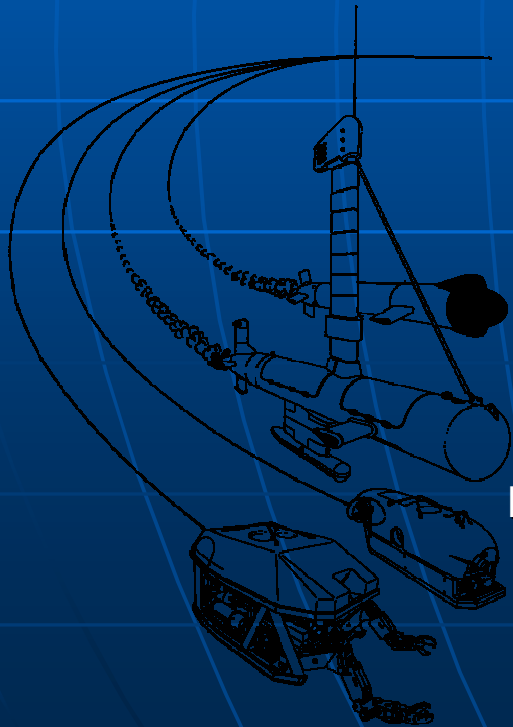


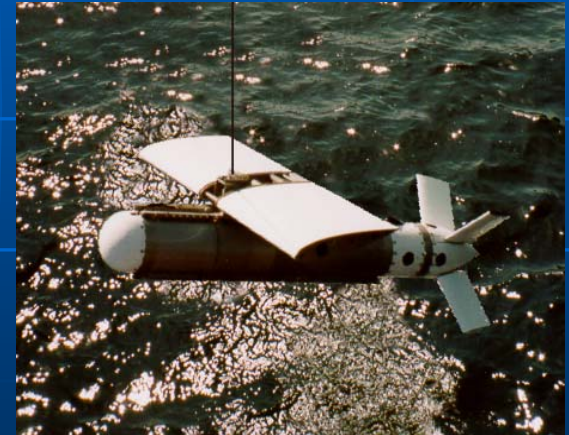
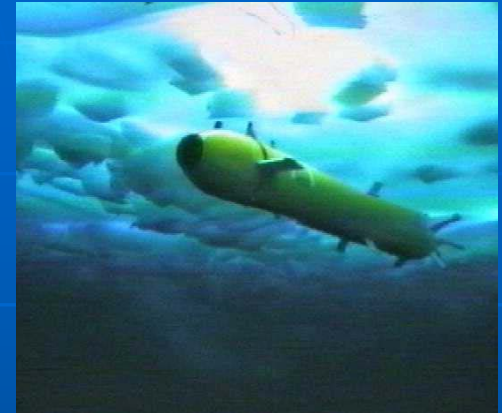
# ISE's Common Control System



International Submarine Engineering (ISE) Ltd.

