New Ocean Technology for Hawaii
A Review of the CEROS Program

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14. ABSTRACT
The National Defense Center of Excellence for Research in Ocean Sciences awards contracts to high-technology firms that propose novel concepts, techniques, and capabilities that support Defense requirements for advanced technology development; promote research and development in ocean sciences and technology in Hawaii; foster the development and use of R&D facilities and infrastructure in Hawaii; serve as an interface between businesses with expertise in ocean-related R&D and Department of Defense users of this expertise; and develop mutually beneficial relationships between firms seeking to expand their ocean sciences expertise and facilities at the University of Hawaii. This program review found that the CEROS program has been a highly successful high-technology incubator and that CEROS projects have produced significant results for DoD. The report recommends actions to build upon CEROS's accomplishments.

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Executive Summary

In September 1992, Congress passed the Supplemental Appropriations, Transfers, and Rescissions Act, which provided for the establishment of the National Defense Center of Excellence for Research in Ocean Sciences (CEROS) for the purposes of

> conducting research and development activities of interest to the Department of Defense on such topics as ocean environment preservation technology, new ship hull design concepts, shallow water surveillance technologies, ocean measurement instrumentation, and the unique properties of the deep ocean environment.[1]

To accomplish its mission, CEROS awards contracts to high-technology firms that propose novel concepts, techniques, and technologies that support Department of Defense (DoD) requirements for advanced technology development; promote research and development (R&D) in ocean science and technology in Hawaii; foster the development and use of R&D facilities and infrastructure in Hawaii; serve as an interface between businesses with expertise in ocean-related R&D and DoD users of this expertise; and develop mutually beneficial relationships between firms seeking to expand their ocean-sciences expertise and facilities at the University of Hawaii.[2]

CEROS operates under the auspices of Hawaii's Natural Energy Laboratory of Hawaii Authority but is funded through cooperative agreements with the Defense Advanced Research Projects Agency. Since its inception in FY93, CEROS has used $54 million to award 140 contracts funding 86 ocean-related technology development projects by commercial firms.

[1] House Resolution 5620, Dire Emergency Supplemental Appropriation Act, Public Law 102-368.

[2] "CEROS Operational Plan," revised February 2002, p. 4.

To assess its progress and the cumulative impact of its program, CEROS asked LMI to evaluate the contribution that CEROS-funded projects have made to the

- ocean-sciences body of knowledge,
- DoD technology base and technical capabilities, and
- Hawaii's technology and commercial-based economic development goals.

LMI interviewed a number of personnel in CEROS, the Navy, and DoD and also reviewed documents and surveyed CEROS contractors. LMI found that CEROS's funding of ocean-related technology projects has produced significant results for DoD, including the following:

- Advanced Real-Time System signal processors (algorithms and hardware boxes) prototyped and tested on attack submarines in Hawaii and then submitted to the Advanced Rapid Commercial Off-the-Shelf Insertion program for insertion in the Navy inventory
- Transition of a data fusion engine to the Commander, Patrol and Reconnaissance Forces, Pacific Task Force (CTF-12), which became the basis for the Web Centric Antisubmarine Warfare Net system that CTF-12 uses for integrated antisubmarine warfare information throughout the Pacific
- Hyperspectral imaging technology that is being adopted by the Navy in one of its littoral systems and has resulted in a $50 million contract award to a CEROS contractor.
- Antisubmarine warfare field processing technologies that utilize Netted Search, Acquisition, and Targeting technology to demonstrate that submarines can use third-party targeting information from communications buoys to increase targeting distance
- Advanced underwater hull designs that are now being used to develop a 180-foot Hybrid Small Waterplane Area Craft
- An electronic charting system that is being used by the Navy to interdict the unauthorized flow of oil from Iraq in the Persian Gulf
- A suite of cable modeling software used for the placement of submarine cables in oceanographic sensors and surveillance systems
- A system to measure cloud height for use aboard ship to improve flight operational safety by enabling the three-dimensional characterization of cloud formations above aircraft carriers.

These results contrast sharply with the technology incubator average of 1,000 good ideas being required to generate one commercial product.

CEROS funding has made important contributions to the ocean-sciences knowledge base and the Hawaiian economy as well. CEROS-funded projects have resulted in 82 patents for the program's contractors. The firms have experienced employment growth attributable to their association with the CEROS program. And of the 38 firms that have received a CEROS contract, 24 reported that, because of CEROS-created opportunities, their revenues increased beyond the value of their initial contracts; 11 of that group experienced revenue increases, and 6 of that group experienced significant revenue increases. Twenty-two of these firms reported an increase in business development opportunities as well, which suggests that CEROS has had a positive effect beyond its own funding.

Every program can be improved, and LMI recommends possible ways for CEROS to build upon the accomplishments of its first 10 years.

First, CEROS should increase product transition opportunities by forging a closer relationship with the Defense acquisition community as a means of accelerating the transition of its products (both Defense-related products and commercial products with possible Defense application) into the DoD acquisition system. A strategy to accomplish that result would require CEROS to

- use a technology broker,
- develop a strategy to identify and fund transition opportunities, and
- broaden the pool of advisors and evaluators.

Second, CEROS should expand the contractor pool to generate more ideas. Because CEROS funds innovation, it is essential that its main source of innovative ideas—Hawaiian firms—continue to grow. To expand the idea pool, CEROS should

- establish a small business set-aside for start-up firms,
- support an intern program in conjunction with the University of Hawaii's School of Ocean and Earth Science and Technology to groom high-tech entrepreneurs, and
- establish a native-Hawaiian-entrepreneur set-aside.

Finally, CEROS should establish a continuous assessment program, using the metrics (employment and revenue growth, patents and scientific publications, and successful transitions into military systems or commercial markets) developed by LMI as part of its review of the CEROS program.

Contents

FIGURES

TABLES

Chapter 1
Introduction

In September 1992, Congress passed Public Law (P.L.) 102-368, the Supplemental Appropriations, Transfers, and Rescissions Act, which provided for the establishment of the National Defense Center of Excellence for Research in Ocean Sciences (CEROS).[1] The statute made available $5,000,000 and directed the Defense Advanced Research Projects Agency (DARPA), working in cooperation with the Hawaii High Technology Development Corporation, to establish CEROS for the purposes of

> conducting research and development activities of interest to the Department of Defense on such topics as ocean environment preservation technology, new ship hull design concepts, shallow water surveillance technologies, ocean measurement instrumentation, and the unique properties of the deep ocean environment.[2]

More specifically, CEROS was established to (1) advance innovation concepts and new approaches to technology, (2) use and leverage facilities and infrastructure in Hawaii, and (3) demonstrate beneficial results and commercial applications germane to Department of Defense (DoD) technical requirements.

In March 2002, the CEROS Research Advisory Board (RAB) recommended an independent management review of the CEROS program to document the technical results and broad-based commercial or economic effects from the CEROS program since its inception. CEROS asked LMI to undertake that review. Specifically, it asked us to evaluate the contribution that CEROS-funded projects have made to the

- ocean-sciences body of knowledge,
- DoD technology base and technical capabilities, and
- Hawaii's technology and commercial-based economic development goals.

APPROACH

LMI's approach to the program review was, first, to analyze the results of the CEROS-funded projects and establish a baseline from which we could make our assessment. Next, we sought to understand how CEROS funding has affected the ocean sciences, DoD, and the state of Hawaii. Last, we evaluated the program

[1] House Resolution 5620, Dire Emergency Supplemental Appropriation Act, P.L. 102-368.
[2] Ibid.

from the obverse perspective; that is, absent CEROS, what innovative concepts, technical capabilities, and commercial developments would not exist?

In conducting our review, we made extensive use of the final technical reports that CEROS has provided to DARPA as a deliverable under its grants and cooperative agreements.[3] These reports briefly summarize the projects funded during the reporting period and contain quantitative and qualitative data detailing scientific significance, residual benefits to Hawaii, and contributions to DoD. To broaden our understanding of the CEROS program, we interviewed DoD personnel, including the CEROS program manager at DARPA, current and former members of the CEROS RAB, Navy personnel, members of the scientific advisory staff assigned to Navy activities in the Pacific, congressional staffers, and Hawaiian governmental officials. In addition, we canvassed all current and past CEROS contractors to learn about their CEROS-funded projects. Specifically, we asked them to assess the impact that CEROS funding has had on their firms and to describe how their CEROS projects contributed to the ocean-sciences knowledge base, DoD, and the state of Hawaii.

Organization of This Report

This report conveys the results of our review. Chapter 2 provides an overview of the CEROS program. Chapter 3 describes the firms that have received funding from CEROS and the cumulative impact of that funding on them and, by extension, on the Hawaiian economy. Chapter 4 highlights some of the projects that CEROS has funded and discusses their impact on DoD and ocean sciences. Chapter 5 contains our conclusions and recommendations. Appendix A lists all CEROS-funded projects, organized by fiscal year. Appendix B lists abbreviations used in this report.

[3] CEROS has received funding through two grants and two cooperative agreements with DARPA.

Chapter 2
Overview of the CEROS Program

Funding novel concepts, techniques, and technologies that further the knowledge and understanding of ocean sciences is at the core of CEROS's mission. That mission is to

- support DoD requirements for advanced technology development,
- promote research and development (R&D) in ocean sciences and technology in Hawaii,
- foster the development and use of R&D facilities and infrastructure in Hawaii,
- serve as an interface between businesses with expertise in ocean-related R&D and DoD users of that expertise, and
- develop mutually beneficial relationships between firms seeking to expand their ocean-sciences expertise and facilities at the University of Hawaii.[1]

The CEROS program promotes technology development and commercial use of ocean research in Hawaii by soliciting proposals from Hawaiian and mainland firms for ocean-related advanced technology projects. CEROS assesses each proposed project's utility to DoD and considers the potential benefits that a contract award may have on private-sector development in Hawaii. CEROS funds projects in ocean research and technology development, especially those that leverage existing capabilities, utilize Hawaiian facilities and infrastructure, address DoD technical requirements and priorities, and increase economic diversity in the state.

