MATE
MARINE ADVANCED TECHNOLOGY EDUCATION CENTER

www.marinetech.org

Oceanographic Instrumentation Technician

Contents

NOPP National Oceanographic Partnership Program

NOAA

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The Importance of Oceanographic Instrumentation Technicians and Ocean Observing Systems

Oceanographic Instrumentation Technicians play an important role in the collection of scientific measurements that allow us to understand how the oceans work and to use the ocean and its resources more safely and wisely.

Historically, most ocean measurements were made from ships, but increasingly they are being made from unmanned platforms such as moorings, drifters, and autonomous underwater vehicles. The earliest of these measurements or observations were made in the spirit of pure exploration: to describe what the ocean floor looks like, where the strongest currents are, how salty the water is, etc. As new technologies were invented and new theories advanced, targeted ocean measurements were made to try to understand ocean dynamics and biological and geological interactions: why the strongest currents are along the western boundaries of oceans, why the biological productivity is greatest along the eastern boundaries of oceans, how life is sustained in the deep ocean.

Today, while ocean measurements are still made for exploration and for research, more and more data are being collected continuously in near real-time and are used to support operational missions, including governmental and commercial uses such as optimizing shipping routes, managing fisheries, mitigating oil spills, and forecasting storm surge. The advent of ocean observing systems that take an integrated long-term approach to observing the ocean can be used to address a number of societal issues, and are important to research, education, and commercial enterprises.

MBARI

Mike Kelley, Ocean Observing Supervisor, works on a mooring observing system in Monterey Bay.

One could consider any ongoing real-time or routinely repeated measurements intended for widespread timely distribution for the purposes of monitoring pollution, ecosystem health, fisheries management, climate change, etc., to be examples of ocean observing systems.

The goal of ocean observing systems is to pull together data from various sources to present a cohesive picture of the oceans, and its biology, chemistry, geology, and physics that can be used for decision-making. Like the global network of weather stations that monitors the atmosphere, ocean observing systems provide current conditions and contribute to short- and long-term ocean and atmospheric forecasts for the public; including pollution alerts for beachgoers, ocean temperatures for recreation and fishing, harmful algal bloom warnings for shellfish

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Introduction to MATE's Knowledge and Skill Guidelines

The process of developing a competent ocean workforce that is well prepared for employment requires collaborating with a wide range of people and organizations. One of the major tasks of the Marine Advanced Technology Education (MATE) Center is to identify and define marine technical occupations and the abilities that men and women need in order to perform well in these occupations. The major product that results from this work is a set of occupational Knowledge and Skill Guidelines (KSGs) for technical marine occupations. These guidelines describe what workers need to know and be able to do in order to perform their jobs well and they are different for each occupation. The KSGs developed by the MATE Center include those for marine technicians, remotely operated vehicle (ROV) technicians, hydrographic survey technicians, aquarists, aquaculture technicians, oceanographic instrumentation technicians, and operational marine forecasters. All the KSGs developed by the MATE Center can be found at www.marinetech.org/marineworkforce, or printed copies can be requested from the MATE Center.

—Deidre Sullivan, MATE Center Director

About the MATE Center

The Marine Advanced Technology Education (MATE) Center is a national partnership of organizations working to improve marine technical education and in this way help to prepare America's future workforce for ocean occupations. Headquartered at Monterey Peninsula College (MPC) in Monterey, California, the MATE Center has been funded as a National Science Foundation (NSF) Advanced Technological Education (ATE) Center of Excellence since 1997. The MATE Center works with community colleges, high schools, universities, research institutions, marine industries, professional societies, and working professionals to facilitate the development of courses and programs based on industry-established guidelines. In this way, the Center is working with industry to create an education system that meets the needs of employers and students, is flexible, and provides employers with direct access to students. The Center is also actively working to increase the awareness of ocean-related careers and provide students, educators, workers, and employers with up-to-date information to assist them in making informed choices concerning their education and future.

The Importance of Marine Technology

The ocean economy is large and diverse, accounting for twenty percent of our national economy and supporting one in six jobs in the country. Marine technology plays a vital role in supporting the ocean economy, from national security to transportation and commerce, energy and exploration activities, telecommunications, recreation and tourism, fisheries and aquaculture, search and recovery, environmental assessment and regulation, and research. Although these economic sectors are diverse, the technology supporting them has many similarities. These similarities include the collection and use of remotely sensed data; the use of advanced computing systems, such as GIS, for organizing and managing data; and the use of electronics and microelectronics for power, controls, and miniaturization in a remote, harsh environment. The need for highly qualified technical professionals who can design, build, operate, and maintain this technology has never been greater. A concerted effort is required to ensure that our workforce is prepared for an economy currently and increasingly dependent on ocean activities and the technologies that make these activities feasible.

MATE Strategy for Improving the Marine Technical Workforce

PRODUCTS	DESCRIPTION
Needs identification ↓	List of critical workforce needs from employer queries
Occupational definitions ↓	Employer recognized occupational categories
Occupational knowledge and skill guidelines ↓	Employee identified knowledge and skills for specific occupations
Competencies ↓	Knowledge and skills grouped by subject area
Instructional materials and services ↓	Competency-based assessments, modules, courses, faculty development workshops, competitions, and internships
Educational programs ↓	Degree and certificate programs aligned with workforce needs
Career management programs	Job placement programs, professional development courses

Knowledge and Skill Guidelines for an Oceanographic Instrumentation Technician

Introduction

MATE Center

OITs servicing a buoy.

On March 18-20, 2009, the Marine Advanced Technology Education (MATE) Center hosted a workshop to define the occupational parameters associated with an oceanographic instrumentation technician (OIT). The workshop panel (on right) combined their individual expertise with results from a pre-workshop survey of technicians and their supervisors working in the marine environment to develop an occupational definition and outline the job functions and tasks for an OIT. The workshop panel also identified the knowledge, skills, and performance indicators for an OIT. Additional information collected from the panel and survey respondents included the personal characteristics, occupational titles, salary ranges, educational backgrounds, and desired course work for an OIT. An initial step in developing the knowledge and skills guidelines was defining some relevant terms related to the technology and platforms used by OITs. Commonly used sensors, instruments, platforms, tools, and related technology are included within this document. The panel also identified the professional societies, conferences/symposiums, and professional publications that are relevant to OITs. Finally, future trends for the occupation were identified within this document.