Copyright 2008

# A Diversity of Mobile Platforms

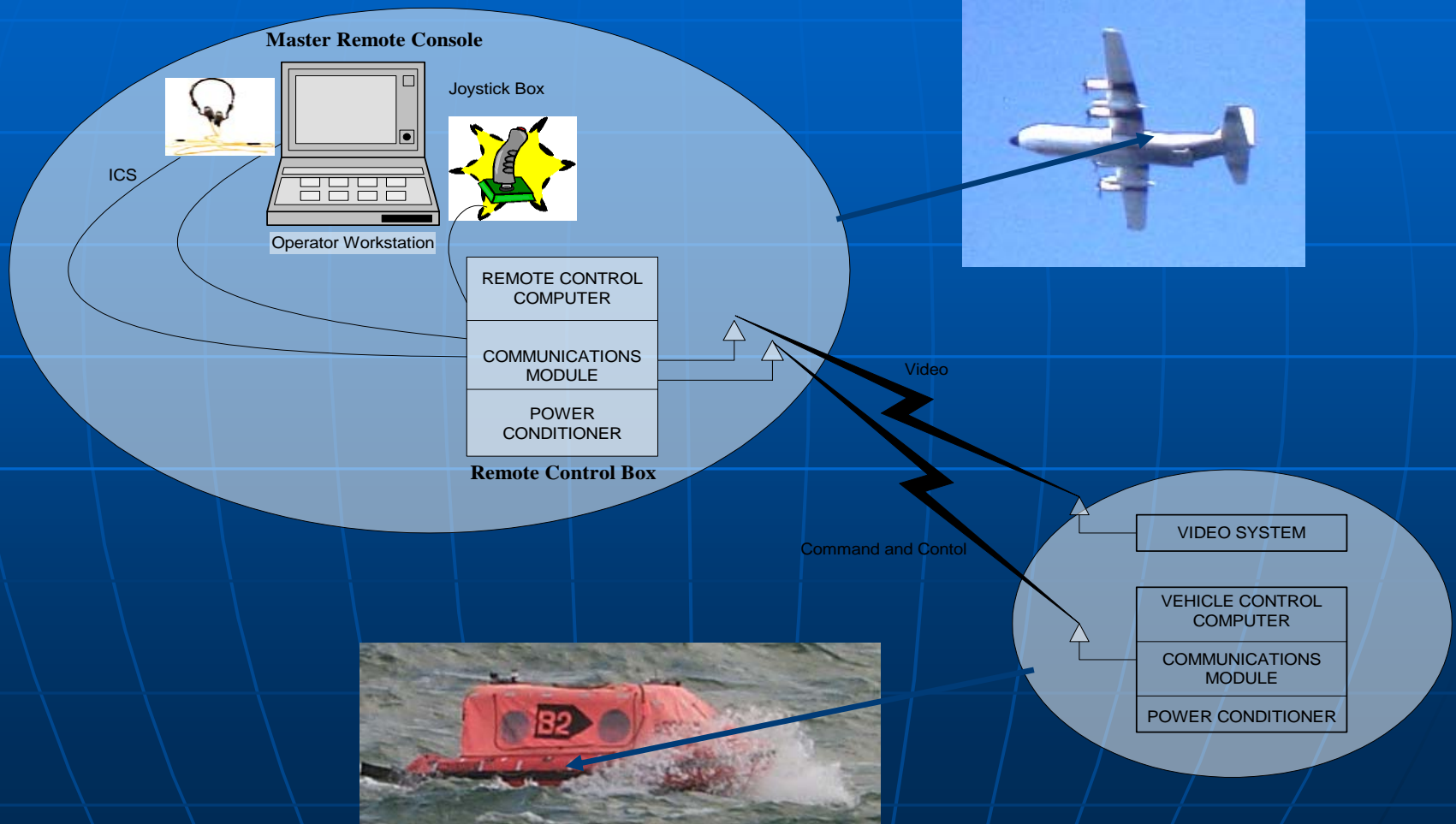


- Strategy- Re-use existing, proven technologies
- Integrate them into modular mobile platforms
  - Configured to fit specified mission requirements.

All with commonality in the control system.