Harnessing ocean research facilities in Hawaii for commercial purposes and supporting DoD requirements for ocean-related advanced technologies are not mutually exclusive activities. By meeting the Department's technical requirements, CEROS also advances one of Hawaii's long-term goals—enlarging the technology base of its economy. The attempt to meet those needs pushes CEROS toward funding projects that may yield commercial products while serving DoD mission requirements. In Hawaii, many Defense mission requirements involve support to Navy/Marine forces and help protect Defense command and control at sea. Hawaii is the home base of the United States Pacific Fleet, the Commander of Submarine Fleet Pacific, and the Commander of Antisubmarine Warfare Force, Pacific.

[1] "CEROS Operational Plan," revised February 2002, p. 4.

Since 1993, CEROS has awarded 140 contracts to fund ocean-related technology development efforts by commercial firms. Of particular value have been projects that have a high potential for producing dual-use technology with near-term DoD utility and a high probability of eventually yielding commercial products. For this reason, CEROS does not typically fund basic research projects where the return on investment may be high but not immediate. Nor does CEROS contract directly with colleges or universities; however, it encourages subcontracting arrangements with Hawaiian universities. Because CEROS is designed to foster economic growth in Hawaii's high-technology sector, the program encourages mainland firms in relevant technology sectors to team or form joint ventures with Hawaiian firms or to establish a Hawaiian division and conduct business through that office.

In the following sections, we describe how CEROS accomplishes its mission. We begin by explaining CEROS's relationship with DARPA and the Natural Energy Laboratory of Hawaii Authority (NELHA). Next, we describe CEROS's core program—the five major research areas for which CEROS solicits proposals and funds projects—and its outreach program. We then briefly address program funding and staffing. Finally, we explain the process that CEROS uses to make its award decisions.

CEROS'S RELATIONSHIP WITH DARPA AND NELHA

CEROS operates under the auspices of NELHA—a center for R&D of natural alternative energy sources. CEROS's current operational plan describes its relationship with NELHA as "CEROS is a project of the NELHA funded through grants from DARPA."[2] NELHA is an 870-acre facility at Keahole Point on the Big Island of Hawaii that, among other scientific endeavors, operates several deep-water pipelines to pump deep seawater to the surface, where it is available for mariculture experiments. CEROS is headquartered on the NELHA campus, where it has funded several projects that utilize this unique facility.

NELHA's Board of Directors advises CEROS and works with its technical director to ensure that CEROS's policies advance innovative concepts in ocean research and demonstrate beneficial results that are germane to DoD's maritime mission and to the development of the high-technology sector in Hawaii. As the federal resource sponsor, DARPA provides similar guidance to ensure that CEROS meets its program objectives. Several times each fiscal year, DARPA program officers meet with CEROS officials to review technical and administrative progress and discuss future program activities. DARPA actively participates in the technical program reviews, which include project presentations, site visits, and reviews of grant funding activities. DARPA personnel also participate in the formulation of the CEROS core program.

[2] Since the time of this description, cooperative agreements have replaced grants as the vehicle for funding CEROS through DARPA. The cooperative agreements and, previously, the grants, are executed between DARPA and NELHA.

CEROS CORE PROGRAM

In accordance with P.L. 102-368, CEROS solicits proposals in five broad research areas that constitute the CEROS core program:

- Shallow Water Surveillance Technologies
- Ocean Environmental Preservation
- New Ocean Platform and Ship Concepts
- Ocean Instruments and Engineering Tools
- Unique Properties of the Deep Ocean Environment.

The area of Shallow Water Surveillance Technologies addresses many topics of interest to DoD, including antisubmarine warfare (ASW); mine identification, classification, and countermeasures; sensor and signal processing applications; and techniques for exploiting shallow-water environmental conditions for Defense applications.

Ocean Environmental Preservation spans the gamut from environmental monitoring to remediation. Given Hawaii's natural endowments and its large naval presence, projects funded in this category are important for both the state and DoD.

The New Ocean Platform and Ship Concepts category encompasses naval architecture topics that have both Defense and commercial applications. Those topics include fast ship design, new hull structure and propulsion designs, and modeling and simulation techniques to support those activities.

Ocean Instruments and Engineering Tools addresses such topics as geophysical sensors and survey techniques; ocean systems modeling; nondestructive testing in a marine environment; and deep-sea facility installation, maintenance, and repair.

The category of Unique Properties of the Deep Ocean Environment attracts proposals to identify, extract, and test unique products and materials related to that environment and to deep-sea energy and fuel production, among other topics.

CEROS OUTREACH PROGRAM

CEROS amplifies the impact of its core program by conducting technical outreach activities and fostering information exchange among CEROS contractors, DARPA, Navy personnel, and state officials. The intent of the outreach program is to ensure that the contractor community is aware of DoD's priorities and technical problems that may be appropriate for CEROS funding. In addition, outreach informs the public of CEROS opportunities and contributions to ocean-sciences research.

Outreach performed by CEROS personnel includes the following:

- Technology workshops and conferences
- A quarterly newsletter disseminating core program developments, project results, and other CEROS-related business
- Conferences and sponsored assemblies in which DARPA, Navy science and technology advisors, Hawaiian ocean technology business leaders, and state representatives have an opportunity to describe issues of mutual interest
- Workshops on proposal writing, report preparation, and presentation skills geared toward strengthening the competition process for contractor abstracts and proposals
- Presolicitation industry briefings to inform the contractor community regarding the scope, direction, and size of future CEROS solicitations.

CEROS FUNDING

The Congress annually appropriates funds to DARPA for CEROS. DARPA initially used grants to fund the program but shifted in 1997 to a cooperative agreement vehicle. The first grant, executed in February 1993, established CEROS and funded 11 contracts with a combined value of $5,070,000. The second grant funded 39 contracts and expired in June 1999. During the performance period, DARPA's funding of that grant totaled $18,737,796. The first cooperative agreement between DARPA and CEROS funded 66 ocean technology contracts totaling $26,726,676.[3] The organizations executed a new cooperative agreement in May 2002.

Table 2-1 itemizes CEROS contract funding by fiscal year.

[3] "CEROS Operational Plan," revised February 2002, p. 3.

Table 2-1. CEROS Funding

Fiscal year	Funding ($)	Contracts awarded
1993	4,496,887[a]	11
1994	5,939,919	16
1995	5,634,768	11
1996	5,445,811	12
1997	5,779,261	16
1998	6,347,637	19
1999	6,201,191	15
2000	6,441,440	16
2001	4,539,611	14
2002	3,825,897	10
Total	54,652,422	140

[a] Includes $246,324 paid for a project that CEROS cancelled.

Over time, the program's funding levels have been relatively steady. Since its funding is subject to the uncertainties of the annual appropriation process, CEROS does not guarantee that outyear funds will be available. CEROS procurement practices address this uncertainty by typically selecting research projects that produce results within 6 to 12 months. However, CEROS's internal procurement regulations recognize that certain projects may require more than one funding cycle to produce results. CEROS may accept future funding requirements without competitive evaluation, if outyear funds are available.

CEROS STAFFING

The CEROS administrative costs are low overall, with just under $4,000,000 spent on operating expenses from 1993 to 2000.[4] A staff of four full-time employees operates the CEROS program. The CEROS Technical Director has overall program management responsibility, develops the core program, and is the interface with state and federal authorities. The technical director's staff includes a contracts and grants administrator, a manager for outreach and administration, and a fiscal assistant. The contracts and grants administrator manages CEROS's contracting activities and ensures compliance with the cooperative agreement's provisions. The manager for outreach and administration oversees CEROS's outreach activities and ensures compliance with state regulations. The fiscal assistant supports the program's financial activities.

[4] Ibid., p. 25.

CEROS Procurement Process

The annual CEROS proposal cycle commences with an industry briefing that CEROS hosts in early September. At that meeting, CEROS presents a program overview, and DoD officials brief attendees regarding the Department's technical requirements and research priorities. In early October, CEROS publishes a broad agency announcement (BAA) to communicate its requirements and solicit proposals. The BAA outlines a two-step proposal-submission process. First, CEROS asks firms to submit abstracts—short descriptions of project proposals—which are due by mid-November. In mid-December, CEROS solicits full research proposals from those firms whose abstracts were deemed best qualified. Proposals are due by late January, and contracts are awarded in late March.

Industry Briefing

The industry briefing serves several purposes. CEROS uses it to inform attendees about the scope, size, and direction of its program as defined in the upcoming BAA, to apprise them of the abstract and proposal submission schedule and other solicitation-related requirements, and to notify them of any changes in the CEROS core program. More important, the industry briefing is a forum where DoD personnel have an opportunity to discuss the technical problems and priorities that they would like addressed through CEROS funding. These insights enable offerors to direct their proposals toward technical areas of interest to DoD and value to the CEROS program. Furthermore, this information is invaluable market research data for the contractor community.

Broad Agency Announcement

The BAA defines the core program, outlines the proposal process, and describes the CEROS evaluation procedures. The BAA states that contract awards are contingent upon proposal merit and funding availability. CEROS funds projects with a base performance period of 6 to 12 months. Firms may propose follow-on options that effectively extend the project's performance period for an additional 12 months. However, as noted above, CEROS operates on an annual appropriation and cannot guarantee follow-on funding.

Proposal Process

Annually, the proposal process begins with the submission of five-page abstracts that provide an overview of proposed projects and their associated costs. CEROS evaluates the abstracts and invites those firms whose ideas it deems best qualified for funding to submit full technical and cost proposals. Because of the page limitation, developing a compelling abstract is challenging; however, the BAA provides guidance.

Aside from supporting the CEROS core program and addressing company qualifications and technology transfer plans, responsive abstracts and proposals must contain five sections:

- Technical rationale—describes the technical problem and how it benefits DoD and Hawaii
- Technical objective—states the intended results and project deliverables, and addresses any anticipated technical innovations
- Technical approach—outlines the project plan and milestones, as well as addresses technical risk and a mitigation plan
- Expected results or products—discusses the expected application of the results, especially in relation to Defense needs and ocean technology development in Hawaii; plans for follow-on developments, and possible transition to commercial application
- Project budget—estimates the project costs; CEROS awards firm-fixed-price contracts, so accurate cost estimates are essential.