Overview of the Oceanographic Instrumentation Technician

OITs make possible the collection of data from the sea. The ocean is a harsh environment, and deploying and maintaining equipment there requires skilled and dedicated professionals. These individuals must be able to interface instrumentation to a wide variety of platforms including ships, moorings, drifters, autonomous underwater vehicles, etc. In many organizations, these technicians are responsible for all aspects of data collection and management, from the deployment of the instrument to the delivery of documented data to the end user. In many applications, the data are required in near real-time, so OITs may be responsible for operating data communications equipment as well. Overall, these technicians provide onshore and offshore laboratory, field, and technical support for *in situ* marine instrumentation and data derived from those instruments.

Definitions:

The following terms are defined and used throughout this guide.

Sensor – technology that measures a desired parameter

Instrument – a sensor or collection of sensors

Components – instruments, positioning systems, data loggers, communications equipment, power supplies, ancillary cables, mounting hardware, etc.

Platform – physical structure on which components are deployed in the field (e.g., ship, mooring, etc.)

System – components plus deployment platform

Users/Customers – persons who have commissioned/caused the data to be collected and to whom the data are to be delivered

Workshop Participants:

Workshop Organizers: **Deidre Sullivan, Shawn Smith, Leslie Rosenfeld, and Tom Murphree**

Workshop Facilitator:

Deidre Sullivan

Workshop Recorder:

Jill Zande

Panel Members:

Fred Bahr	CeNCOOS
Raymond Boone	National Data Buoy Center
Mark Bushnell	National Ocean Service
Lynne Butler	University of Rhode Island
Chip Haldeman	Rutgers University
Kevin Hart	Naval Oceanographic Office
Steven Hartz	University of Alaska
Cheryl Hickey	National Data Buoy Center
Mike Kelley	Monterey Bay Aquarium Research Institute
Erich Rienecker	Monterey Bay Aquarium Research Institute
Leslie Rosenfeld	Naval Postgraduate School
Shawn Smith	Florida State University
Jan van Smirren	Fugro GEOS
Phil White	NOAA Marine and Aviation Operations

Oceanographic Instrumentation Technician Job Description

OITs are responsible for the installation, maintenance, troubleshooting, repair, engineering, and operation of instrumentation and systems used for the collection of oceanic and marine atmospheric observations. They collect reliable, quality data using *in situ* ocean observing instrumentation to meet user needs for government, industry, academia, and the public.

Knowledge and Skill Overview Chart for Oceanographic Instrumentation Technicians

JOB FUNCTION	TASK AREAS						
A. Apply environmental, safety, quality, and technical standards (e.g., ISO)	A1 Properly handle hazardous materials	A2 Understand and comply with established safety regulations	A3 Comply with technical and quality procedures				
B. Communicate effectively (oral and written)	B1 Produce technical and standard operating procedures (SOP)	B2 Present results	B3 Coordinate with personnel (including ship's crew)	B4 Relate problems in timely fashion	B5 Mentor less experienced personnel	B6 Interact with vendors and suppliers	B7 Maintain good customer relations
C. Prepare for deployment	C1 Understand observational requirements	C2 Obtain permits	C3 Identify instrument requirements and select instruments	C4 Procure instruments	C5 Verify calibrations or calibrate sensors	C6 Instrument (hardware and software) setup and implementation of modifications	C7 Conduct end user acceptance test (known as the factory acceptance test, FAT)
	C8 Package and ship instruments	C9 Coordinate logistics (e.g., travel)	C10 Maintain records				
D. Integrate components with platform	D1 Test instruments on site	D2 Install instruments on platform	D3 Test system end-to-end or conduct site acceptance test (SAT)				
E. Deploy and recover system	E1 Develop a deployment and recovery plan	E2 Locate site	E3 Communicate plan	E4 Implement plan	E5 Verify system operation and position	E6 Conduct post-recovery inspection and documentation	
F. Operate, monitor, maintain, and troubleshoot system	F1 Monitor instrument performance	F2 Clean instruments	F3 Identify failures	F4 Make repairs	F5 Document actions		
G. Manage and quality control data	G1 Retrieve data	G2 Backup data files	G3 Convert raw data to end user units	G4 Visualize and scrutinize raw data	G5 Flag or edit data	G6 Transfer data and metadata	
H. Manage and maintain computers and networks	H1 Use software programs	H2 Perform system administration	H3 Perform scripting or programming	H4 Operate computer hardware			

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function A: Apply environmental, safety, quality, and technical standards (e.g. ISO)

Task	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
A1. Properly handle hazardous materials	• All agency rules are complied with • No incident reports are required • MSDS sheets are readily available • Materials are properly stored, per regulations • Materials are properly inventoried, per regulations • Appropriate containment procedures are in effect • Safety protocol is in place • Spills are cleaned up quickly and properly • All required documentation is completed	• Ability to read MSDS sheets • Knowledge of and ability to apply appropriate state, federal, institutional, and international regulations, such as DOT, OSHA, and IAT • Ability to respond to accidents • Knowledge of basic chemistry and hazardous materials • Knowledge of basic radioisotope safety, such as lab procedures and isolation
A2. Understand and comply with established safety regulations	• Accidents and need for workers' compensation claims are minimized • Safety procedures are in place and implemented • All persons are familiar with safety procedures • Safety briefings are well-documented • All required documentation is completed	• Knowledge of first aid, CPR • Seamanship/rigging skills • Situational awareness • Survival skills • Ability to make decisions quickly and effectively • Ability to conduct job safety analysis and briefings
A3. Comply with technical and quality procedures	• Complete and well-written reports are on hand when requested • Required reports and documentation are completed on time • Corrective actions are minimized	• Ability to communicate clearly orally and in writing • Knowledge of technical terms • Ability to meet deadlines

Personal Characteristics of an Oceanographic Instrumentation Technician

An OIT tends to be a "jack of all trades." Often, OITs must function as their own boss, or as a one-person department, yet they also need to be able to work in a team. Successful OITs have the following characteristics:

- Knack for troubleshooting
- Delight in knowing how things work
- Enjoy fixing things
- Mechanical aptitude
- Electrical and electronic aptitude
- Ability to operate and maintain complex electronic equipment
- Ability and willingness to read technical manuals
- Commitment to excellence in data acquisition (care about data)
- Willingness to seek technical advice from diverse sources
- Ability to multitask
- Ability to work in high stress, sleep- or food-deprived environment
- Ability to get along with others
- Ability to maintain focus
- Ability to learn from mistakes
- Willingness to travel, fly, and be away from home for extended periods
- Pride in the job
- Passion for the job
- Patience
- Flexibility
- Creativity
- Adaptability
- Good sense of humor

Successful OITs are also:

- Organized
- Assertive
- Self-motivated
- Proactive
- Diplomatic
- Good listeners
- Physically fit
- Comfortable with heights and confined spaces
- Quick learners