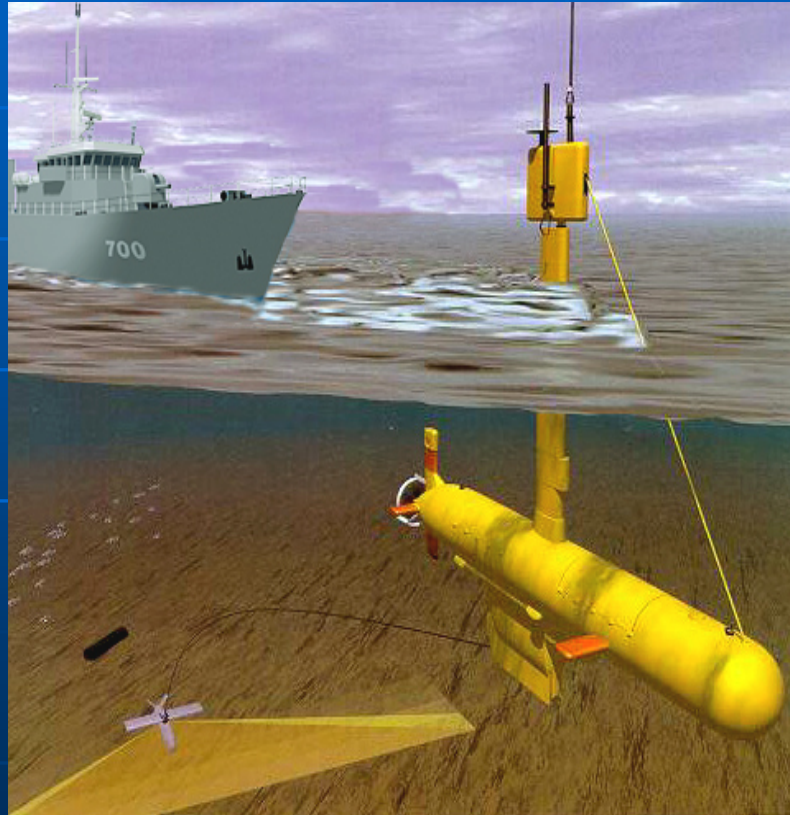
# USV Command & Control



# Control System Design Considerations

## Electrical / Mechanical Interfaces

- Sensors
- Actuators
- Power Distribution
- Communications



# Control System Design Considerations

## Operator Interfaces

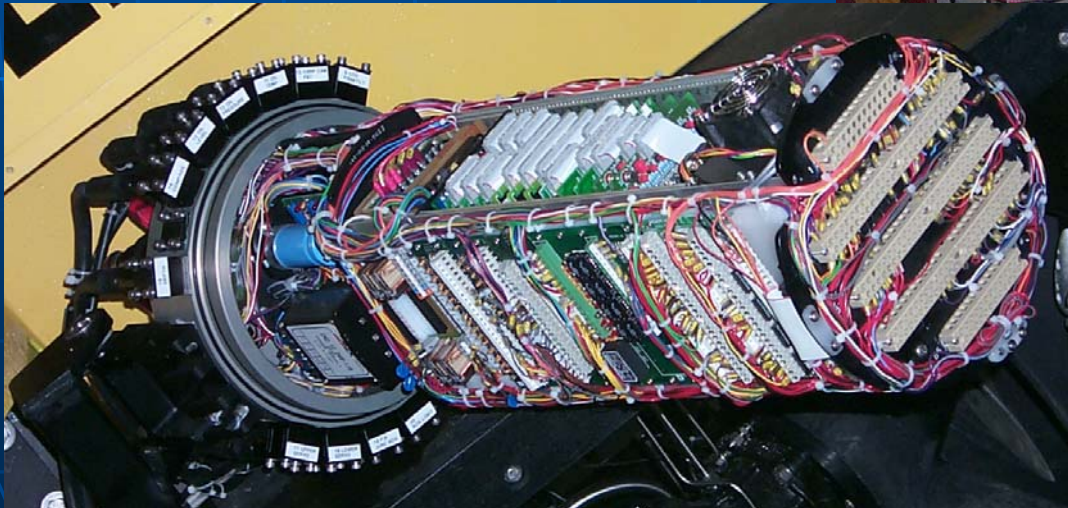
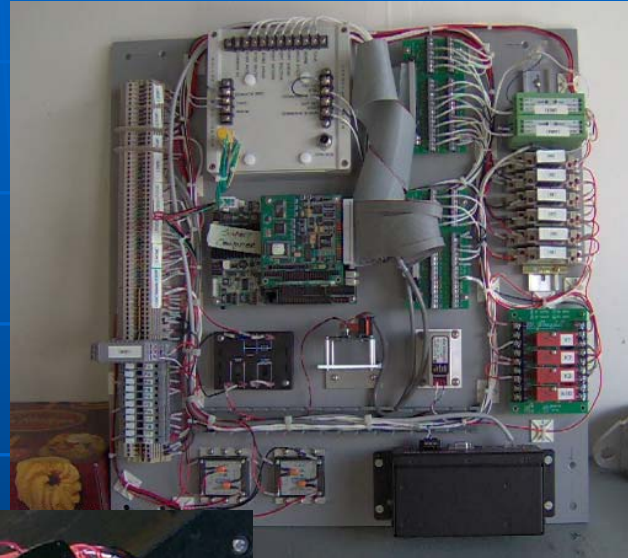
- Joysticks
- Buttons/Lights
- Displays
- Video Systems
- Audio



# Control System Design Considerations

## Computers

- Form factor (eg. cPCI)
- Processor
- Input and Output Distribution
- Electrical Terminations & Signal Conditioning



# Control System Design Considerations

## Operator Interfaces

- Joysticks
- Buttons/Lights
- Video Systems
- Audio

## Computers

- Form factor (eg. cPCI)
- Processor
- Input and Output Distribution
- Electrical Terminations & Signal Conditioning

## Electrical / Mechanical Interfaces

- Sensors
- Actuators

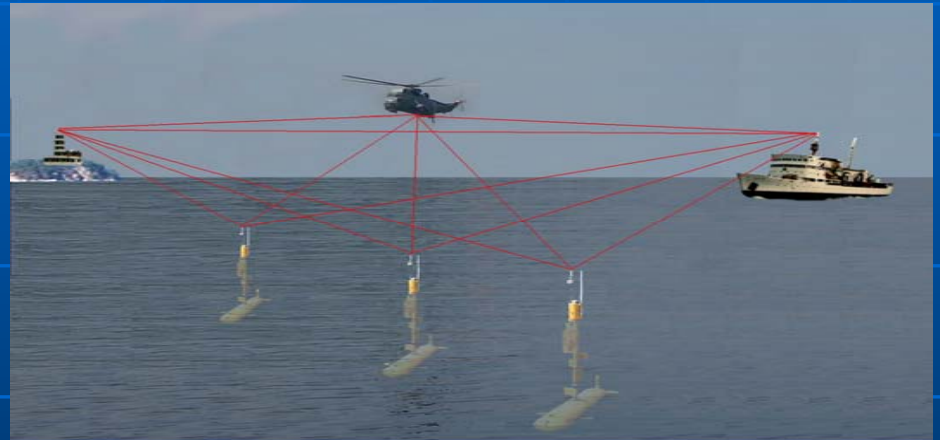
## Software

- Operating System
- Graphical User Interfaces
- Control Software



# Common Software Components

- Sensor Interfaces & I/O
- Positioning & Navigation
- Autofunctions – Autoheading, Cruise, Stationkeeping
- Waypoint & Route Following
- Mission Planner & Scripts
- Communications & Telemetry
- Multi-vehicle Operations
- Transfer of Control
- Operator Interface



