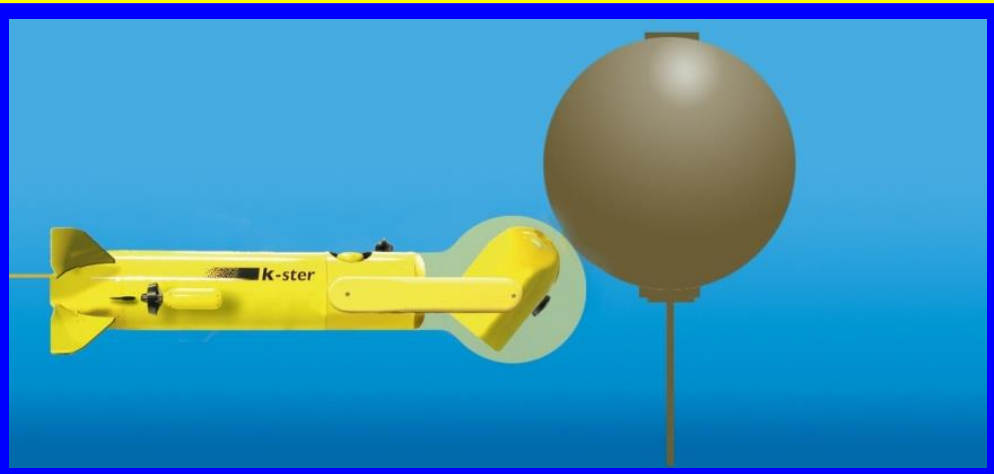


Dual Downline Remotely Operated Tool Being Positioned