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function B: Communicate effectively (oral and written)

Task	**Performance Indicators** How do we know when the task is performed well?	**Technical Knowledge and Skills** What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
B1. Produce technical and standard operating procedures (SOP)	• SOPs are in place and implemented • Equipment damage and loss is minimized • Personnel injury is minimized	• Ability to write in technical style • Knowledge of operating procedures • Knowledge of appropriate technical terms
B2. Present results	• Audience understands information presented	• Ability to effectively communicate to an audience • In-depth knowledge of the subject
B3. Coordinate with personnel (including ship's crew)	• Briefings accomplish objectives • Miscommunications are minimal • Hand signals are used properly • Debriefings provide good, positive feedback • Mission is successful	• Ability to conduct a briefing/debriefing (e.g., communicate mission and clarify terminology) • Knowledge of chain of command • Ability to use hand signals • Knowledge of platform procedures • Knowledge and ability to use wireless communications (radio)
B4. Relate problems in a timely fashion	• Hazards are avoided because they are known	• Ability to make decisions quickly and effectively • Knowledge of chain of command • Ability to use hand signals • Knowledge and ability to use wireless communications (radio)
B5. Mentor less experienced personnel	• Trainees perform tasks correctly and efficiently • Trainees perform operations properly, with minimal assistance and oversight • Data and equipment integrity are maintained	• Knowledge of training procedures • Ability to assess trainees' skills • Ability to communicate clearly, both orally and in writing • Ability to maintain data and equipment in good condition
B6. Interact with vendors and suppliers	• Systems (hardware, software, firmware, and documentation) are current • System performance is optimized • Rapport is established and maintained • Vendor makes contact to provide updates on existing products and information	• Organizational skills to keep track of updates • Interpersonal communication • Ability to conduct market research • Ability to keep abreast of current and emerging technologies
B7. Maintain good customer relations	• Customer is satisfied • Customer objective is completed • Information is recorded accurately and legibly • Logs and other records are current, correct, and well-documented	• Ability to communicate clearly, both orally and in writing • Ability to solve problems • Good customer relation skills

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function C: Prepare for deployment

Task	**Performance Indicators** How do we know when the task is performed well?	**Technical Knowledge and Skills** What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
C1. Understand observational requirements	• Project plan developed and accepted	• Knowledge of project objectives • Understanding of the project environment • Familiarity with instrument capabilities and limitations • Understanding of platform capabilities and limitations • Understanding of financial constraints • Knowledge of the scientific method
C2. Obtain permits	• Proper permit(s) obtained	• Knowledge of regulations • Knowledge of regulating authorities
C3. Identify instrument requirements and select instruments	• Proper instrument is identified and selected • Proper instrument options/configuration are specified	• Familiarity with instrument capabilities and limitations • Understanding of platform capabilities and limitations • Understanding of financial constraints • Ability to read and comprehend technical specifications • Knowledge of galvanic properties
C4. Procure instruments	• Equipment and supplies are ordered in a timely manner • Proper instrument arrives in a timely fashion • Equipment works properly • Adequate equipment and supplies are on hand • Proper inventory of equipment and supplies is maintained	• Ability to maintain an inventory of equipment and supplies • Knowledge of inventory systems • Ability to locate and contact vendors and manufacturers • Knowledge of purchasing procedures • Ability to use the Internet, web browsers, and search engines • Written, oral, customer relations, and communication skills

Occupational Titles for Oceanographic Instrumentation Technicians

Based on the workshop and survey results, the following titles are currently in use for the occupation we define here as an OIT:

- Electronics Equipment Specialist
- Electronics Technician
- Engineer (oceanographic and others)
- Field Technician/Researcher/Service Lead
- IT Specialist
- Marine Technician
- Mooring Technician
- Oceanographer
- Oceanographic Technician
- Offshore Technician
- Physical Scientist
- Physical Science Technician
- Research Technician
- Ship Technician
- Survey Technician

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function C: Prepare for deployment (continued)

Task	**Performance Indicators** How do we know when the task is performed well?	**Technical Knowledge and Skills** What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
C5. Verify calibrations or calibrate sensors	• Equipment/instrumentation functions within manufacturer's specifications • Equipment/instrumentation complies with current calibration standards • Calibration records are complete, current, and documented • Log book is current	• Familiarity with calibration procedures and standards • Ability to apply calibration according to manufacturer specifications • Ability to perform field calibrations • Ability to maintain calibration records • Computer skills • Basic understanding of scientific notation • Knowledge of and ability to apply mathematical skills, including statistics, algebra, and geometry • Knowledge of sensor operation • Ability to communicate clearly, both orally and in writing
C6. Instrument (hardware and software) setup and implementation of modifications	• Instrument performs as planned	• Knowledge of electronic and mechanical test • Ability to troubleshoot systems • Ability to use computer diagnostics • Ability to read schematics and mechanical drawings • Time management skills • Ability to use vendor and other supplied software • Ability to write software (an advanced skill) • Computer skills
C7. Conduct end user acceptance test (known as Factory Acceptance Test, FAT)	• End user satisfied that instrument is within specifications	• Knowledge of electronic and mechanical test equipment • Ability to troubleshoot instruments • Ability to use computer diagnostics • Ability to perform relevant computer, electronic, and mechanical repairs on equipment • Ability to communicate clearly, both orally and in writing • Ability to maintain calibration records
C8. Package and ship instruments	• Instruments arrive on time and in working condition at anticipated cost	• Ability to pack, secure, and ship equipment/instrumentation • Knowledge of shipping procedures and time lines • Ability to operate a forklift • Knowledge of domestic and foreign customs regulations • Knowledge of export restrictions (e.g., ITAR, CCL) • Knowledge of hazmat and other shipping regulations

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function C: Prepare for deployment (continued)

Task	**Performance Indicators** How do we know when the task is performed well?	**Technical Knowledge and Skills** What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
C9. Coordinate logistics (travel, spare parts/ instuments, etc.)	• All personnel/equipment arrives at intended destination on time and within budget • Travel documents obtained • Necessary immunizations and medications obtained • Required permits obtained	• Knowledge of organizational procedures and timelines • Knowledge of local customs and regulations • Ability to obtain necessary documents/permits
C10. Maintain records	• Records are current • Information is recorded accurately and legibly • Logs are current, correct, and well-documented	• Knowledge of and ability to perform record keeping • Knowledge of logs (e.g., maintenance, inventory, finance, customer, event)

Common Platforms Used by Oceanographic Instrumentation Technicians

- Ships and boats (including packages lowered or towed from them)
- Moorings (surface buoys, subsurface moorings, and bottom mount platforms such as tripods)
- Surface drifters
- Profiling floats
- Autonomous/unmanned underwater vehicles (AUVs/UUVs) including gliders
- Remotely operated vehicles (ROVs)
- Fixed coastal sites (lighthouses, docks, piers etc.)
- Offshore structures
- Cabled observatories
- Submarines/submersibles
- Aircraft

Salary Range for Oceanographic Instrumentation Technicians

Entry level OITs, with Associate's degree and 0-5 years experience, typically earn ~ $27,000 - $50,000 per year.