# AUV Payload Integrations

- Loran C Navigation
- Elac Single Beam Echo Sounder (2)
- Syledis Positioning system
- NRL Custom Payload
- Ametek Straza DVL
- Robertson SKR 80 series Gyrocompass (2)
- Mesotech 1007 Obstacle Avoidance Sonar
- Oceano Long Baseline System
- Collins AN/ARC 182 Data Radio
- Klein 595 Side Scan Sonar
- Metratek Forward Looking Sonar
- Nautronix SBL Positioning System
- UV High Bandwidth Acoustic Comms
- Polarfix Laser Positioning System
- Simrad EM950 and 1000 Multibeam Echosounder (2)
- DRDC Motion Recording Pack (2)
- Simrad 992 Sidescan Sonar
- DataRadio 450KHz modem
- Novatech RF Beacon
- Novatech Emergency Strobe
- ORE Trackpoint II USBL
- ORE LXT USBL
- Honeywell 726 MAPS INU
- EDO Western 3050 DVL
- FCT 60 and 100 KWh fuel cell (2)
- Fibre-optic cable integrations (3)
- ORE Homing System
- Datasonics Communications and Pos'n Systems (2)
- Watson AHRS – various models
- Seabird SBE Conductivity, Temperature Depth (3)
- Imagenex Multibeam (Delta T)
- AN/AQS 14 Sidescan Sonar
- DRDC experimental Klein Sidescan Sonar
- Reson 8101 Multibeam Echosounder
- C-Span High Bandwidth Data Radio
- Klein 5500 Multibeam Sidescan Sonar
- Rockwell Collins Quartz Rate C-Migits INU
- RDI DVL and ADCP (3)
- AMS Mass Spectrometer
- AMS Conductivity, Temperature Depth
- GPS – various including Thales, Motorola, SOS
- IxSea PHINS INU (2)
- Kongsberg Mesotech 1007 Altimeter (3)
- Kearfott 6053 SEADeVil INU
- Sercel Orca MATS 200 Acoustic Telemetry
- Datalinc RF modem 900 and 2400 MHz (3)
- Video Cameras (2)
- Wilan RF data Modems – 3.5 and 5.8 GHz (2)
- Kongsberg Simrad EM 2000 Multibeam Echosounder
- LinkQuest UWM series Acoustic Telemetry (2)
- Kongsberg Simrad EK60 Fish Stock sonar
- NAL Iridium modem
- Reson 7125 Multibeam Echosounder
- IxSea Posodonia LBL\USBL
- Fluorometer
- DSTL custom payload
- Motorola RF data modem
- IxSea Synthetic Aperture Sonar

# Software Development Costs \$\$\$

So

1. New software development must be minimized
2. Existing software must be leveraged

How?

1. Systems approach
2. Open Architecture
3. Code reuse by modular design

# System Design Approach

- ISE takes a “Systems” approach for integrated development of Hardware and Software.
- Project teams are formed including “Software Engineer” in overall design.
- Thus, software impact can be minimized in overall design (or traded-off)

# Reduce-Reuse-Recycle

- New development **reduced** by systems design approach
- Software **reused** by leveraging previously proven, documented, tested, components and utilities
- New project development is implemented separately  
... and then **recycled** back when proven.

# Control System Development Strategy

Common Control System - ISE has developed a control system with a modular open architecture that is common to ISE products. The control system for any project is implemented by selecting re-usable components from a library and configuring them to fit the mission requirements.

Graphical User Interface – Configured from modular graphical widgets and standardized hardware. This simplifies production, troubleshooting, and training.

*ISE's proven capability is attributed to our robust, flexible, adaptable control software.*

# Open Architecture Software

## ACE Professional Software Development Kit

- 15 years development and field validation.
- Mature reusable software reduces project risks in technical, budgetary and scheduling aspects.
- Code, documentation and processes are well established.

## ISE's Modular Open Architecture Software

- facilitates complex integrations
- common interfaces and protocols for interoperability
- rapid GUI prototyping and modifications
- adjust vehicle behavior

# What is ACE ?

It is ISE's in house "Automated Control Engine", consisting of:

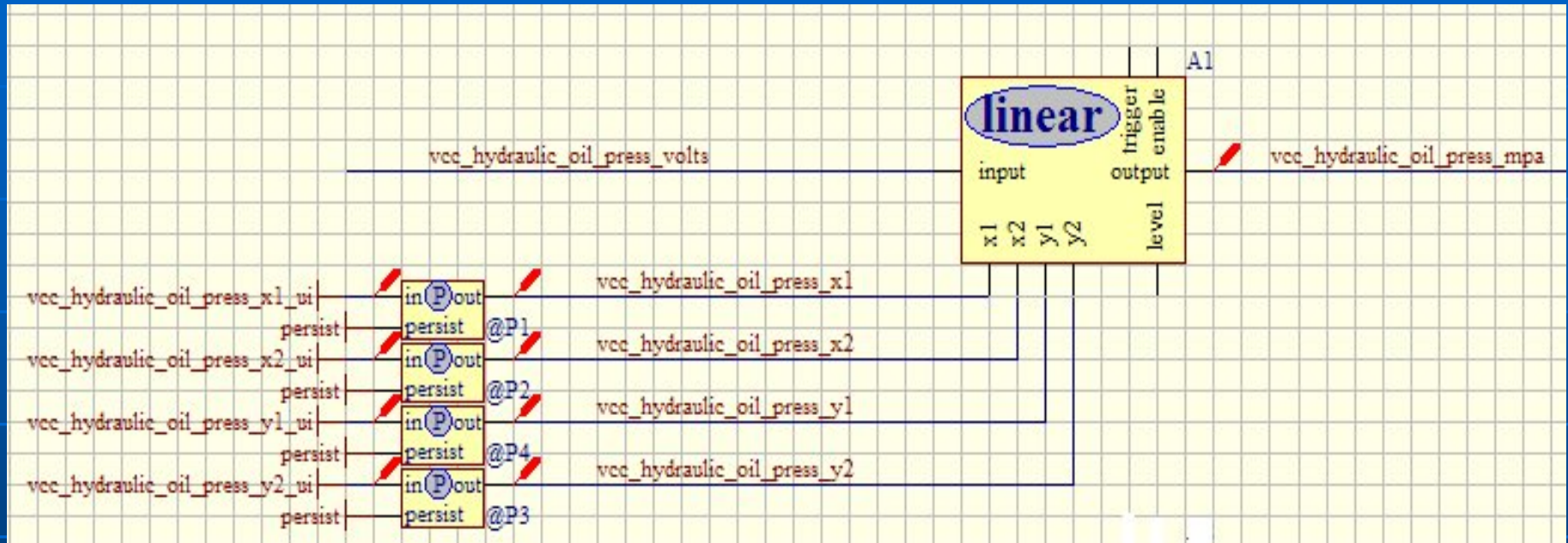
- Libraries of Components, encapsulated in C++ class which export functionality via common API
- Components which execute when triggered by an action, and produce event data output
- Components are linked at runtime, by "events", in a configuration that is produced graphically.



# Graphical Control System

- ACE is configured in “Electrical Schematic” format
- Component icons are placed, and connected to graphically represent control data flow
- Graphical layout aids design and understanding – leading to fewer errors
- Runtime configuration also applies to GUI’s

# ACE Configuration

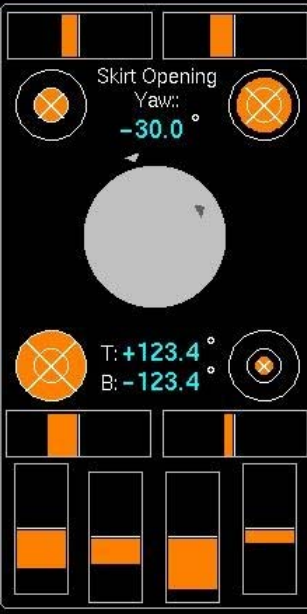
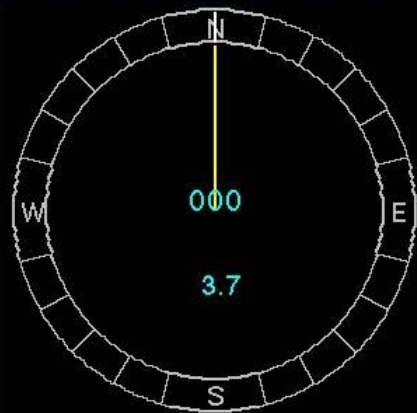
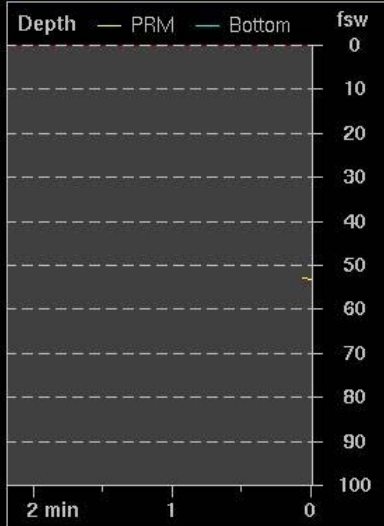


Example, "Linear Conversion"