STANDARD INTERFACES NOW EXIST FOR VARIOUS TOOLS

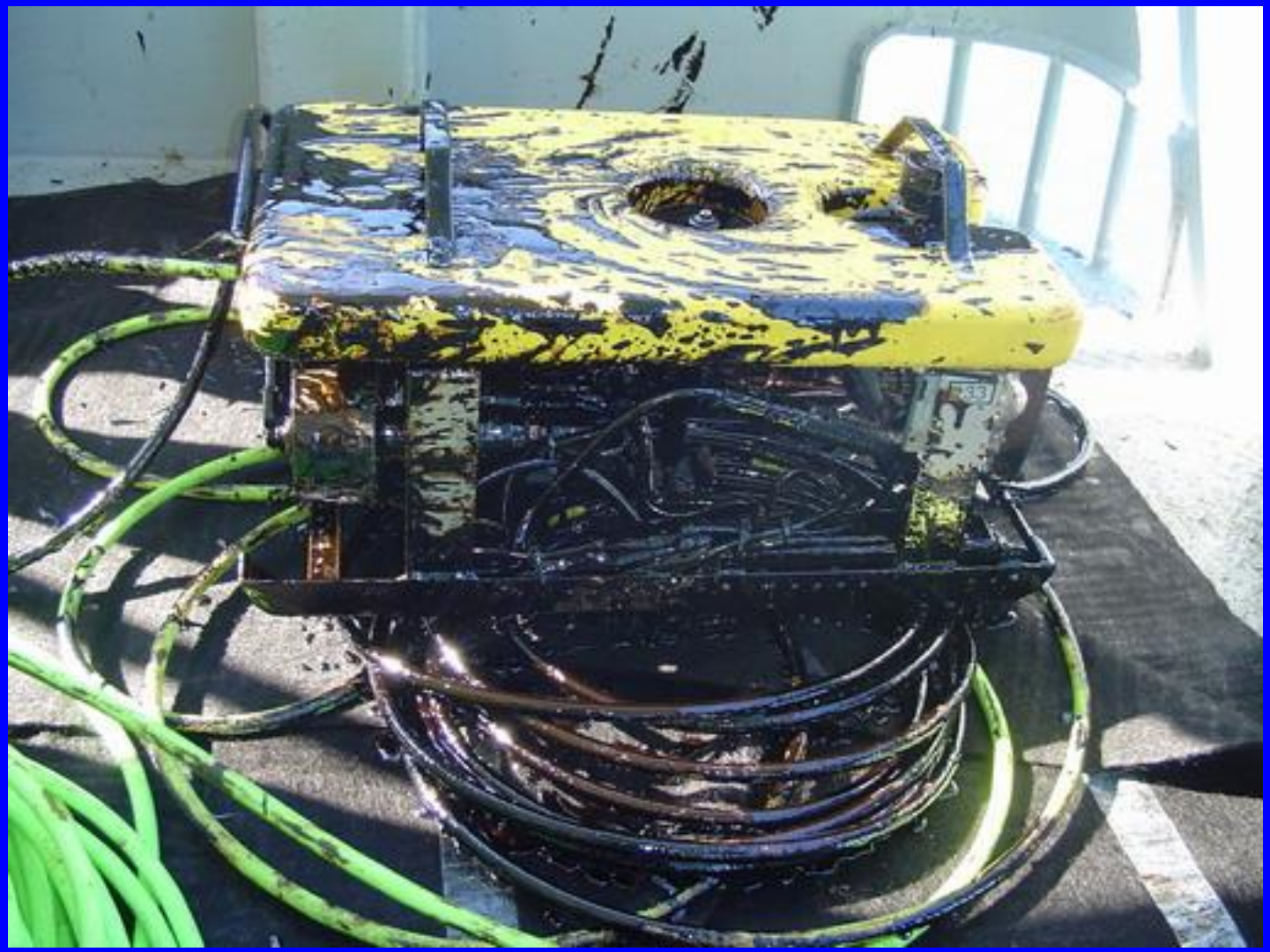
(Courtesy Schilling Robotics)