As noted previously, CEROS invites full technical and cost proposals from those contractors whose abstracts represent the best value. Not all proposal submissions are funded; however, it is CEROS's policy to request proposals only from contractors whose abstracts meet the funding threshold. This two-tier approach is beneficial for several reasons. First, it minimizes offerors' investment in the proposal development process. Second, it allows CEROS to develop its annual core program from a pool of strong candidates. Finally, by evaluating the best of the annual submissions, CEROS minimizes the administrative costs associated with the proposal evaluation process.

An offeror's proposal should develop its abstract further. CEROS requires the offeror, aside from expanding upon the proposed project's technical merits and objectives, to elaborate on how the proposed effort would serve the business objectives of the firm and support any future business strategy for commercialization or dual use of the project output. In addition, the proposal must explain the project's relevance to DoD technical requirements and programs, as well as identify the residual benefits that would accrue to Hawaii.

Evaluation Criteria

CEROS applies the same evaluation criteria to abstracts and proposals, funding only those that it determines represent the best value to the government. It weighs all evaluation criteria equally except for quality, which receives a double weight. In assessing quality, CEROS evaluates the proposals with respect to their scientific and technical merits. Evaluators expect compelling arguments addressing the technical importance of the proposed effort and results, the relevance to DoD's

technical needs, and the economic benefits that would accrue to Hawaii if CEROS were to fund the project. Of equal importance to one another, but of lesser importance than quality to the evaluation, are the following criteria:

- Approach and capabilities—whether the qualifications of the project team and technical approach suggest a reasonable likelihood of success
- Anticipated benefits—whether the proposed effort has great potential return for DoD and Hawaii and would contribute to the offeror's business development plans and goals, and whether the offeror has developed a transition plan that addresses the project's future commercial potential
- Cost and budget—whether the project's budget is realistic and leverages cost-savings opportunities where practicable.

Other evaluation factors that CEROS may consider include technical innovation, use of Hawaiian facilities, beneficial economic impact on Hawaii, potential for eventual commercialization, likelihood of follow-on DoD funding, use of University of Hawaii resources, and likelihood that a final result or product will be achieved.

Source Selection

The CEROS Technical Director is the source selection authority (SSA) responsible for protecting the integrity of the solicitation process. The SSA ensures that the evaluation criteria, solicitation requirements, BAA, and other related documents are consistent and reflect a core program that supports the CEROS mission. Having overall responsibility for the source selection process, the SSA makes sure that a technically competent team is available to evaluate the abstracts and subsequent proposals. After the proposal evaluation process is completed, the SSA selects those that represent the best value, conducts any contract negotiations, and awards the contracts.

The CEROS RAB oversees the evaluation process and plays a significant role in the composition of the annual core program. The RAB is a six-member board of distinguished scientists, retired military personnel, and members of the technical community. It sets the proposal evaluation criteria and procedures and determines the composition of the CEROS core program through project selection. Ad hoc technical experts (evaluators) assist the RAB with the evaluation of the technical proposals. Usually, these evaluators are associated with government organizations such as DARPA, the Office of Naval Research, the federal laboratories, the University of Hawaii, and DoD commands in Hawaii or the mainland, and they have professional credentials in Defense-related research, development, testing, and evaluation efforts.

The evaluators base their decision on a 20-point scale. The evaluation instructions provided by the SSA define the five possible ratings—excellent, very good, good,

adequate, and poor. Proposals with scores of 17 to 20 receive an "excellent" rating, and those with scores of 13 to 16 receive a rating of "very good." Since CEROS invites full proposals only from those offerors whose abstracts received high scores, the core program represents the best of the pool of projects that are worthy of funding based on the criteria established by CEROS and its founding legislation. Once the evaluations are complete, the RAB, with DARPA's assistance, makes its recommendations—prioritized by funding preference—to the SSA. Because CEROS source selection procedures maximize flexibility, the RAB may identify specific proposals for full funding and others for funding only if additional funds become available. The SSA makes the final selections and forwards them to the NELHA Board of Directors, requesting approval to enter into contract negotiations with the finalists.

SUMMARY

The overarching goal of the CEROS program is to solicit and fund projects that develop advanced ocean technology, have possible Defense application, and promote the development of a self-sustaining, technology-based economy in Hawaii. The program undertakes this mission possessing significant advantages: (1) its proximity to the United States Pacific Fleet, (2) its location at NELHA—one of the premier Pacific Ocean research facilities, and (3) a supportive state government dedicated to diversifying the Hawaiian economy. As discussed in the next several chapters, CEROS has utilized these resources to maximize the contributions the program is making. It has funded dozens of projects that leverage these resources, creating jobs and expanding the ocean-sciences knowledge base.

Chapter 3
CEROS Contractors

For the analysis presented in this and subsequent chapters, LMI developed a questionnaire and sent it to the 38 firms that have contracted with CEROS since the program's inception.[1] Of those firms, 33 responded, giving us an 87 percent response rate. The questionnaire asked the firms to provide demographic data and project-specific information addressing the impact that their projects had on DoD, Hawaii, and the ocean sciences. Table 3-1 identifies the 38 firms that received the LMI questionnaire.

Table 3-1. CEROS Contractors

Firm	Contract awards	CEROS funding ($)
Aquaculture Technologies	3	818,445
Band, Lavis and Associates	1	225,483
BBNT Solutions	4	3,712,256
Black Pearls	3	432,690
Cox Environmental Systems	1	215,004
CTA	1	385,794
Detection Limit Technology	7	2,418,437
Dynamic Technologies	1	98,239
Edward K. Noda and Associates	2	396,274
Gateway Technologies International	2	490,920
Guidenet	3	1,062,050
IBM Federal Systems	1	432,000
Innovations Hawaii	2	418,288
Innovative Technical Solutions	1	34,953
Makai Ocean Engineering	9	3,321,194
Mission Research	1	381,000
Neptune Technologies	2	239,300
Nextwave Engineering	1	75,700
Ocean Engineering Consultants	4	615,326

[1] Similar to the recent experience of other segments of the Defense industrial base, there has been some consolidation among the CEROS contractors.

Table 3-1. CEROS Contractors (Continued)

Firm	Contract awards	CEROS funding ($)
Ocean Imaging Consultants	2	515,134
Oceanic Institute	1	216,766
Oceanit Laboratories	5	1,344,190
Oceantek	1	188,000
Oceantronics	1	393,000
Orincon Hawaii	19	10,479,971
Pacific Environmental Technologies	2	313,607
Pacific Marine and Supply[a]	8	4,713,700
Raytheon[b]	6	4,375,954
SAIC	3	1,816,192
Science and Technology International[c]	12	6,133,309
Scientific Solutions	2	600,392
Sea Engineering	8	2,041,821
See/Rescue	3	235,007
Structural Solutions[d]	10	2,748,450
Synthetic Technologies	3	781,641
Thermal Energy Storage	1	250,000
Trex Enterprises	2	1,036,826
Varian Associates	2	695,109
Total	140	54,652,422

[a] Includes one contract awarded to Navatec.

[b] Includes three contracts awarded to Alliant Techsystems.

[c] Includes five contracts awarded to TerraSystems and one awarded to SETS Technology.

[d] Includes three contracts awarded to Knapp Engineering.

The CEROS contractors are a diverse group of firms that specialize in technically complex areas related to the CEROS core program. Four of the 33 firms that responded to our questionnaire described themselves as active in the commercial market, and 11 indicated that they were active only in the government marketplace. Eighteen others divided their efforts between the two. These firms sell products and services in diverse segments of the technology marketplace. There are firms that sell marine-based biotechnology, biophotonics, environmental and industrial technologies, opto-mechanical technology, ocean engineering products and software, military-approved rescue technology, advanced materials, sensors, acoustic and vibration modeling, remote autonomous systems, ocean modeling sonar system development, and other areas too numerous to mention.

Twenty-eight of the 38 CEROS contractors are headquartered in Hawaii, four in California, two each in Massachusetts and Virginia, and one each in Colorado and

Maryland. Location is important because of CEROS's mission focus on Hawaii. Funding of projects from Hawaiian firms directly supports economic activity in the state and provides employment for Hawaiian scientists and engineers. Out-of-state firms that have received contract awards from CEROS typically engage Hawaiian firms as subcontractors or utilize facilities associated with organizations such as the University of Hawaii and NELHA. Table 3-2 distributes the CEROS contractors by state.

Table 3-2. Distribution of CEROS Contractors by State

State	Number of contractors	Contract awards	Funding received ($)
Hawaii	28	121	44,192,832
California	4	5	1,424,348
Massachusetts	2	8	6,175,773
Virginia	2	4	2,248,192
Maryland	1	1	225,483
Colorado	1	1	385,794

In the sections below, we describe the size, employment levels, and revenue levels of the firms that have received CEROS funding; we then address the effect that CEROS funding has had on the firms. We contend that if CEROS benefits the contractors receiving funding, then, by extension, it meets the requirements of P.L. 102-368 by benefiting the Hawaiian economy and its high-technology industries as well. In other words, employment growth, revenue growth, and the expansion of business opportunities have lasting benefit to the Hawaiian economy, DoD, and the continued development of the ocean-sciences technology base in Hawaii.

SIZE OF CEROS CONTRACTORS

Of the 33 respondents to our questionnaire, 28—or 85 percent—defined themselves as small businesses. Table 3-3 shows the number of small businesses that have received awards from CEROS. Nine of these firms have fewer than six employees; that figure includes three firms that are single-employee companies. Six firms range in size from 6 to 10 employees, five firms have between 11 and 20, three have between 21 and 30, and five firms have more than 30. Not shown in the table are the four large firms that have received CEROS funding. (One of the 33 respondents did not disclose its size.)