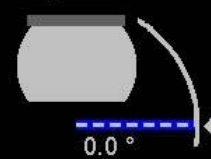
Input is in units Volts

Output is in units mpa

Scaling parameters can be changed online

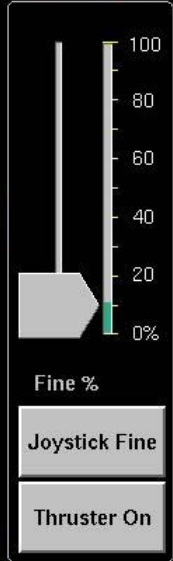


Skirt Opening Angle to Horizontal:



- Pan & Tilt Select
- Forward Camera
  - Landing Assist
  - Skirt Interior
  - Aft
  - Forward Sonar
  - Aft Sonar
  - Yaw Thrusters:
    - Lateral
    - Longitudinal

Wed May 11 10:11:54 2005



VCC 1 Watchdog VCC 2 Watchdog

Dive No: 100  
Water Temp: 36.8 °F

Status Indicators:

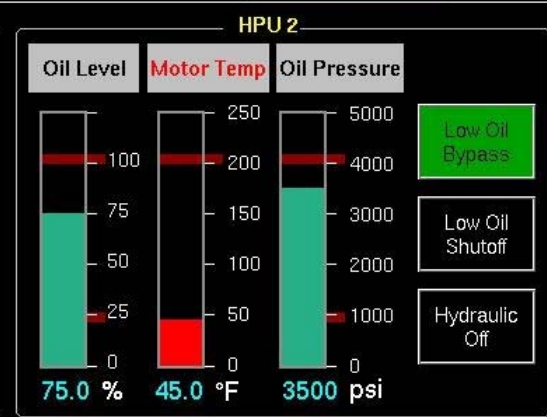
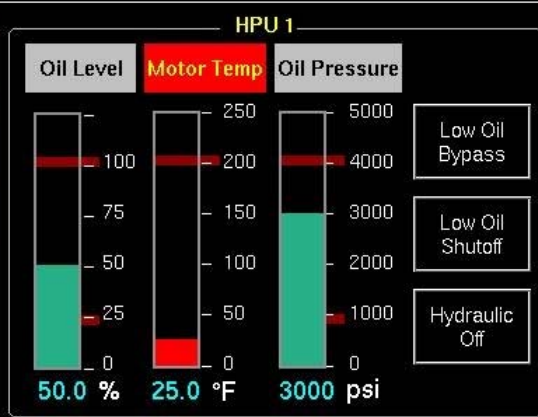
- Auto Heading OFF
- Auto Depth OFF
- Auto Altitude OFF
- Station Keeping OFF
- PDS In Control
- Cruise OFF
- Alternate Reference Frame

Depth in fsw 1st: 53.3 2nd: 1.1 Sp:  
Altitude in fsw 1st: 200.2 2nd: 5.9 Sp:

- Telem Water Alarms
- Telem Alarms
- PVHO GF Alarms
- GF & Water Alarms
- Low Oil Alarms
- Other Alarms

- Altimeter Fault
- Water: Fwd Stbd Servo Pack
- Water: Fwd Port Servo Pack
- Water: Aft Stbd Servo Pack
- Water: Telemetry Can #1
- GF: VCC2 Incandescent Lights
- GF: VCC1 PVHO PS 2
- GF: VCC1 PVHO PS 1

ACKNOWLEDGE ALL



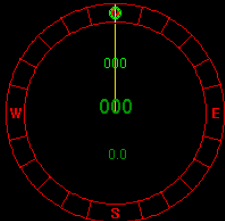
Power Monitoring

HPU 1 Current:	22.0	A
HPU 2 Current:	24.0	A
Hotel 1 Current:	15.0	A
Hotel 2 Current:	16.0	A
Hotel 1 Voltage:	48.0	V
Hotel 2 Voltage:	48.0	V
Hotel 1 Power:	221.0	kVA
Hotel 2 Power:	250.0	kVA

Dive Number: 100

Pilot Mode: SCC 1

- Status
- Instruments
- Velocities & Overlay
- Lights & Power
- Cameras
- DISSUB Docking
- Logging
- Diagnostics
- Settings
- Life Support

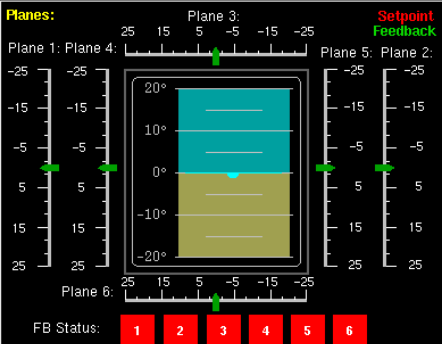


**Alarms:**

- Low Energy
- Planes Fault
- GF: Main Bus
- GF: Navigation Devices
- GF: Man. Devices
- GF: VCC & I/O
- GF: Auxiliary Devices
- GF: Comm. Devices
- GF: Payload #1
- GF: Payload #2
- Water: Main Hull
- Water: Thruster Motor
- Water: Plane 3 or 4
- Water: Forward Planes
- Water: Mast
- Water: Payload #1
- Water: Payload #2
- Water: Plane 5 or 6
- Telemetry Timeout