APPLICATIONS ARE UNLIMITED



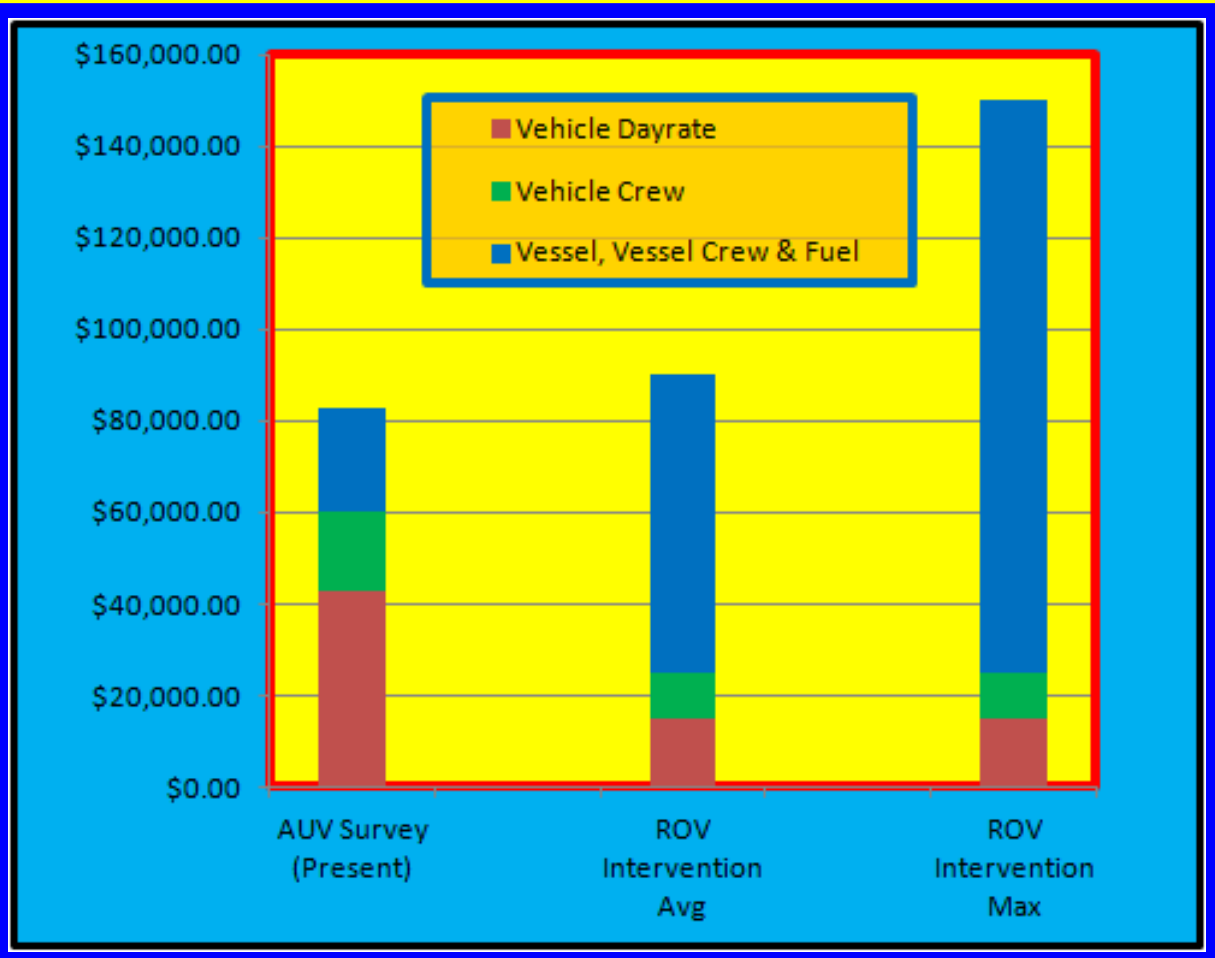
(Courtesy Sub-Atlantic, ECA SA., JW Fishers, SeaBotix)