Additional education will add to this base salary:

- Bachelor's degree typically adds $5,000 - $10,000 per year
- Master's degree typically adds $10,000 - $15,000 per year

Salary for a senior technician (more than 15 years experience) ranges from $60,000 to over $100,000.

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function D: Integrate components with platform

Task	**Performance Indicators** How do we know when the task is performed well?	**Technical Knowledge and Skills** What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
D1. Test instruments on site	• Instrument performs as planned • Equipment/instrumentation functions within manufacturer's specifications under field conditions • Equipment/instrumentation complies with current calibration standards • Calibration records are complete, current, and documented • Log book is current	• Familiarity with calibration procedures and standards • Knowledge of electronic and mechanical test equipment • Computer skills • Mechanical aptitude and dexterity • Ability to communicate clearly, both orally and in writing
D2. Install instruments on platform	• Instrument and related components are appropriately positioned and properly secured • Mounting systems meet the observational and environmental requirements • Mounting system works • Proper materials are used • Operation of components meets observational requirements • Components meets applicable standards • Log book is filled out	• Ability to design and fabricate mounting hardware (advanced skill) • Knowledge of proper materials to use • Knowledge of basic wiring – what equipment draws and how to get power to it • Ability to interface components • Ability to secure equipment safely • Ability to locate and comply with relevant standards, policies, applicable laws, and regulations • Ability to read schematics and mechanical drawings • Ability to obtain SCUBA dive certification • Ability to safely work at height, in confined spaces, and in other adverse conditions to secure components • Knowledge of platform layout and capabilities • Ability to operate crane • Mechanical aptitude and dexterity
D3. Test system end-to-end/ conduct site acceptance test (SAT)	• System performs as planned • System functions within manufacturer's specifications under field conditions • Log books and documentation are complete	• Knowledge of electronic and mechanical test equipment • Ability to troubleshoot systems • Ability to use computer diagnostics • Ability to perform relevant computer, electronic, and mechanical repairs on the system • Computer skills • Mechanical aptitude and dexterity • Ability to communicate clearly, both orally and in writing

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function E: Deploy and recover system

Task	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
E1. Develop a deployment and recovery plan	• Standard operating proceedures (SOPs) and safety considerations are incorporated • Plan is executable with available personnel • Contingency plans are included	• Knowledge of rigging equipment (e.g., shackles, eyes, snatch blocks, bridles, slings) • Knowledge of salvage equipment • Knowledge of trigonometry • Knowledge of physics • Knowledge of ship's procedures • Knowledge of chain of command • Knowledge of safety procedures
E2. Locate site	• Site meets mission and permit requirements	• Knowledge of navigation systems • Knowledge of trigonometry (visual sighting) • Ability to communicate with ship's crew • Knowledge of surveying • Knowledge of environmental conditions • Knowledge of platform limitations • Ability to come up with contingency plan on short notice
E3. Communicate plan	• Team goals are accomplished • Mission is successful • Communications are clear and concise • Scientists are well-informed as to the capabilities and limitations of the platform • All parties are informed of plan of action, time line, and individual roles • Platform operator has been briefed on scientific mission	• Ability to communicate clearly, both orally and in writing • Ability to conduct briefings • Ability to solve problems • Knowledge of chain of command • Knowledge of platform procedures • Ability to use hand signals • Ability to focus on team goals • Ability to get along with fellow team members

Educational Background for Oceanographic Instrumentation Technicians

Persons entering into the occupation of an OIT can have a wide range of educational experience. In some cases, OITs enter the field with a high school diploma and some specialized work experience (e.g., military service focused on a technical field). Common formal educational backgrounds include the following degree programs:

Associate's (2-year) degree
- Biology
- Computer technology
- Electronics
- Instrumentation
- Marine science
- Marine technology
- Oceanographic technology

Bachelor's (4-year) degree
- Computer science
- Electrical engineering
- Marine science
- Marine technology
- Mechanical engineering
- Ocean engineering
- Oceanography
- Physical/earth sciences

Master's degree
- Applied ocean science
- Computer science
- Engineering (all types)
- Hydrography
- Marine science
- Meteorology
- Ocean observing systems
- Oceanography (physical or other)
- Operational oceanography
- Physics

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function E: Deploy and recover system (continued)

Task	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
E4. Implement plan	• Knots, gear, and rigging equipment are used properly • Rigging is accomplished safely, correctly, and in a timely manner • Items are moved or secured safely and without damage • Hand signals are used properly • Personal floatation devices and safety gear are used properly • Environmental concerns are addressed adequately • Overhead loads and other hazards are assessed properly	• Knowledge of rigging equipment (e.g., shackles, eyes, snatch blocks, bridles, slings) • Knowledge of salvage equipment • Knowledge of trigonometry • Knowledge of physics • Ability to operate launch and recovery equipment (e.g., pelican hooks, happy hooker ring) • Ability to operate winches, cranes, and frames safely • Ability to operate a forklift • Knowledge of seamanship, rigging, knot tying • Ability to use hand signals • Understanding of, and ability to, apply safety protocols • Ability to recognize unsafe conditions and react swiftly and appropriately • Ability to operate small boats
E5. Verify system operation and position	• System in position and data coming through (if applicable)	• Knowledge of navigation systems • Computer/software skills • Ability to communicate with ship's crew • Knowledge of system communication protocols (e.g., satellite telemetry, RF, cabled, etc.)
E6. Conduct post-recovery inspection and documentation	• Component condition properly assessed and noted • Mission completed successfully • Documentation completed	• Ability to operate photo and video documentation equipment • Knowledge of and ability to perform record keeping

Desired Basic Courses

- Algebra
- Chemistry
- Communication systems
- Computer networking
- Computer programming
- Data analysis
- Data loggers and sensor integration
- Electrical engineering
- Electronics (2 courses minimum)
- Fabrication
- First aid
- Mechanics
- Meteorology
- Oceanographic instrumentation/sensors
- Oceanography
- Photo documentation
- Physics
- Project management
- Public speaking
- Scientific/working diving
- Seamanship/navigation
- Statistics
- Technical writing
- Trigonometry
- Web programming

Internships related to any of the above fields of study and/or basic course options are very beneficial for persons interested in working as an OIT.