Table 3-3. Small Businesses Receiving CEROS Funding

Firm size	Number of firms	Contract awards	Funding received ($)
5 or fewer employees	9	22	4,884,984
6 to 10 employees	6	28	6,902,245
11 to 20 employees	5	10	2,790,616
21 to 30 employees	3	35	18,158,865
More than 30 employees	5	15	7,042,843

The smallest firms (those with five or fewer employees) have received substantial funding given their size, with an average contract award of $222,045. Because CEROS contractors use contract funds to purchase project equipment, a precise reckoning of the impact that this funding has on them is difficult. Nonetheless, the impact that a sizable contract award has on a small firm—sustaining it during slow periods, contributing revenue, and increasing its opportunities to invest in its intellectual capital and additional capabilities—is undeniably significant. As one of the one-person firms noted, "The firm first began with a CEROS grant and that helped [with] getting additional funding to continue R&D funds for software development."[2]

This comment underscores an important contribution that CEROS makes to the development of high-technology firms in Hawaii. Unlike most federal and state agencies that award contracts or grants, CEROS will fund a start-up firm that shows potential but lacks strong past performance qualifications. Indeed, its procurement policies encourage such firms to submit abstracts for evaluation.[3] Because relevant past performance is not a barrier to participation, start-up firms have an opportunity to compete for and receive CEROS funding; three companies reported receiving their first contracts from CEROS. Given that one of its core functions is to foster the development of the high-technology base in the Hawaiian economy, awarding contracts to start-ups is an effective strategy and essential for the development of a vibrant technology base in the state.

EMPLOYMENT LEVELS AMONG CEROS CONTRACTORS

Most CEROS contractors participate in niche sectors of the economy where revenue-enhancing opportunities either are small or have not yet been developed.[4]

[2] CEROS questionnaire respondent.

[3] Underpinning the past performance requirement is a need to protect the government's interests from firms that lack the experience to perform effectively. To date, only one former CEROS contractor has failed in business.

[4] Certain CEROS-funded projects may generate technologies or products that are so innovative that no market exists to absorb them.

For that reason, we expect that employment growth among CEROS firms will be low but the impact of a CEROS contract on these firms will be high. Given that the majority of them do not have scale or market reach, a CEROS contract award represents a significant opportunity that, at a minimum, either provides continued employment for existing personnel, creates a hiring requirement, or necessitates the hiring of a subcontractor or consultant.

In determining the impact of CEROS funding on participating contractors' employment levels, LMI asked them if they hired additional employees because of their CEROS contracts and if they still employ those individuals. To help verify any affirmative results, we requested that each contractor complete an employment-history matrix consisting of 10 rows, one for each year between 1993 and 2002, and two columns, one for the number of permanent professionals employed by the firm and one for permanent administrative employees. Using this two-pronged approach enabled us to test the veracity of the responses and measure the health of these firms—employment trending upward being a positive indicator.

Eleven firms stated that their CEROS contracts did not cause employment growth, and 22 firms—or 66 percent—reported that their CEROS contracts did cause employment growth.[5] One firm's response to the question regarding employment growth illustrates how CEROS funding affects this area: "Yes, employment levels increased, directly and indirectly, because of relationships with CEROS. CEROS funding promoted sustainable lines of R&D through which expanded technical support is needed."[6]

To provide an upper bound on CEROS-related job growth, we used the results from the 22 firms that indicated that their association with CEROS caused employment growth. From that group, we eliminated two firms that reported that the positions resulting from their CEROS work no longer exist.[7] Utilizing the employment history matrix, we subtracted the current-year's employment total from 1993's to generate a delta for each firm. The results are as follows:

- Three firms lost between 1 and 4 positions, for a total of 6 employees.
- Six companies experienced stability—no growth.
- Five firms hired between 1 and 4 new employees, for a total of 19.
- Six firms hired between 7 and 46, for 109 new employees.

In sum, the employment growth experienced by the CEROS contractors totaled 122 professional positions. These positions represent an upper bound for em-

[5] Four of the 11 firms that responded negatively are large businesses (e.g., Raytheon and SAIC) with enormous in-house staffs available to work on these projects. It is unlikely that the relatively small size of a CEROS contract award would cause them to hire additional staff.

[6] CEROS questionnaire respondent.

[7] These firms still showed upward trending employment growth totaling 10 positions.

ployment growth related to CEROS. CEROS funding caused some portion of that growth, but precisely how much cannot be determined. Employment growth among CEROS contractors benefits these firms and, by extension, Hawaii. Projects funded in CEROS's core program afford them employment and a chance to pursue follow-on business opportunities.

REVENUE LEVELS AMONG CEROS CONTRACTORS

To assess the effect that CEROS funding had on revenue growth among the CEROS contractors, LMI asked them if their annual revenues increased because of their relationship with CEROS. Twenty-four of the 32 firms—or 75 percent—indicated that CEROS increased their revenue base.[8] Eight of the 32 firms indicated that CEROS funding did *not* cause an increase in their revenues. Five of those 8 firms reported annual revenues in excess of $5,000,000, and the remaining three firms indicated that their revenues had increased, but they did not attribute that increase to their association with the CEROS program. Since a CEROS contract award would increase a firm's revenues, it is not surprising that most CEROS contractors reported that result.

To examine the effects of CEROS funding more closely, LMI asked if the firms expanded their business bases and received follow-on contracts related to their CEROS-funded projects, but from other organizations. Of the 24 firms that reported that CEROS increased their revenues, 20 indicated that their business bases expanded because of their CEROS association. Twenty-two firms reported that they had received follow-on contracts from other organizations related to their CEROS-funded projects. These results suggest that CEROS funding contributed to revenue growth and led to business expansion beyond the value of the initial CEROS contracts.

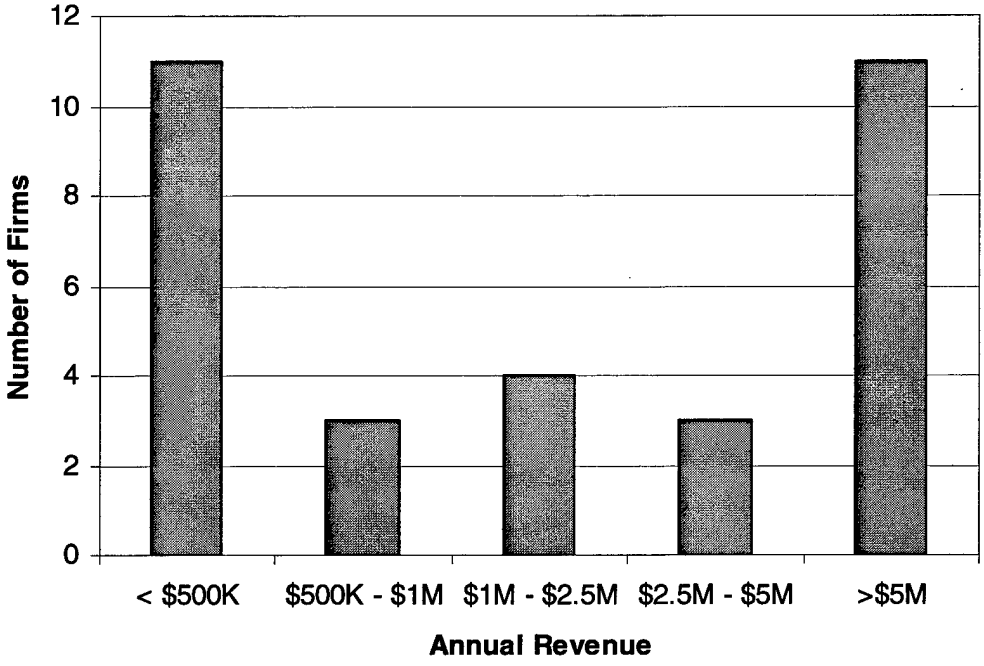
In addition, we asked the firms to complete a matrix that arrayed revenue by fiscal year over the 10-year period. To prevent the possible release of business-sensitive information, we requested annual revenue information in the following increments:

- Less than $500,000
- Between $500,000 and $1,000,000
- Between $1,000,000 and $2,500,000
- Between $2,500,000 and $5,000,000
- Greater than $5,000,000.

[8] One of our 33 respondents reported growth but would not disclose revenue information.

Figure 3-1 categorizes the 32 firms that provided annual revenue increment information.

Figure 3-1. Annual Revenue of 32 CEROS Contractors in 2002



To provide an indication of how much revenues increased among the CEROS contractors, we used the matrix that arrayed revenue by fiscal year over the 10-year period to calculate the increase in revenues in 2002 compared with 1993 or the earliest year for which the company reported this information. We analyzed the 20 firms that reported that their revenues and business bases increased because of their CEROS association. In that group, 11 of 20 showed revenue enhancement, while 9 remained in their respective revenue increment. Of the 11, 6 firms exhibited substantial revenue growth by jumping over at least one revenue increment. For example, one firm reported increased revenue from less than $500,000 to between $2,500,000 and $5,000,000. Table 3-4 shows the results of this analysis.

Table 3-4. Change in Revenue Categories Among CEROS Contractors

Number of firms	Change in revenue category
8	Remained in the less than $500,000 increment
3	Increased revenues from less than $500,000 to between $500,000 and $1,000,000
1	Increased revenues from less than $500,000 to between $1,000,000 and $2,500,000
1	Increased revenues from less than $500,000 to between $2,500,000 and $5,000,000
1	Increased revenues from between $500,000 and $1,000,000 to between $1,000,000 and $2,500,000
1	Increased revenues from between $500,000 and $1,000,000 to between $2,500,000 and $5,000,000
1	Increased revenues from between $500,000 and $1,000,000 to more than $5,000,000
1	Increased revenues from between $1,000,000 and $2,500,000 to between $2,500,000 and $5,000,000
2	Increased revenues from between $1,000,000 and $2,500,000 to more than $5,000,000
1	Remained in the more than $5,000,000 increment

These data alone cannot be used to isolate the effect of CEROS funding on company revenues; other factors may have led to revenue growth among these firms. However, the facts that 20 firms reported that CEROS increased both their revenues and business bases and that 22 firms reported follow-on contracts related to their CEROS projects indicate that CEROS funding had a positive effect.