THE DIVERS AREN'T COMPLAINING



IT'S NOT ALWAYS FUN AND GAMES…$$$$

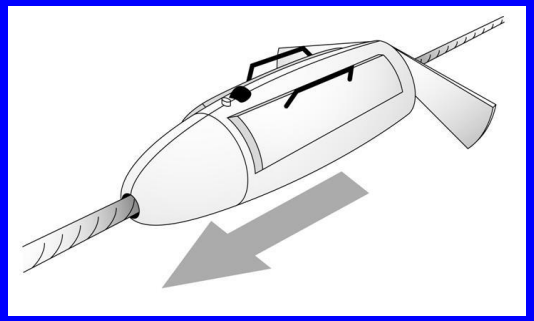
INTERVENTION IS COSTLY!



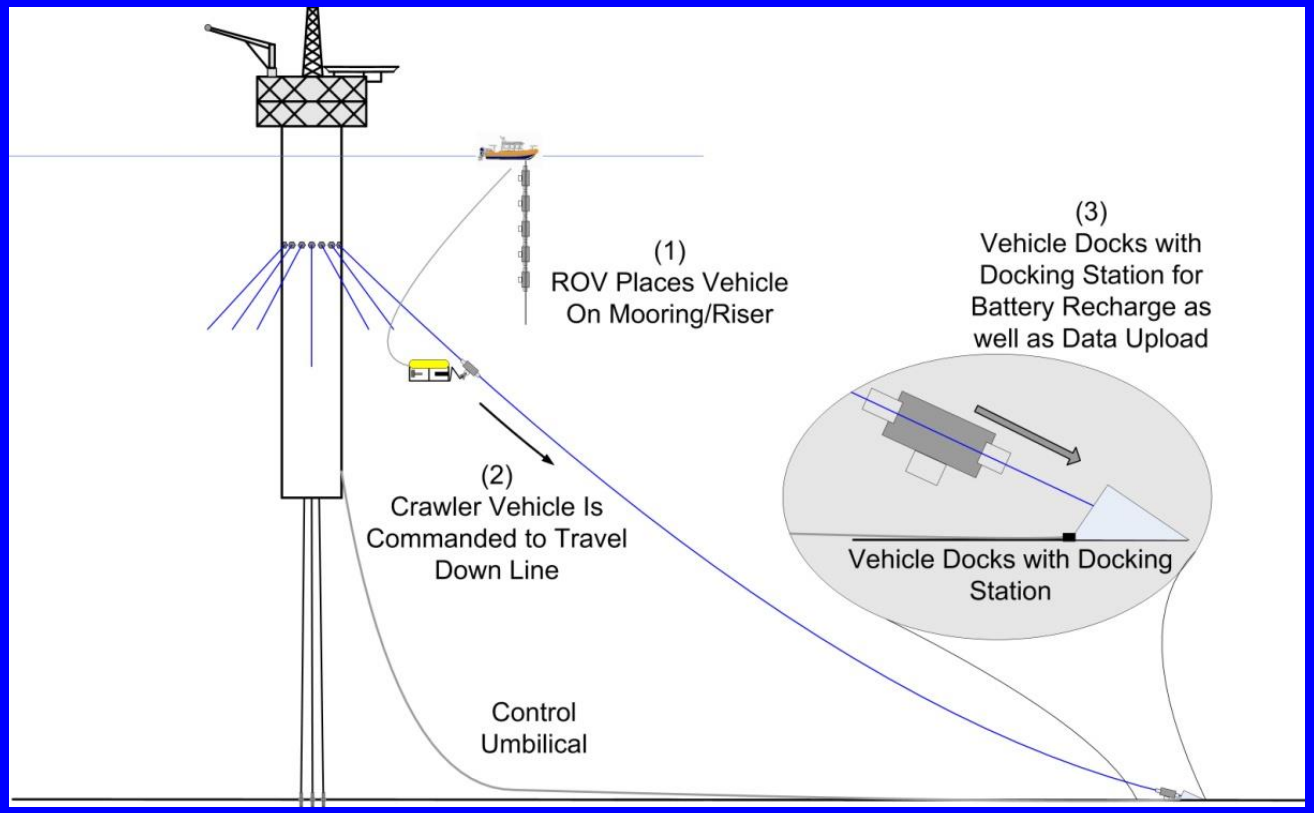
Offshore crew and vessel daily costs.
(Courtesy 3U Technologies)

WHAT'S THE FUTURE HOLD?