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function F: Operate, monitor, maintain, and troubleshoot system

Task	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
F1. Monitor instrument performance	• Problems are identified in a timely manner • Results are within expected limits • Data are validated (e.g. inter-comparison between sensors)	• Ability to communicate clearly, both orally and in writing • Computer/software skills • Knowledge of system and environment • Knowledge of physics • Data visualization and analysis skills
F2. Clean instruments	• Scheduled cleaning is performed • Environmental regulations are followed • Data quality is maintained • Sensor meets or exceeds expected life span	• Ability to delegate • Knowledge of hazardous materials regulations • Ability to troubleshoot systems • Knowledge of appropriate materials and methods

Components Typically Operated and Maintained by Oceanographic Instrumentation Technicians

Environmental sensors and instruments

- CTD/XBT/thermosalinograph/ other conductivity and temperture sensors
- Current profilers and meters (all types)
- Standard meteorological sensors (humidity, air temperature, pressure, wind)
- Inherent optical sensors (transmissometer, fluorometer, attenuation meter, etc.)
- Apparent optical sensors (atmospheric radiation, PAR, radiance/ irradiance sensor)
- SONAR (sidescan, multibeam, echosounder, sub-bottom profiler)
- Pressure sensors (ocean)
- Dissolved gas sensors (oxygen, CO_2, freon)
- Other meteorological sensors (precipitation, lightning, CO_2, cloud height or ceiling, visibility)
- Tide gauges and other water level sensors
- Wave sensors
- Biological sampling devices (video plankton recorders, UBAT)
- Magnetometers
- Gravity meters
- Radioactivity meters

Position and orientation devices

- Global Positioning Systems (e.g., DGPS, WAAS, GCGPS, RTK)
- Compasses (magnetic, gyro)
- Chart plotters/navigational software
- Inertial navigation systems (e.g., POS-MV)
- Pitch/roll/heave sensors
- Doppler velocity logs
- Acoustic positioning systems (pingers, USBL, transponders, etc.)
- Automatic Identification Systems (AIS) (ship positioning, transponder)
- Location finders (e.g., Radio direction finder, ARGOS beacon, IALA (visual)

Data loggers/acquisition systems

- COTS (commercial off the shelf) or custom design
- Stand alone and networked
- Integrated marine management systems

(continued on page 14)

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function F: Operate, monitor, maintain, and troubleshoot system (continued)

Task	**Performance Indicators** How do we know when the task is performed well?	**Technical Knowledge and Skills** What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
F3. Identify failures	• Correct test equipment is chosen for each task • Test equipment is used properly to accomplish required task(s) • Tests are conducted in a safe manner • Test and measurement data are used to troubleshoot and resolve problems successfully	• Knowledge of and ability to use electronic and mechanical test equipment (e.g., oscilloscope, megohmmeter, multimeter) • Ability to determine proper equipment for test • Ability to troubleshoot systems • Ability to use computer diagnostics software • Ability to inspect components (e.g., for corrosion, wear, damage) • Knowledge of system and environment • Data visualization and analysis skills • Ability to make and use flow charts • Ability to read schematics and mechanical drawings • Computer/software skills
F4. Make repairs	• Relevant repairs are coordinated with manufacturer • Repairs are completed safely (lockout, tagout), correctly, and in a timely manner • System demonstrates increased reliability • Logs are current	• Ability to perform relevant computer, electronic, and mechanical repairs on equipment • Ability to replace parts to board level • Knowledge of electronics • Ability to solder • Ability to take apart and rebuild instruments • Knowledge of safety (lockout, tagout) procedures • Ability to read schematics and mechanical drawings • Time management skills
F5. Document actions	• Problem and solution clearly documented, disseminated, and filed	• Ability to communicate clearly, both orally and with technical writing

Components Typically Operated and Maintained by Oceanographic Instrumentation Technicians

(continued from page 13)

Telemetry (communications) equipment

- Acoustic modems
- RF systems (subsea, line of sight)
- Cables (fiberoptic, copper, wave guide)
- Infrared technology
- Satellites (lower earth orbit [ARGOS, IRIDIUM], geostationary earth orbit [INMARSAT,VSAT,GOES])
- Cell phones
- Microwave transmitters/receivers
- Inductive modems

Power types

- Solar
- Battery (primary and secondary)
- Generator
- Wind turbine
- Kinetic
- Inverter and rectifier (AC/DC)
- UPS

Cables/connectors

- Wet pluggable
- Underwater splices

Associated equipment

- Mounting brackets, etc.
- Shackles, chain, wire rope (rigging)

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function G: Manage and quality control data

Task	Performance Indicators How do we know when the task is performed well?	Technical Knowledge and Skills What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
G1. Retrieve data	• Data are recovered from instruments successfully • Files are properly named • Documentation is completed	• Ability to operate vendor or other software • Ability to interface equipment • Ability to troubleshoot systems • Ability to operate telemetry equipment
G2. Back up data files	• Data are stored on appropriate media with sufficient copies to meet observational requirements • All data arrive at "home base" in good order	• Computer skills
G3. Convert raw data to enduser units	• Data are converted properly	• Computer skills • Ability to operate vendor or other software • Ability to apply computer scripting • Knowledge of software programming
G4. Visualize and scrutinize raw data	• Plots created are clear and well documented (e.g., axes are labeled, correct units are used). • Potential problems are correctly identified • Anomalies are properly identified • Interesting physical features are correctly identified	• See G3 • Understanding of visualizations • Knowledge of environment (e.g., oceanography, meteorology, chemistry, physics) • Understanding of instrument performance in environment
G5. Flag or edit data	• Suspect data are flagged correctly • Invalid data are properly rejected • Anomalous data are properly documented • Data quality objectives meet observational requirements	• See G4
G6. Transfer data and metadata	• Data distribution requirements are met in a timely manner • Metadata allows data discovery • Data are transferred to archive as per observational requirements • Documentation of data transmittal is accurate and complete	• Computer skills • Ability to post data and/or metadata to appropriate electronic forums (e.g. the web, data servers)

Tools Typically Used by Oceanographic Instrumentation Technicians

- Multimeter and oscilloscope
- Spectrum analyzer
- Fox and hound
- Network tools
- Serial communication
- Termination and cable crimping tools (e.g. RJ45)
- Solder station
- Hand tools
- Power tools
- Welding equipment