Acknowledge All

**Planes:**



FB Status: 1 2 3 4 5 6

Pitch: 0.0 Roll: 0.0 Depth: 0.0

Wed Jan 28 17:26:11 2004

VCC <-> SCC

Planes OFF

Thruster OFF

Mast OFF

Radio OFF

F/O OFF

Acoustic ON

Payload 1 OFF

Mast Not Ext

TRIAD ON

DGPS OFF

PHINS ON

DVL OFF

Altimeter OFF

Payload 2 OFF

Mast Not Retr

Exit

Stop

Tech

Pilot

Mission

Lat: 0.00000000 Long: 0.00000000

No Fault Response

**Setpoint: Feedback:**

Pitch:	0.0	0.0	0.0
Roll:	0.0	0.0	0.0
Altitude:	0.0	0.0	0.0
Depth:	0.0	0.0	0.0
Heading:	0.0	0.0	0.0

**Mast Control**

Extend

Stop

Retract

**Speed Setpoint**

5 m/s

SP: 0.0

FB: 0.0

Zero Speed

**RPM Setpoint**

500 rpm

SP: 0.0

FB: 0.0

Zero RPM

Reverse RPM

**Attitude Source**

PHINS/Watson

DVL

TRIAD

**Rudder Setpoint**

-25 -12.5 0 12.5 25

Center Rudder

SP: 0.0

FB: 0.0

Depth Mode: Pitch Heave

**Emergency Control**

Drop Weight	Release	Attach
Popup Buoy	Release	Attach
Parking Sphere	Open	Close

**Position Source**

PHINS

GPS

TRIAD

DR

**Speed Source**

DVL

GPS

RPM

PHINS

TRIAD

**PHINS/Watson Attitude Source:**

PHINS Source

Phins/Watson toggle

Watson Fine

Note: Check the validity of instruments before selection. Thruster rpm speed is used if instrument faults.

- Pilot Mode Settings
- Tech Mode Settings
- Instruments
- History Plots
- Acoustic Telem Data
- Mission Planner
- Calibration I/O
- Tuning
- Logging
- Ground Faults
- Diagnostics

User can modify the appearance and functionality

# Graphical “Widgets”

Code reuse extends to GUI's by standardized Widget, design, interface and export in ACE SDK

The image displays a graphical user interface (GUI) control panel for a vehicle, featuring several standardized widgets and a sidebar menu.

**Camera Controls:** The top section shows four camera views: "Nav Forward", "Landing / Nav Assist", "Nav Aft", and "Skirt Interior". Each view includes a 2x2 grid with a green dot in the center, indicating the camera's pan and tilt. Below each grid are directional arrows (up, down, left, right) for manual control. The pan and tilt values for the first three cameras are: Pan: 10.0°, Tilt: 20.0°.

**Camera Power:** A table below the camera controls shows the power status for various camera modes:

Camera Power:			
Nav Forward	Port	Stbd	All Cameras ON
Nav Aft	Umbilical / Latch #1	Skirt Landing	All Cameras OFF
Landing / Nav Assist	Umbilical / Latch #2	Skirt Interior	

**Camera Reference Frame:** A vertical stack of buttons shows the current reference frame: "Forward", "Skirt Landing", and "Aft".

**Sonar Controls:** Two sonar widgets are shown: "Fwd Sonar" with a tilt of 6° and "Aft Sonar" with a tilt of -12°. Each has up and down directional arrows.

**Sidebar Menu:** A vertical sidebar on the right contains a list of menu items, each with a checkbox:

- Status
- Instruments
- Velocities & Overlay
- Lights & Power
- Cameras
- DISSUB Docking
- Logging
- Diagnostics
- Settings
- Life Support