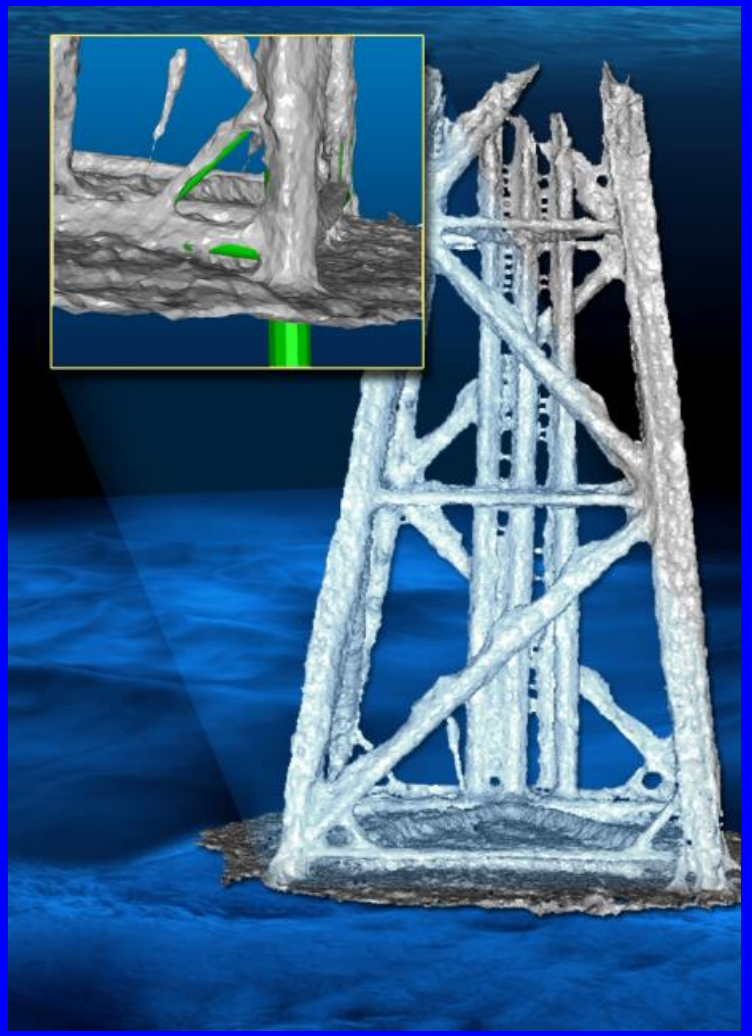
RISER CRAWLERS



(Courtesy SeaTrepid)



AUTONOMOUS 3-D SURVEYS



Coda Octopus Echoscope™ 3-D Imaging Sonar on Marlin AUV (Courtesy Lockheed Martin)

RF COMMUNICATIONS

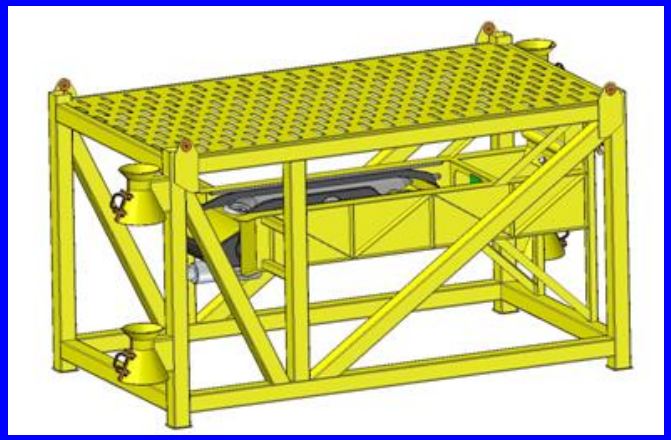
The Autonomous Inspection Vehicle (AIV) (Courtesy Subsea 7)

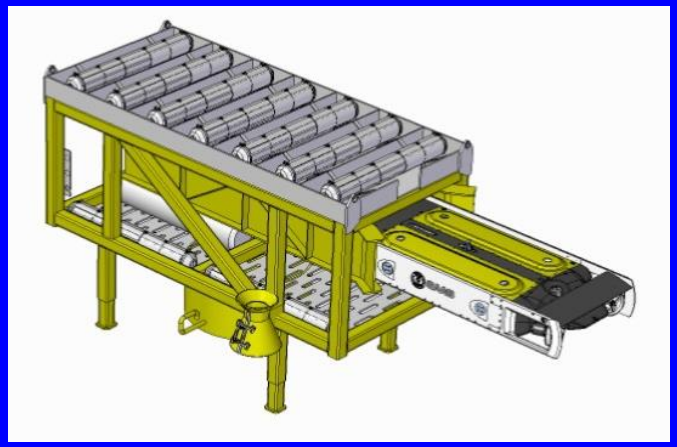
WiFi node communication link (Courtesy WFS Technologies)

AUV/ROV INTERVENTION

SWIMMER launches ROV from underwater docking station (Courtesy Cybernetix)