Knowledge and Skill Chart for Oceanographic Instrumentation Technicians

Function H: Manage and maintain computers and networks

Task	**Performance Indicators** How do we know when the task is performed well?	**Technical Knowledge and Skills** What oceanographic instrumentation technicians need to know and/or be able to do in order to perform this task well.
H1. Use software programs	• Appropriate software is selected for each task • Desired end product is efficiently created	• Ability to use relevant software (e.g., Matlab, SQL, Microsoft Office including macros, GIS, CAD, Lab-view, VNC, Ocean data viewer) • Ability to learn new software
H2. Perform system administration	• System functions within specifications • System operates with high reliability • Maintenance is performed on schedule • Log books are current and legible • Multiple systems are interfaced successfully • Scientific data are recorded, backed up, and made accessible • Customers are satisfied	• Knowledge of and ability to install and maintain operating systems (Windows, LINUX, MacOS), software, hardware, and networks • Knowledge of and ability to troubleshoot/repair operating systems, software, hardware, and networks • Ability to write clear, concise log entries • Knowledge of incremental back-up techniques • Knowledge of storage media (e.g., DVD) • Knowledge of computer security • Ability to use TCP/IP, UDP, etc. • Understanding of file structures and permissions
H3. Perform scripting or programming	• Program performs planned tasks • Program is well documented • Source code is provided	• Knowledge of scripting languages, such as JavaScript, PHP, Power Shell, DOS, BAT • Knowledge of programming languages, such as Java, C, Matlab, PERL, NET • Knowledge of web languages, such as HTML, XML • bility to document program/source code in clear, concise language • Knowledge of version control
H4. Operate computer hardware	• Operates correctly • Uninterrupted operation • Instruments properly interfaced to computer	• Ability to install components • Knowledge of interface ports • Knowledge of power budgets and UPSs • Knowledge of electronics

Relevant Conferences for Oceanographic Instrumentation Technicians

- Buoy Workshop (MTS)
- Current Measurement Technology (IEEE)
- International Marine Technicians (INMARTECH) Symposium
- Ocean Optics
- Ocean Sciences (AGU/ASLO/TOS)
- Oceans (MTS/IEEE)
- Offshore Technology Conference
- Underwater Interventions (ADC/MTS)
- UNOLS Research Vessel Technical Enhancement Committee (RVTEC)
- Workboat Show
- Digital Ship Conference

Professional Societies Relevant to Oceanographic Instrumentation Technicians

- American Geophysical Union (AGU)
- American Meteorological Society (AMS)
- IEEE (Institute of Electrical and Electronics Engineers)
- Marine Technology Society (MTS)
- Society for Underwater Technology (SUT)
- The Oceanography Society (TOS)
- National Marine Electronics Association (NMEA)

Important Publications for Oceanographic Instrumentation Technicians

- Bulletin of the American Meteorological Society (AMS)
- Journal of Oceanic and Atmospheric Technology (AMS)
- Marine Technology Reporter
- Ocean News and Technology
- Sea Technology
- Marine Electronics (official journal of the NMEA)
- Technical reports (e.g., those produced by the Alliance for Coastal Technology)
- Vendor newsletters
- Digital Ship newsletter/magazine
- Computer magazines, websites, email newsletters and blogs

Future Trends Likely to Affect Oceanographic Instrumentation Technicians

- Experienced workers aging out of the system
- Higher data rates and larger data volume
- Higher personnel turnover rates
- Increase in real-time data delivery
- Increase in international interaction
- Increasingly complex systems
- More autonomous platforms deployed with increasing numbers of instruments
- More computerized automation
- More data management requirements (standardization)
- More remotely controlled systems
- More technicians will be needed (numbers depend on funding)
- Technicians will need to be more versatile
- Technicians will need to be more interdisciplinary
- Technicians will need to deal with research to operations issue
- Technicians will need to function on a higher level
- Technicians will need to more frequently learn new technologies

How these Guidelines are Developed

The process used by the MATE Center closely follows that outlined in the Skill Standards Guidebook I (October 1996) prepared by the Boeing Company, the Center for Career and Work-Related Education, and the Washington State Board for Community and Technical Colleges. Very simply, MATE selects a marine occupation based on employer surveys, the advice of experts in the field, and other labor market information. A highly-structured workshop (modified DACUM[1] – **D**eveloping **A CU**rriculu**M**) is then conducted with a group of eight to twelve technical professionals. These professionals work with a trained facilitator for two days to define the job functions and tasks associated with their specific occupation. The information gathered during the workshop is used to develop draft guidelines, which are then sent out to hundreds of technical professionals, representing large and small organizations from the public and private sector, for validation. The resulting guidelines represent the consensus of hundreds of professionals on the breadth of the occupation. No one technician would be expected to master all knowledge and skills and some may specialize in a subset of the job functions.

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[1]Norton, R.E. 1996. DACUM Handbook. Center on Education and Training for Employment, College of Education, The Ohio State University, 1900 Kenny Road, Columbus, Ohio 43210

(continued from page 1)
harvesters, wave conditions for surfers, and impending El Niño conditions for farmers and others. Long time-series observations, a central part of many ocean observing systems, are essential for effective policy planning regarding issues such as sea level rise and ocean acidification.

Many ocean observing systems in the U.S. fall under the umbrella of the government sponsored Integrated Ocean Observing System (IOOS). Other ocean observing systems are privately funded by charitable foundations, sponsored by consortia of local governments and/or public utilities, or funded by industries needing the information for commercial operations. In practice, funding from all these sources may be used together to support ocean observing systems.

As described on the IOOS website, "The IOOS is a multidisciplinary system designed to enhance our ability to collect, deliver, and use ocean information. The goal is to provide continuous data on our open oceans, coastal waters, and Great Lakes in the formats, rates, and scales required by scientists, managers, businesses, governments, and the public to support research and inform decision-making."[2]


MATE Center

A MATE student intern prepares a CTD for deployment.