Examining results for firms that did not receive follow-on contracts also suggests that, for some, CEROS had positive effects. Nine firms responded that they did not receive follow-on contract awards based on their CEROS contract awards.[9] Inspecting other data gathered on these nine firms did not reveal any obvious explanation. Most participated in both the government and commercial marketplaces, all were small, and most were located in Hawaii. However, evaluating their projects provides some insight.

One firm used the funding to reposition away from engineering services to become a developer of commercial off-the-shelf (COTS) software products; that firm no longer depends on the contracting market. Several firms are in market niches (for example, human reintroduction into the marine environment and survival technology) that are not likely to generate extensive federal or state contracting requirements. Business opportunities may emerge from the commercial exploitation of these products but have not done so yet. The others' projects sim-

[9] Two firms did not respond to questions regarding business impact.

ply did not produce follow-on business—a result that contractors recognize as a cost of doing business.

SUMMARY

In this chapter, we have summarized the employment, revenue, and business development experiences of 33 of the 38 firms that have received funding from CEROS. These firms are mostly small, Hawaiian-based, for-profit companies that develop products and services in the ocean-sciences-related high-technology sector of the Hawaiian economy. For CEROS to be one engine of growth for high-technology industry in the state, awarding contracts to firms in this demographic is essential.

During and because of their association with CEROS, these firms experienced employment stability and even growth, and some are now well situated on a business-growth trajectory. Increases in firm revenues and business opportunities reinforce this observation. Twenty-four firms reported that because of CEROS-created opportunities, their revenues increased, and 11 of that group experienced revenue increases. Not surprisingly, these firms reported an increase in business development opportunities as well.

Chapter 4
CEROS Projects

Since 1993, CEROS has awarded 140 contracts to fund 86 ocean-related technology development efforts by commercial firms.[1] Optimally, CEROS projects achieve three distinct outcomes. They yield a product or service of value to DoD, they foster the development of the high-technology sector of the Hawaiian economy, and they contribute to the ocean-sciences knowledge base. In this chapter, we describe the degree to which the CEROS-funded projects have supported DoD and have contributed to our knowledge of ocean sciences in areas that may benefit or be of interest to DoD.[2] Ultimately, our objective was to gauge program success. An assessment of the success of the CEROS projects is important because funding projects to promote technology development efforts may be more of an art than a science. The disastrous deployment of venture capital during the 1990s Internet boom makes that abundantly clear.

A straightforward measure of success is how many projects produced results that DoD uses (or have commercial potential that may also benefit DoD). Shallow Water Surveillance Technologies is the core research area in which CEROS has funded many projects that directly benefit the Department. The Submarine Electronic Charting System project exemplifies the type of product developed to support a naval mission undertaken in this area. However, successful projects in the core program do not always produce such tangible results. Frequently, they produce intermediate results or analyses that later can be applied to a different problem. A good example of this type of project is HYDROFIST: A Non-Explosive Means for Generating Intense and Focused Underwater Shock Waves; the results of that project may be employed later by naval architects to design ships capable of withstanding greater percussive shockwaves or as a countermeasure against enemy torpedoes and mines.

Looking for tangible outputs with direct Defense application is an entirely inadequate metric for core research areas such as Ocean Environmental Preservation and Unique Properties of the Deep Ocean Environment. Projects in those areas tend not to have an immediate Defense application because they address broader scientific interests. However, that does not mean that the projects do not benefit the Department. For example, the projects to develop naturally occurring antibiotics from algae and ocean thermal energy conversion—exploiting ocean water temperature differentials to generate electric current—are representative of non-mission-critical Defense applications; their merits should not be measured strictly

[1] Appendix A lists all CEROS-funded projects, organized by fiscal year.

[2] LMI's questionnaire asked CEROS contractors to detail the economic, Defense-related, and technological impact of each CEROS-funded project. We interviewed Defense and Hawaiian officials to verify the results.

by their rapid transition to the Defense environment, but rather by their contribution to less mission-critical Defense goals.[3] The CEROS statute underscores this point by directing that the CEROS program fund projects of interest to the Defense Department. Given the breadth of its activities, alternative energy sources and pollution remediation techniques are two of many non-mission-critical areas in which DoD has an interest. Quite appropriately, CEROS evaluates these projects by measuring their commercial prospects, addressing their potential utility in the Defense arena, and looking to their expected contribution to the ocean-sciences body of knowledge.

We begin our review of CEROS projects with a short description of CEROS's five core research areas. We then describe each area in more detail; we highlight salient results, address contributions to the ocean-sciences knowledge base, and touch on promising commercial or Defense prospects.

OVERVIEW OF CORE RESEARCH AREAS

As stated above, since 1993, the CEROS program has awarded 140 contracts to fund 86 projects in its five core research areas. In selecting projects for funding, the CEROS evaluators weigh the proposals against selection criteria designed to ensure that the resulting projects are relevant to Defense needs and contribute to ocean-sciences technology development in Hawaii.

Although CEROS evaluates all abstracts and proposals employing the same process, the CEROS contractors use a variety of channels as sources for their project proposals.[4] Some firms actively canvass the military presence in Hawaii to develop an understanding of their technical problems. Armed with that information, these firms create new products that already have a Defense customer. Another group of firms uses a similar technique to identify project ideas or product enhancements that extend the capabilities of existing systems; these firms act as integrators. A third group proposes ideas that generate new products that have near-term commercial market potential. A fourth group proposes technology demonstration projects to CEROS, in effect using it as a funding source for proof-of-concept demonstrations. Finally, some project proposals arrive at CEROS through Defense sources. Frequently, they address a unique aspect of the local environment that is germane to the CEROS program. Table 4-1 summarizes project activity in the CEROS core program based on these source selection decisions.

[3] Transitioning technology bedevils even the large contractors. For small firms like most of the CEROS contractors, the prospects for a successful transference of non-mission-critical technology into a Defense application are daunting. That CEROS-funded projects have successfully transitioned is eloquent testimony to their quality.

[4] CEROS questionnaire responses.

Table 4-1. Distribution of Projects in the CEROS Core Program

Core research area	Projects	Contract awards	Professional hires	Patents
Shallow Water Surveillance Technologies	38	58	83	36
Ocean Environmental Preservation	15	21	3	13
New Ocean Platform and Ship Concepts	7	18	14	8
Ocean Instruments and Engineering Tools	20	34	16	20
Unique Properties of the Deep Ocean Environment	6	9	6	5
Total	86	140	122	82

CEROS contractors reported that their CEROS-funded projects have generated 82 patents and led to increased employment, as Table 4-1 indicates. Furthermore, these results reinforce the impression that the CEROS source selection procedures generate a core program that contributes to ocean sciences. We highlight some of these projects in the following sections.

SHALLOW WATER SURVEILLANCE TECHNOLOGIES

CEROS has awarded 58 contracts to fund 38 projects in the Shallow Water Surveillance Technologies research area—more than in any other area. In this area, CEROS funds projects that support ASW; mine identification, classification, and countermeasures; sensor and signal processing applications; and techniques for exploiting shallow-water environmental conditions for Defense applications. A brief summary highlighting some of the CEROS project accomplishments in this area follows:[5]

- Several projects utilizing hyperspectral-imaging techniques (imaging all colors simultaneously) have shown impressive results. Hyperspectral imaging leverages the unique electromagnetic signatures that all objects emit at an optimal resolution for detection, discrimination, and material identification purposes. These projects have numerous Defense applications, ranging from ASW to mine detection. Follow-on projects applied these results to an airborne platform to increase high-speed, wide-area surveillance capabilities. The Navy is adopting this technology in one of it littoral systems, which has resulted in a $50,000,000 contract for the CEROS contractor involved in their development.

[5] For more complete project summaries, see "CEROS Final Technical Report Grant No. MDA972-93-1-0008," September 1998, and "CEROS Final Technical Report Grant No. MDA972-94-1-0010," September 1999. DARPA requires a final project summary from CEROS at the end of each grant or cooperative agreement. A summary detailing the project activity under the first cooperative agreement will be developed soon.

- A second series of projects exploited hyperspectral imaging further by combining it with laser-imaging radar to create a superior, shallow-water mine and pollution detection device.

- Several different projects were undertaken to mimic the echolocation abilities of marine mammals using signal-processing algorithms and computer-based neural networks; these were followed by projects to advance the state-of-the-art in real-time signal processing to upgrade the sonar signal and information processing system that is used to automatically detect and classify threat submarine acoustic signatures. These projects took advantage of an intern program to tap University of Hawaii engineering, mathematics, and computer science students, providing them with training opportunities in signal and information processing techniques. A culminating project in this area harnessed signal processing techniques to create an all-source data fusion, localization, and tracking-of-targets system for the Navy's ASW program.

- A different series of projects demonstrated the efficacy of field processing technologies combined with Netted Search, Acquisition, and Targeting (NetSAT) technology to support ASW concepts in a net-centric environment. Utilizing the facilities at the Pacific Missile Range Facility, the projects demonstrated that submarines could use third-party targeting information from communications buoys to increase targeting distance—a critical factor in ASW.

OCEAN ENVIRONMENTAL PRESERVATION

CEROS has awarded 21 contracts to fund 15 projects in the Ocean Environmental Preservation research area.[6] The projects funded support environmental monitoring and remediation. A brief summary of some of the CEROS project accomplishments in this area follows:

- A series of significant projects have developed bottom-penetrating acoustic sensors designed to map the ocean floor. These projects applied synthetic aperture sonar techniques to search for and map the location of unexploded ordinance (UXO). Four publications resulted from these projects, and the University of Hawaii is using this equipment to complete a seabed survey of UXO off the Hawaiian coast.

- A series of pollution detection projects have explored novel ideas and technologies to monitor pesticide contamination and industrial pollution in coastal waters. For example, one project used mullet as free-ranging bio-

[6] Environmental protection and remediation are real concerns for DoD. In addition to federal statutes, DoD must adhere to Hawaii's stringent environmental protection statutes. CEROS projects funded in this category, while not directly tied to a military mission, are important to the Department.

indicators to test the biological uptake of some priority pollutants found in ocean sediments off Hawaii. Other projects developed chemical sensors to monitor the presence, evolution, and hydrological transport of toxic substances such as heavy metals, BTEX (benzene, toluene, ethylbenzene, and xylenes), nitrates, and polychlorinated biphenyls (PCBs) in ocean sediments.