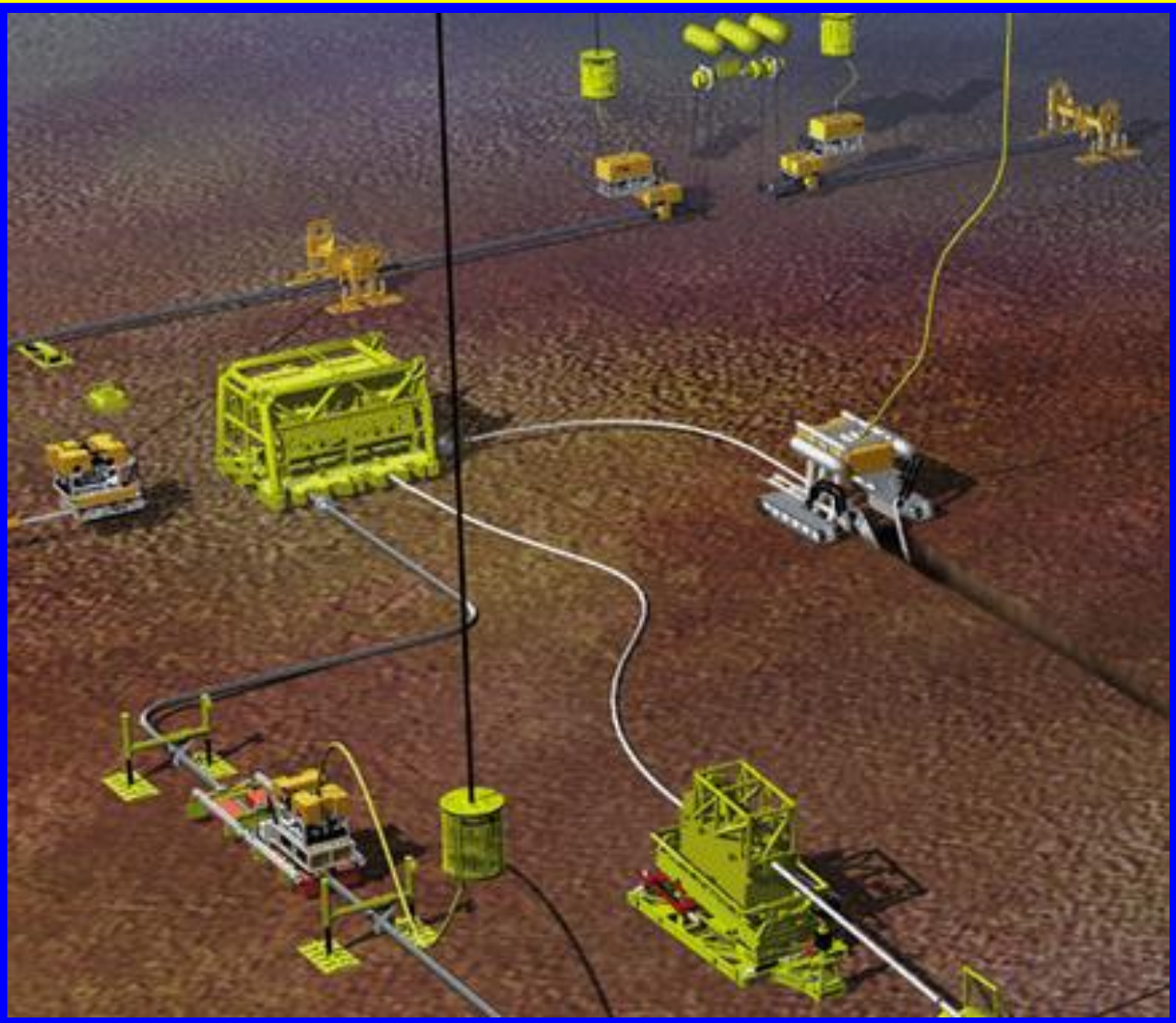
LONG-TERM AUTONOMOUS INTERVENTION





Sabertooth AUV and docking station (Courtesy Saab Seaeye)

THE “INTER-SEA-NET”



VEHICLE FORECASTS

World ROV Operations Market Forecast 2013-2017

ROV Work-Class Operations Expenditure to Grow by 80%

Douglas-Westwood (DW) forecast the market for the operation of work-class ROVs through to 2017 in this sixth edition of the *World ROV Operations Market Forecast*. Results forecast total ROV operations expenditure of $9.7 billion, an increase of nearly 80% over the previous five-year period.

Global AUV Fleet to increase 42% by 2018

Douglas-Westwood (DW) forecast that the global AUV (autonomous underwater vehicle) fleet will increase 42% in the 2014-2018 period, compared to the previous five years. The fleet is forecast to total 825 units in 2018, led by strong demand in the military sector.

ALSO IN E-BOOK (W/COLOR!)