Ocean instrumentation technicians work in a variety of academic, government, environmental, and for-profit organizations; and through their efforts reliable, quality, in situ ocean data are obtained to support:

- ocean and coastal resource managers;
- emergency responders, including search and rescue operations and planning for coastal storms;
- scientists studying ocean and coastal ecosystems and phenomena;
- policy makers at the national, state, and local levels;
- educators seeking to convey the complexity and importance of ocean resources; and
- members of the general public, including anyone who uses oceans for their livelihood or recreation.[1]

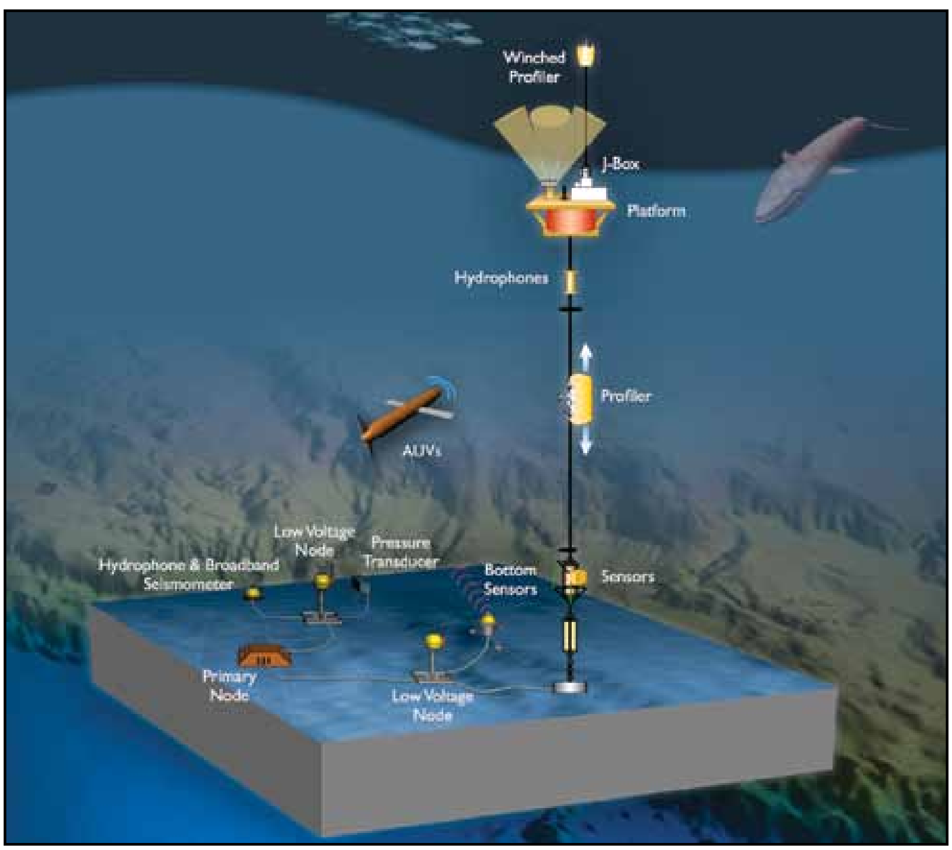


Illustration by the University of Washington

Diagram of an example of a modern ocean observing system.

The IOOS is expected to contribute to improvements in at least seven areas:

- predictions of climate change and its socio-economic consequences;
- the safety and efficiency of maritime operations;
- the mitigation of effects of natural hazards such as storms;
- national and homeland security;
- reduction of public health risks;
- protection and restoration of healthy marine ecosystems; and
- ecosystem-based management of natural resources.

The goal of the Ocean Observatories Initiative (OOI), the National Science Foundation's contribution to IOOS, is "to install transformational technology in ocean observatories where it can serve researchers, policymakers and the public."[3] The OOI "will construct a networked infrastructure of science-driven sensor systems to measure the

(continued on page 20)

[1, 2] http://ioos.gov

[3] http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/

Demographics of Oceanographic Instrumentation Technicians (OITs)

We surveyed 77 technicians prior to conducting the OIT workshop to understand the nature of their educational backgrounds and experience. The following charts summarize their responses.

Figure 1: What is your highest level of education?

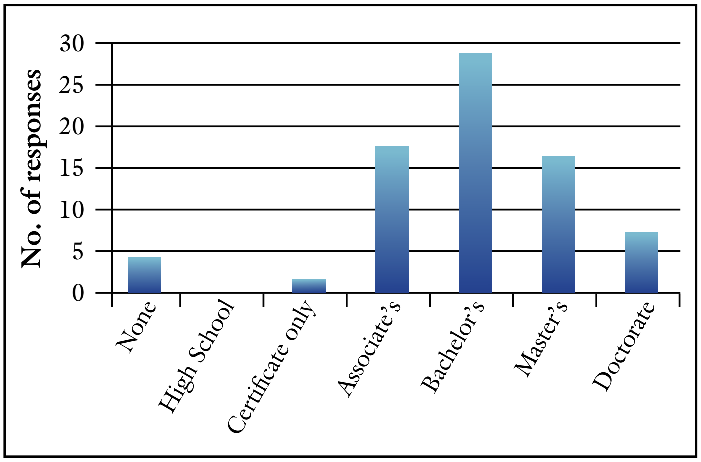


Figure 2: How long have you worked with ocean observing system instruments?

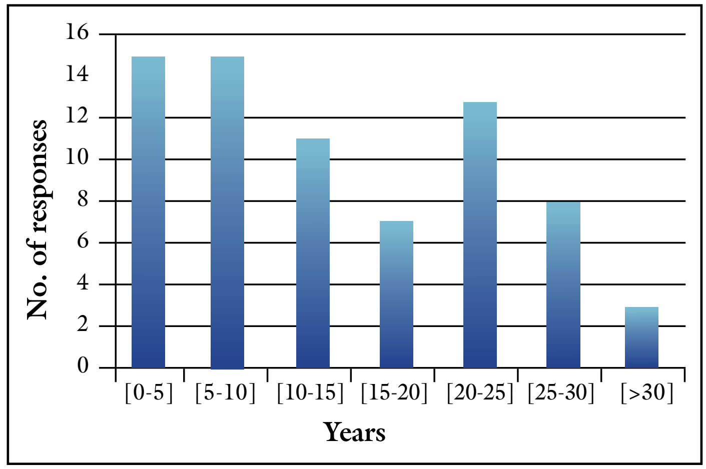
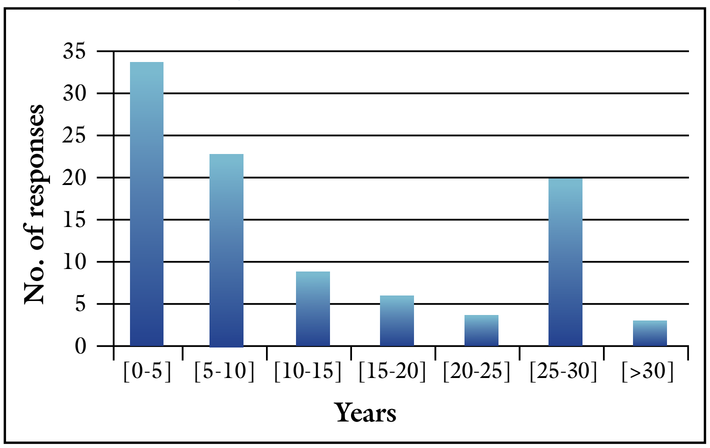


Figure 3: How long have you been in your current job?