- A third series of projects explored the development of antifouling compounds from organic sources. Ships in port experience bio-fouling—the accretion of organic materials on hulls. Antifouling materials—materials to reduce the accretions—relied on toxic materials that have been removed from the market. CEROS funded research to develop antifouling compounds from organic substances. All shipping (naval and commercial) would benefit from the successful development of this product.

NEW OCEAN PLATFORM AND SHIP CONCEPTS

CEROS has awarded 18 contracts to fund 7 projects in the New Ocean Platform and Ship Concepts research area. The focus in this area is on naval architecture concepts that have both Defense and commercial applications that may serve DoD in the future. Examples include fast ship design, new hull structure and propulsion designs, and modeling and simulation techniques to support these activities. A brief summary of some of the CEROS project accomplishments in this area follows:

- A series of projects supported the design, development, and testing of underwater lifting bodies (mechanisms to lift a ship's hull such that it rides on the ocean's surface) that are used to make a broad range of conventional ship hull forms—monohulls, catamarans, trimarans, small waterplane area ships, and hydrofoil hull forms. These projects led to several important Defense contracts with a combined award amount of $21,000,000. Among them are the conversion of a surface effect ship (SES-200) into a 500-ton, 180-foot Hybrid Small Waterplane Area Craft (HYSWAC)—a large-scale lifting body technology demonstrator. These CEROS-funded projects also led to the development of a commercial, partial-hydrofoil fast ferry that will run between San Diego and Oceanside, CA. These projects generated 13 professional positions for the firm and a technology patent. According to the firm, the CEROS experience "helped us develop invaluable technical and scientific staff depth; helped us grow our company which allowed us to hire more engineers; brought us to the attention of the Navy, and allowed us to demonstrate our competence as a small company that can successfully compete with the major Defense contractors in terms of innovation, quality, and impact on our nation's defense."[7]

[7] CEROS questionnaire respondent.

- CEROS funded a series of small waterplane area twin hull (SWATH) ship software design and development projects. The SWATH design enables a ship to ride smoothly in rough seas, enhancing crew safety and passenger comfort. It has both military and commercial potential. These projects have led to the development of a SWATH ship design and analysis firm in Hawaii. This firm has sold four European SWATH ship designs, and a fifth one is in production. Numerous technical publications have resulted from these projects.

- A series of projects to develop unique survival flotation devices, including one that fits into a shirt pocket, have been made possible by CEROS funding. The projects have both military and commercial applications; patents have been awarded.

OCEAN INSTRUMENTS AND ENGINEERING TOOLS

CEROS has awarded 34 contracts to fund 20 projects in the Ocean Instruments and Engineering Tools research area. CEROS-funded projects in this areas include geophysical sensors and survey techniques; ocean systems modeling; nondestructive testing in a marine environment; and deep-sea facility installation, maintenance, and repair. A brief summary of some of the CEROS project accomplishments in this area follows:

- A suite of cable modeling software has proven very useful to DoD and the scientific and commercial communities for the placement of submarine cables in oceanographic sensor and surveillance systems and telecommunications applications. The modeling software, which is sold commercially, reduces cable design development time and attendant costs. These projects resulted in the publication of three articles and the hiring of one permanent professional.

- A different cable modeling application supports the submarine installation of cables. This project resulted in the publication of three articles, the sale of 80 software licenses to date, and the hiring of two professionals.

- A system to measure cloud height for use aboard ship to support naval aviators is designed to make flight operations safer by enabling the three-dimensional characterization of cloud formations above aircraft carriers. A patent is pending for this technology, and the developer hired two permanent professionals because of this work.

- The first successful shallow seawater tri-nitro-toluene (TNT) detector to support naval mine detection operations represents the practical extension of a technology developed and expanded under CEROS funding. Three articles, one patent, and one technical hire resulted from this work.

- A final set of projects in this area demonstrated the efficacy of implanting fiber-optic sensors in lightweight compressed air tanks to improve their safe usage. A patent is pending, and four articles were written to disseminate this work.

UNIQUE PROPERTIES OF THE DEEP OCEAN ENVIRONMENT

CEROS has awarded nine contracts to fund six projects in the Unique Properties of the Deep Ocean Environment research area. In this area, CEROS funds projects to identify, extract, and test unique products and materials related to that environment and to deep-sea energy and fuel production, among other topics. CEROS contractors have undertaken some fascinating projects in this area, such as the following:

- Two projects exploited the deep-water facility at NELHA to pursue marine biotechnology research designed to produce a micro-algal culture useful in aquaculture. A second set of projects isolated naturally occurring antibacterial compounds from marine diatom algae. In vitro tests indicated that these compounds were effective against certain antibiotic-resistant bacteria. Two patents resulted from this work, as did follow-on research conducted at Tripler Army Medical Center in Honolulu.

- One project to expand ongoing design and development work in ocean thermal energy conversion (OTEC) at NELHA included a design for a 1-megawatt OTEC system.

- Two projects investigated desalination (potable water from seawater) techniques. One was based on clathrates—chemicals that crystallize water at temperatures above its normal freezing point—and the other developed scaled physical and computation models for a portable desalination facility.

SUMMARY

We approached this assessment from the perspective that all CEROS funding contributes to the ocean-sciences body of knowledge. We believe that to be an appropriate view because, absent the program, the funding dedicated to 86 projects germane to topics in ocean sciences would have been deployed elsewhere. Measuring the magnitude of that contribution is more complex.

The CEROS firms have extended their technical capabilities because of their CEROS projects, and their successes have led to the hiring of additional scientists and engineers and, more important, opened new markets and added to the intellectual capital extant in Hawaii. A reasonable indicator of the growth in intellectual capital is the number of patents flowing from these projects. At a minimum,

82 patents (as reported by the CEROS firms) and a large number of technical publications exist because of the projects performed with CEROS funding. These metrics are all indicators of CEROS's contribution to ocean science, but they do not address the quality of the science conducted through this funding.

In effect, the RAB, working in conjunction with ad hoc evaluators, judges the scientific merits of the proposals during source selection. Their credentials and combined academic and professional experience suggests that they are eminently well qualified to perform that function. In addition to their academic and professional qualifications, CEROS selects them because of their experience with source selections in similar scientific or applied research endeavors. It is their responsibility to assess the quality of the science—a judgment they make using well-honed source selection procedures. These procedures ensure that well-qualified, properly credentialed individuals staff the firms engaged in these projects; and, more important, these procedures guarantee that the proposals submitted are on topics that benefit DoD and contribute to ocean technology development in Hawaii.

In sum, the contributions that the CEROS projects have made to DoD appear substantial. As the examples above suggest, CEROS projects have contributed to both mission-critical requirements and broader areas that affect both defense and commercial markets.

Chapter 5
Findings and Recommendations

In the preceding chapters, we have laid the groundwork to assess the first 10 years of the CEROS program. In Chapter 2, we described CEROS and its history, purpose, and procurement process. Next, in Chapter 3, we established a baseline from which we could assess the impact that CEROS funding has had on the firms receiving contract awards. We believe that CEROS has a beneficial effect on these firms; by extension, those benefits accrue to the Hawaiian economy of which these firms are a part. In Chapter 4, we described the CEROS projects. Of particular relevance to our study is the effect that CEROS funding has had on the ocean-sciences knowledge base and DoD—through the Defense-related and commercial products resulting from CEROS funding. In this chapter, we present our findings and recommendations.

FINDINGS

Often, the rate of return for technology incubators in the commercial world is quite low: for every 1,000 ideas funded, only one viable product reaches the market.[1] By commercial standards, CEROS's 86 ocean-related technology development efforts should have failed to produce any results, but that is not what has happened. CEROS funding has resulted in these products for DoD:

- Advanced Real-Time System signal processors (algorithms and hardware boxes) prototyped and tested on attack submarines in Hawaii and then submitted to the Advanced Rapid COTS Insertion program for insertion in the Navy inventory
- Transition of a data fusion engine to the Commander, Patrol and Reconnaissance Forces, Pacific Task Force (CTF-12), which became the basis for the Web Centric Antisubmarine Warfare Net system that CTF-12 uses for integrated ASW information throughout the Pacific
- Hyperspectral imaging technology that is being adopted by the Navy in one of its littoral systems and has resulted in a $50 million contract award to a CEROS firm
- ASW field processing technologies that utilize NetSAT technology to demonstrate that submarines can use third-party targeting information from communications buoys to increase targeting distance

[1] Greg A. Stevens and James Burley, "3000 Raw Ideas Equals One Commercial Success," *Research Technology Management*, Volume 40, Issue 3. May/June 1997, p. 2.

- Bottom-penetrating acoustic sensors to search for and map the location of UXO
- Advanced underwater hull designs that are now being used to develop a 180-foot HYSWAC
- An electronic charting system that is being used by the Navy to interdict the unauthorized flow of oil from Iraq in the Persian Gulf
- A suite of cable modeling software used for the placement of submarine cables in oceanographic sensors and surveillance systems
- A system to measure cloud height for use aboard ship to improve flight operational safety by enabling the three-dimensional characterization of cloud formations above aircraft carriers.

These projects have produced significant results for DoD; and without CEROS funding, this technology might not be available to the Department. CEROS funding has made important contributions to the ocean-sciences knowledge base as well: CEROS-funded projects have resulted in 82 patents for the program's contractors. Because CEROS contractors have benefited significantly from their work on CEROS projects, the Hawaiian economy has benefited as well. The firms have experienced employment growth of approximately 122 professional positions. These positions represent an upper bound; CEROS funding caused some portion of that growth, but precisely how much cannot be determined. Twenty-four firms reported that because of CEROS-created opportunities, their revenues increased, and six of that group experienced pronounced revenue increases. These firms reported an increase in business development opportunities as well. Twenty-two firms indicated that they received follow-on contracts from other organizations because of their CEROS award. Employment among CEROS contractors benefits these firms and, by extension, Hawaii. Projects funded in CEROS core research areas afford them employment and a chance to pursue follow-on business opportunities.