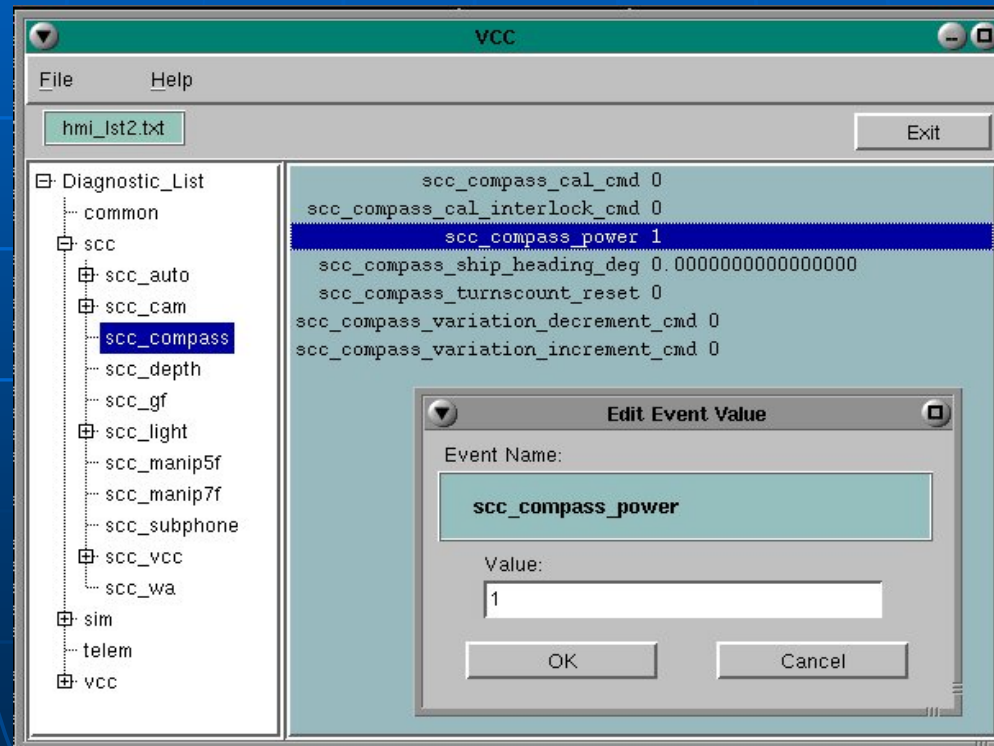
# Diagnostics and Settings

Can be integrated into the GUI

<input type="checkbox"/> Other Settings	<b>HPU 1 Oil Level</b>	<b>HPU 1 Oil Pressure</b>	<b>Camera Nav Fwd Pan Degree</b>	<b>Camera Nav Fwd Tilt Degree</b>	<b>Sonar Fwd Tilt Degree</b>	<input type="checkbox"/> Status
<input type="checkbox"/> Pilot's Chair Duplicate	x1: -25.0	x1: -25.0	x1: -25.0	x1: -25.0	x1: -25.0	<input type="checkbox"/> Instruments
	y1: -25.0	y1: -25.0	y1: -25.0	y1: -25.0	y1: -25.0	<input type="checkbox"/> Velocities & Overlay
<input type="checkbox"/> Alarm Limits	x2: 25.0	x2: 25.0	x2: 25.0	x2: -25.0	x2: 25.0	<input type="checkbox"/> Lights & Power
	y2: 25.0	y2: 25.0	y2: 25.0	y2: 25.0	y2: 25.0	<input type="checkbox"/> Cameras
<input type="checkbox"/> Gains & Other Parameters	Raw Volts: 20.2	Raw Volts: 20.2	Raw Volts: 20.2	Raw Volts: 20.2	Raw Volts: 20.2	<input type="checkbox"/> DISSUB Docking
<input type="checkbox"/> Joystick Calibration	Calibrated: 50.0	Calibrated: 3000.0	Calibrated: 10.0	Calibrated: 20.0	Calibrated: 5.7	<input type="checkbox"/> Logging
<input type="checkbox"/> PDS Calibration	<b>Ts Upper Rotate Pos.</b>	<b>Ts Lower Rotate Pos.</b>	<b>HPU 1 Electric Motor Temp.</b>	<b>VCC1 Can Temp.</b>		<input type="checkbox"/> Diagnostics
<input type="checkbox"/> SCC1 Calibraton	x1: -25.0	x1: -25.0	x1: -25.0	x1: -25.0		<input checked="" type="checkbox"/> Settings
<input type="checkbox"/> SCC2 Calibraton	y1: -25.0	y1: -25.0	y1: -25.0	y1: -25.0		Life Support
<input type="checkbox"/> VCC1 Calibraton	x2: 25.0	x2: 25.0	x2: 25.0	x2: 25.0		
<input type="checkbox"/> VCC2 Calibraton	y2: 25.0	y2: 25.0	y2: 25.0	y2: 25.0		
	Raw Volts: 20.2	Raw Volts: 20.2	Raw Volts: 20.2	Raw Volts: 20.2		
	Calibrated: 20.2	Calibrated: 20.2	Calibrated: 20.2	Calibrated: 20.2		

# Diagnostics & Troubleshooting

Generic “Diagnostic List” for real-time diagnostics and system tuning



# Software Development Process

## Document Control

- standardized authoring, review, approval and distribution

## Software Configuration Management

- All software under Revision Control System
- Change Request, Approval, Implementation & Testing process in place
- Coding Standards
- Peer reviews, catch faults early!



# Summary

- ACE SDK is a software toolbox of tested components and configurations for a variety of applications.
- System similarities result in field proven software, documented and controlled.
- Capability is demonstrated.
- Development process reduces cost and risk of new software.

THE END

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