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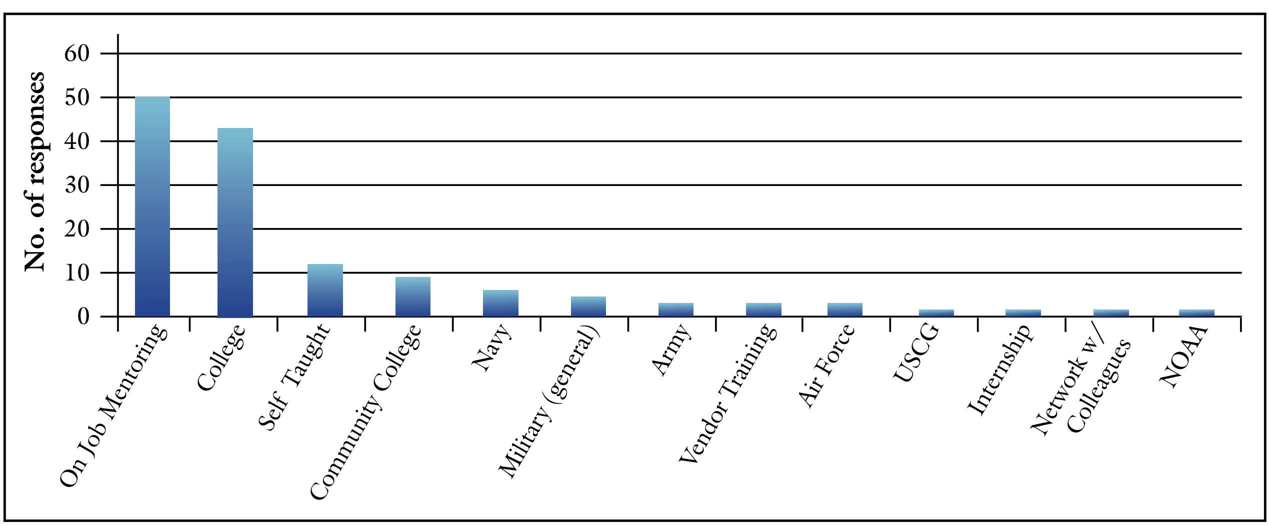
MATE student interns at sea.

Figure 4: Where did you obtain your physical science technician training?



(continued from page 18)
physical, chemical, geological and biological variables in the ocean and seafloor."[4] The global component of OOI will include a network of buoys measuring a variety of atmospheric and oceanic variables. On a regional scale, ocean floor observatories cabled to shore will provide long term and adaptive access to measurements of geological and oceanographic phenomena. Coastal nodes will combine moored and mobile assets to enable research in the complex coastal environment.

These exciting new developments in ocean observing systems will require the services of many oceanographic instrumentation technicians who will need to be knowledgeable about a range of instruments and platforms and how to install, maintain and operate them in often harsh, remote ocean environments.

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[4] http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/

MATE Center Focuses its Efforts in Eight Major Areas:

1. Supporting institutions interested in developing or improving ocean technology-related programs.
2. Assessing workforce needs and developing knowledge and skill guidelines for new and emerging occupations.
3. Developing curricula in the areas of submersible technology, marine data collection including real-time data (ocean observing systems), marine geospatial technology, and career awareness.
4. Offering professional development for high school, college, and university faculty that focus on a broad array of marine technologies, workplace skills, and pedagogical innovations.
5. Conducting regional and international underwater robotics (ROVs) competitions to increase students' learning experiences and build academic and employer partnerships.
6. Improving student preparation for the workplace through at-sea and shore-based technical internships.
7. Disseminating MATE products, including curricula, textbooks, occupational guidelines, competencies, and process guides (internship manuals, survey materials, etc.) both in traditional formats and electronically though the Center's web site.
8. Disseminating up-to-date, comprehensive workforce information via OceanCareers.com (www.oceancareers.com) created in partnership with the Centers for Ocean Sciences Education Excellence (COSEE)

Increasing the diversity of the ocean-related workforce is an overarching goal of the Center's work.

Ocean Drifter Project Provides OOS Workforce Skills

MATE's Ocean Drifter Project illustrates its commitment to helping community colleges and universities meet the demands of the rapidly evolving ocean observing system (OOS) workforce. The project helps high schools, community colleges, and universities develop curriculum and activities that incorporate ocean observing and data collection technologies that are critical to the OOS workforce.

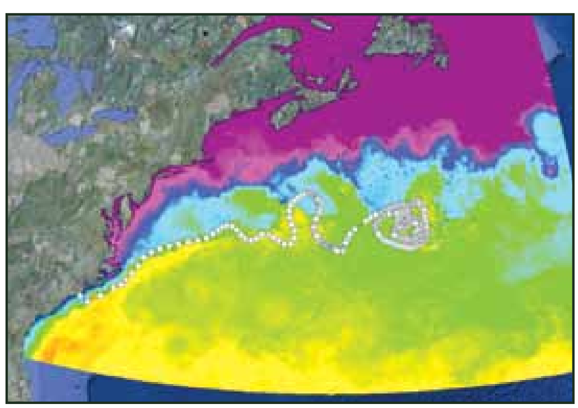

Cape Fear Community College

Students from Cape Fear Community College of Wilmington, NC launch a drifter that collects real-time information about ocean currents.

Ocean drifters are floating platforms equipped with sensors and satellite communication technology that can transmit data on a nearly continuous basis. They provide scientists and the general public with real-time observations relating to ocean properties such as currents and temperature, which have widespread applications in shipping, search and recovery, recreation, and science.

The goal of MATE's Ocean Drifter Project is to incorporate ocean technology, real-time data collection, and data sharing into the curriculum. Faculty participants in the Ocean Drifter Project are given the knowledge and skills necessary to help their students build and deploy ocean drifters and analyze and visualize collected data. This helps students prepare for jobs in the ocean observing workforce, where technical knowledge and skills such as gathering, analyzing, visualizing, and sharing real-time data are essential.

The MATE Ocean Drifter Project was launched in 2009, with funding from NSF and technical assistance from NOAA (NEFSC & SWFSC) and COSEE-NOW (Centers for Ocean Sciences Education Excellence-Networked Ocean World, http://coseenow.net).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The white dots above represent the path Cape Fear Community College's drifter followed in the Gulf Stream (displayed in Google Earth.)

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