RECOMMENDATIONS

CEROS is a successful program, especially for one that funds innovative ideas. However, all programs can be improved. LMI recommends that CEROS build upon the accomplishments of its first 10 years by doing the following:

- Increase product transition opportunities
- Expand the contractor pool to generate more ideas
- Continue the program assessment process by establishing a continuous assessment program.

Increase Product Transition Opportunities

CEROS should forge a closer relationship with the Defense acquisition community as a means of accelerating the transition of its products (both Defense-related products and commercial products with possible Defense application) into the DoD acquisition system. A strategy to accomplish that result is multi-faceted and depends on understanding the warfighters' needs, establishing closer contacts within the broader Defense establishment outside of Hawaii, and leveraging its resources to undertake important new challenges.

While CEROS has already demonstrated success in transitioning its products into the Defense acquisition system, it can build on those results as more Defense organizations become familiar with its project results and the firms responsible for them. To increase its impact, CEROS may wish to

- use a technology broker,
- develop a strategy to identify and fund transition opportunities, and
- broaden the pool of evaluators and advisors.

USE A TECHNOLOGY BROKER

A technology broker is an individual who can match industry technologies with potential government needs. An ideal technology broker for CEROS would be a member of the Defense acquisition community assigned to CEROS under the authority of the Intergovernmental Personnel Act.[2] This individual would be familiar with his or her organization's near-term requirements and key personnel, as well as long-term goals and opportunities. Ideally, this person would act as an ambassador linking CEROS contractors with appropriate members of the requirements community.

DEVELOP A STRATEGY TO IDENTIFY AND FUND TRANSITION OPPORTUNITIES

CEROS should consider developing a strategy to identify and fund transition opportunities. Some CEROS contractors interact with military organizations to identify unmet requirements and then use the CEROS BAA to propose solutions.

One possible source of ideas that the CEROS contractors may be able to use for inspiration are the reports produced by the Defense Science Board, an organization chartered to advise the Secretary of Defense on scientific, technical, manufacturing, and other matters of special interest to DoD. Ideas drawn from these reports could become the basis for proposals to CEROS.

[2] Intergovernmental Personnel Act of 1970, as amended, P.L. 91-648. Its purpose is to facilitate federal-state-local cooperation and to aid in solving problems and delivering improved services at all government levels through the sharing of professional, administrative, and technical expertise.

If even a small project based on one of these reports were too large for CEROS to fund alone, the firms would have to attract additional investors. One possibility recently has been made available through Act 221, which modified Hawaii's tax code by creating a tax credit for investment in high-technology firms.[3] Tax credits may be very attractive to venture capitalists and might be used to leverage the funding received directly from CEROS. The military services are a second potential source for such funding, through their dual-use programs, or CEROS funds could be used to augment Small Business Innovation Research Program Phase II fast-track awards. CEROS would have to negotiate a commitment before awarding a contract under these scenarios.

BROADEN THE POOL OF EVALUATORS AND ADVISORS

Broadening the CEROS evaluator pool to include additional Defense and federal ocean-sciences research organizations will increase awareness of the CEROS program and its projects to a larger audience of potential users and/or customers within the DoD acquisition community. This approach creates networking opportunities with potentially influential organizations and engenders greater familiarity with the capabilities of Hawaiian technology firms. Finally, interacting with a broader defense community will enable CEROS to take advantage of fresh perspectives and, perhaps, create more opportunities for CEROS contractors.

Among the Defense organizations from which CEROS may recruit additional evaluators are the

- Atlantic Fleet Submarine Force,
- Space and Naval Warfare Systems Center,
- Naval Surface Warfare Center,
- Naval Underwater Warfare Center, and
- Naval Research Laboratory.

In addition, personnel associated with the National Oceanic and Atmospheric Administration and participating in the National Oceanographic Partnership Program may wish to participate as CEROS evaluators.

CEROS might also consider broadening its pool of formal advisors by adding selected members to its board. By adding members, perhaps including some representatives from groups listed above, CEROS could expand representation and help ensure that its projects remain useful to the Navy and DoD.

[3] Hawaiian Bill 175, passed in 2001, encourages the growth and development of high-technology businesses and associated industries in Hawaii by offering accelerated tax credits to qualified investors. Investors receive tax credits equal to 100 percent of their investments up to $2 million; the credits must be taken over a 5-year period but can be done so on an accelerated basis.

Expand the Contractor Pool to Generate More Ideas

Because CEROS funds innovation, it is essential that its source of innovative ideas—Hawaiian firms—continue to grow. To expand the idea pool, CEROS should redouble its efforts to tap existing firms and solicit proposals from new firms. Developing new sources will not be easy, but CEROS can pursue that course by doing the following:

- *Establishing a small business set-aside.* One of CEROS's unique strengths is that it awards contracts to start-up firms. This recommendation formalizes that practice to the extent that CEROS would establish a set-aside specifically for that purpose. This technique would slowly increase the number of firms to which CEROS awards contracts. Furthermore, it would strengthen CEROS's support of local innovators and would further enhance CEROS's contribution to economic development in Hawaii.

- *Supporting an intern program in conjunction with the University of Hawaii's School of Ocean and Earth Science and Technology (SOEST) to groom high-tech entrepreneurs.* This program would foster the entrepreneurial development of a promising SOEST graduate by providing "seed" funding to finance the development of a business plan for an entrepreneur whose business idea is appropriate for the CEROS core program. Based on the robustness of the business plan, CEROS might invite this embryonic firm to submit an abstract during the annual proposal cycle.

- *Establishing a native-Hawaiian-entrepreneur set-aside.* This approach would serve an important but untapped community, and it would be another way for CEROS to invest in Hawaiian innovators.

Establish a Continuous Assessment Program

CEROS should use the metrics (employment and revenue growth, patents and scientific publications, and successful transitions into military systems or commercial markets) developed for this review as a baseline for a continuous assessment program. These data are measures of program effectiveness and, as such, serve as indicators of future progress and accomplishments. They could become the basis for an annual progress report to DARPA and other relevant organizations. To simplify the data gathering, CEROS could request that the firms report these data as part of their proposal submissions. Following are the important data to track for the CEROS-funded contractors:

- Employment levels and revenue growth—these data are valuable for assessing the program's impact on Hawaii

- Patents, publications, and scientific activities—these data are valuable for assessing the program's impact on ocean sciences

- Successful product transitions into Defense acquisition programs or commercial markets—these data provide measures of program impact on the Hawaiian economy, the ocean sciences, and DoD.

Appendix A
CEROS-Funded Projects

This appendix contains tables listing all projects funded under the CEROS program to date. They are divided according to fiscal year, from 1993 to 2002.

Table A-1. CEROS-Funded Projects, FY93

Project
Acoustic Analysis Tool Kit
Development of a Broadband Frequency Modulation (FM) Sub-Bottom Profiler for Seafloor Imaging and Sediment Classification
Development of a Cost-Effective Global Positioning System (GPS)-Based Sensor for Measurement of Heave, Pitch, Roll, and Heading on Oceanographic Platforms
Development of Fiber-Optic Chemical Sensors (FOCS) for Remote In-Situ Monitoring of Potential for Hydrogen (pH) and Carbon Dioxide in Seawater
Extended Source Apparent Motion (E-SAM) Lighted Signals for Protection of the Marine Environment
Hyperspectral Remote Sensing for Maritime Applications
Low-Cost, Prebuckled Cylindrical Pressure Hulls (two projects)
Modeling of Hurricane-Induced Coastal Flooding
Radar/Sensor Signal Processing Research of Shallow Water Surveillance Technologies
Underwater Echolocation for Object Recognition

Table A-2. CEROS-Funded Projects, FY94

Project
Design and Deployment of a Fiber-Optic Based Autonomous Buoy for In-Situ Monitoring of pH, pC02, Temperature, 02 and Water Quality in Seawater, Phase II
Development of a Cost-Effective GPS-Based Sensor for Measurement of Heave, Pitch, Roll, and Heading on Oceanographic Platforms, Phase II
Development of a Technique to Identify Pollutant Sources and Impacts in Coastal and Oceanic Waters
Development of an Automated Control System for Deployment of Small-Diameter Cables and Towed Bodies
Development of Broadband FM Subbottom Profiler for Seafloor Imaging and Sediment Classification
E-SAM Lighted Signals for Protection of the Marine Environment
High-Resolution, Bottom-Penetrating Acoustic Sensors and Signal Processing Algorithms for Reduction of False-Alarm Probability in Unexploded Ordinance Hunting
Hyperspectral Remote Sensing for Maritime Applications, Phase II
Low-Cost, Prebuckled Cylindrical Pressure Hulls (two projects)
Naturally Occurring Antibiotics from Marine Algae Chaetoceros
Product Development Project for Hawaii Radar Simulator (HIRADSIM)
Small Water-Plane Area Twin Hull (SWATH) Motion/Structural Software Development
Tri-Strut Ship Research and Development
Underwater Echolocation for Object Recognition

Table A-3. CEROS-Funded Projects, FY95

Project
Advanced Real-Time Multifunctional Signal Processor
Bioactive Marine Isonitrile Compounds from Hawaiian Sponges as Models for Synthetic Nontoxic Antifoulant and Antibiotic Agents
Design, Construction, and Sea Trials of a 30-Foot Manned Test Model of a Midfoil Small Waterplane Area Ship (SWAS)
Diver Homing Device
Dual-Mode Fluorescence Imaging for Maritime Application
High-Resolution, Bottom-Penetrating, Synthetic Aperture Sonar Using Multi-Vertical Row Array and Subbottom Classifier Sonar
Laser Heterodyne Imaging for Shallow-Water Surveillance
Naturally Occurring Antibacterial and Anti-Fungal Substances from Marine Algae
Ocean Doppler Lidar
SWATH Motion/Structural Software Development and Verification
Underwater Echolocation for Object Recognition

Table A-4. CEROS-Funded Projects, FY96

Project
Advanced Real-Time Sensor Upgrade
Bioactive Marine Isonitrile Compounds from Hawaiian Sponges as Models for Synthetic Nontoxic Antifoulant and Antiobiotic Agents, Phase II
Development and Testing of a Clathrate Desalination Demonstration Research Facility
Development of an Underwater Video Camera for Optical Contrast and Range Enhancement Using Spectral Stretching
Dual-Mode Fluorescence Imaging for Maritime Applications, Phase II
Finite Element Design of Cables
Flow Simulation and Visualization for SWATH Ships
Grazing Angle Imaging Lidar for Organic Mine Countermeasures
High-Resolution, Bottom-Penetrating, Multi-Mode, Synthetic Aperture Sonar for Use in Buried Unexploded Ordinance (UXO) Hunting
Loop Avoidance Control during the Deployment and Retrieval of Submarine Cables
Solution + In-Situ Ocean Sediment Chemical Analyzer
Submarine-Launched, Two-Way, Fiber-Optics Linked Communications Buoy

Table A-5. CEROS-Funded Projects, FY97

Project
Three-Dimensional Finite Element Design of Cables
Improved Acoustic Intercept Receiver for Submarine Applications
Antisubmarine Warfare Commander's Workstation Upgrades and Advanced Real-Time Signal Processor for Combined Task Force Applications
Application Techniques and Comparative Effectiveness of Non-Toxic Antifouling Surfaces to Immersed Nettings Used in Naval and Aquaculture Industries
Bioactive Marine Isonitrile Compounds from Hawaiian Sponges as Models for Synthetic Nontoxic Antifoulant and Antibiotic Agents, Phase III
Computational and Physical Modeling of the Hurricane Tower Desalination System
Computational Fluid Dynamics Code Validation and Improvement Using Large-Scale Tests; Optimization of Design for High-Froude-Number, Underwater Body Operating at Near Surface (MIDFOIL and SLICE); and Subsequent Construction and Testing of Optimized Underwater Body
Continuous Production of Marine Algae Chaetoceros Species (Spp.) in an Open System
Development of a Three-Dimensional, Forward/Aft-Sweeping, High-Resolution Buried Object Imaging System
Diver Homing Device
Integrated Sensor System for Search and Classification of Subbottom Objects
Integrated System for Detection, Classification, Localization, Tracking, and Reporting of Submarine Contact Data
Laser Heterodyne Imaging for Littoral Water Surveillance
On-Site, Preliminary Analysis of Sediment Core Samples
Probiotic Bacteria: The Key to Expanded Use of Deep Seawater in Tropical Aquaculture, and the Solution to a Growing Industry Problem
Solution Plus In-Situ Ocean Sediment Chemical Analyzer

Table A-6. CEROS-Funded Projects, FY98

Project
Probe for In-Situ Characterization of Marine Carbonate Sands and Other Sediments
Upgraded Advanced Real-Time Sensor (ARTS) Processor for Maritime Patrol Aircraft Applications
Development of a Three-Dimensional, Forward/Aft-Sweeping, High-Resolution Buried Object Imaging System, Phase II
Development of a Patentable Combination Propeller-Pump, Jet-Integrated Propulsion Pod with Boundary Layer Suction
Development of an Ultra-High-Resolution, Non-Destructive Technique for Stress Detection for Marine Applications
Development of an Underwater Compositional Mapping (UCM) System
Improved Acoustic Intercept Receiver for Submarine Applications, Phase II
Internet-Enabled Engineering Tool for Dynamically Analyzing and Planning World-Wide Subsea Cable and Array Installations
Life/Float, the One-Person Survival Craft
Modeling of Hurricane-Induced Coastal Flooding for the Hawaiian Islands
Multispectral, Interferometric Synthetic Aperture Imaging Sonar
Patuxent River Direct Fuel Injection (DFI) Prototype
Polychlorinated Biphenyls (PCB) Analyzer for Shallow Ocean Water
Personal Emergency Lifesaving System (PELS)
Situation Awareness System Processor for Submarine Applications, Phase II
Smart Scuba
The DiVRS Eye Terrain Database Visualization as an Aid to Underwater Navigation
Undersea Fanbeam Spectral Imaging (FSI) Risk-Reduction Technology Demonstration
Using Software Agents to Acquire and Visualize Environmental Information for Antisubmarine Warfare (ASW) Surveillance

Table A-7. CEROS-Funded Projects, FY99

Project
A Proposal to Develop HYDROFIST: A Non-Explosive Means for Generating Intense and Focused Underwater Shock Waves
An Ocean Bottom Span Analyzer for Survey Planning and Installations of Submarine Cables and Pipelines
At-Sea Evaluation of the Situation Assessment System (SAS) Processor
Automation and Integration of Environmental Factors into ASW Tracking
Cultured Fish as Biological Indicators of Pollution
Development of a Miniaturized Mass Spectrometer-Based Sampling System for In-Situ Measurements of Dissolved Gas and/or Solutes in Marine Waters, and for Protein Characterization That Leads to Microbial Identification
Development of an Enhanced Resolution Filter for Improving Sonar Imagery
Enhanced Sea and Land Rescue Visibility System
Fabrication and Demonstration of a Patentable Combination Propeller-Pump, Jet-Integrated Propulsion Pod with Boundary Layer Suction
Frequency Agile Sequential Transmission Synthetic Aperture Sonar (FastSAS)—Risk Reduction Technology Demonstration for NetTORP
Smart Scuba II
Submarine Electronic Charting System
The Rover's Eye Terrain Database Visualization as an Aid to ROV Navigation, Phase II
Using Software Agents to Acquire and Visualize Environmental Information for ASW Surveillance
Web-Based Processing for State-of-the-Art, Large-Aperture Multi-Dimensional (SLAM) Array

Table A-8. CEROS-Funded Projects, FY00

Project
Continuous-Culture, Closed-System, Deep-Seawater Photobioreactor for Microalgal Culture for Hatcheries and Pharmaceuticals
Proposal to Expand HYDROFIST: A Non-Explosive Means for Generating Intense and Focused Underwater Shock Waves
Analysis of Synthetic Aperture Sonar Data for Geological Surveys
Automated Surface-Enhanced Raman Scattering (SERS) Immunoassay Detection System: Detection of an Aquaculture Virus and "Dog Nose" Sensor for TNT Detection
Capillary Electrophoresis-Mass Spectrometry and Other Instrumental Enhancements for In-Situ Measurement of Dissolved Gas and Solutes in Marine Waters, Atmospheric Gases and Aerosols, and Large Organic Compound Identification
Compact-Inflatable-Mobile Survival Platform for Military/Special Forces and Commercial Applications
Development of a Sensor for Pesticide Monitoring Based on Porous Silicon Optical Biosensor
Improving Flow from Deep-Water Pipelines
Large-Scale Producibility Demonstration of CEROS-Developed, Three-Dimensional Lifting Bodies for Use in the U.S. Navy's Littoral Support Craft (LSC) Program
Mission Reconfigurable Signal Processing System
Modeling of Cable Fatigue
Remote Monitoring and Expert Control of Submarine Cable and Array Installations
SWATH Ship Software and Verification
Water Properties Miniature Optical Sensor Project
Web-Based, Propagation and Noise Effects on Signal Processing
Workflow Paradigm for ASW by Reliable Meteorology and Oceanography (METOC) Data and Tasks

Table A-9. CEROS-Funded Projects, FY01

Project
Developing a Sensitive, Sessile Monitor for Non-Point Source Heavy Metal Pollution for Tropical and Sub-Tropical Indo-Pacific Waters
Experimental Investigation of Cable Fatigue
Exploration of a Surf Zone Reconnaissance System
Flapping Foil Technology for Motion Stabilization of Novel High-Speed Vehicles
Implement and Demonstrate ASW Targeting and Weapon Control Using Non-Organic Sensors: Netted Combat Control System (CCS)
Implementation of an Ocean Acoustic Laboratory at Pacific Missile Range Facility
Passive Assured Access System
Porous Silicon Biosensor
Snap-To Amphibious Footwear System
Temporally Enhanced Adaptive Multi-Spectral (TEAMS) System for Detection of Underwater Objects
Theater-Wide Situational Awareness for Decision Wall
Three-Dimensional Cloud Height Indicator for Marine Application (3D-CHIMA)
vSAR: Video Search and Rescue
Web-Based Simulation, Modeling, and Signal Processing

Table A-10. CEROS-Funded Projects, FY02

Project
Proposal to Implement and Demonstrate ASW Targeting and Weapon Control Using Non-Organic Sensors: Netted CCS, Year 2
Computation of Submarine Towed Array Shapes and Dynamics Based on Array Sensors, Indirect Current Sensing, and In-Situ Drag Coefficient Measurements
Emergency Supplemental Flotation System (ESFS)
Improved Extrinsic Raman Labels (ERL) for Real-Time Ocean TNT Detection and Quantification
Modification of a Whole-Ship Design Synthesis Model to Accept Ship Designs Employing Advanced Lifting Body Technology
Ocean Acoustic Laboratory at Pacific Missile Range Facility (PMRF)—Continuation: Model and Data for Acoustic Observations at PMRF
Portable and Improved Mission Reconfigurable Signal Processor (PIMRSP)
Safety-of-Ship System (SOSS)
Structural Modeling of Synthetic Fiber Ropes
Three-Dimensional Cloud Height Indicator for Marine Application, Phase II—System Marine Testing

Appendix B
Abbreviations

ASW	antisubmarine warfare
BAA	broad agency announcement
CCS	combat control system
CEROS	National Defense Center of Excellence for Research in Ocean Sciences
COTS	commercial off-the-shelf
DARPA	Defense Advanced Research Projects Agency
FM	frequency modulation
GPS	global positioning system
HYSWAC	Hybrid Small Waterplane Area Craft
NELHA	Natural Energy Laboratory of Hawaii Authority
NetSAT	Netted Search, Acquisition, and Targeting
OTEC	ocean thermal energy conversion
PCB	polychlorinated biphenyl
R&D	research and development
RAB	Research Advisory Board
SAS	Situation Assessment System
SOEST	School of Ocean and Earth Science and Technology
SSA	source selection authority
SWATH	small water-plane area twin hull
TNT	tri-nitro-toluene
UXO	unexploded ordinance