NAVAL SEA SYSTEMS COMMAND

NSWC
Naval Surface Warfare Center
INDIAN HEAD DIVISION

FLASH POINT

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The Center for Energetic Concepts Development (CECD), *a cooperative agreement between the Indian Head Division, Naval Surface Warfare Center (IHDIV, NSWC) and the University of Maryland, College Park (UMCP), was signed on 14 December, 1998. The vision IHDIV, NSWC and UMCP share is to establish a preeminent national resource in energetic systems development.*

The key components of the CECD are:

- **Developing the next generation of DoD energetic experts.**
- **Creating new Concepts for 5th generation explosives.**
- **haring expertise and facilities.**
- **Accessing world-class experts.**

In establlishing the CECD, IHDIV, NSWC and UMCP intend to develop an internationally recognized energetics capability.

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FLASH POINT

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Center for Energetic Concepts Development Signing Ceremony Marks Alliance Between IHDIV and University of MD, College Park

by Allyn Cook Buzzell

Developing the next generation of energetic materials to use in explosives and propellants for national security and public safety applications is only part of the reason that IHDIV, NSWC recently entered into a cooperative agreement with the University of Maryland at College Park (UMCP) to create the Center for Energetic Concepts Development (CECD). Their goals have an even wider horizon than that. Through their alliance, IHDIV, NSWC and UMCP aim to establish a national resource for the development of advanced energetics concepts *and* to cultivate the next generation of energetics experts.

On December 14, 1998, a signing ceremony was held to mark the creation of the CECD at UMCP and the beginning of a more formal alliance between the University's School of Engineering and IHDIV, NSWC. An ad hoc relationship has existed since at least the early 1970s, back when part of NSWC was housed at the White Oak Laboratory in Silver Spring, Maryland. With College Park just two miles down the road, it was natural that the two research communities, both interested in energetics concepts, would share facilities and ideas and that long-term relationships among the scientists and engineers would flourish.

photo by Chris Adams

On hand for the signing ceremony establishing the Center for Energetics Concepts Development were: standing l to r: Dr. William Forney, Dr. Ronald Armstrong, Ms.Evan Crierie, Dr. Chester Clark, Mr. Mark Eagles, Ms. Penny Kennedy, Mr. Bob Kavetsky, and Ms. Lisa Davie. Seated are l to r : Dr. Jim Short, Mr. Roger Smith, Dr. Ira Blatstein, Dr. Daniel Mote, Dr. William Destler, CAPT Walsh, and Dr. David Anand.

When a team of NSWC experts moved to Indian Head some five years ago, the relationship continued, albeit at a less convenient proximity. "I guess you could say the distance made our hearts grow fonder," says Dr. Ronald W. Armstrong, Professor in UMCP's Department of Mechanical Engineering. Armstrong was named Director of the CECD, a post he shares with his counterpart at IHDIV, NSWC, Co-Director Dr. James Short. Both are already immersed in promoting cooperative projects and planning future research and educational activities.

Armstrong and Short also sit on the CECD Council, a guiding body that includes Dr. Davinder K. Anand, Chairman of UMCP's Department of Mechanical Engineering; Dr. William Fourney, Department of Aerospace Engineering, UMCP; Dr. Chester F. Clark, Director of the Explosives and Propellants Division at IHDIV, NSWC; and Mr. Bob Kavetsky, Program Manager for Undersea Weapons at IHDIV, NSWC.

A Seed of an Idea Turns to Reality

At the agreement signing ceremony in College Park, held in the Atrium of Adele H. Stamp Student Union and open to students and the public, CECD Co-Director Short recalled the infusion of funding that the United States offered to the nation's universities after the U.S.S.R. launched Sputnik in 1957. "Our universities built curricula to train rocket scientists. Recruiting qualified people to work on propellants and explosives at a place like Indian Head was relatively easy."

But "times have changed," noted Short, and many of the economic incentives offered to universities to train energetics specialists have disappeared. "Each year, it seems that fewer and fewer universities are able to continue their rocket science curricula."

At least two repercussions were beginning to be felt by the 1990s. According to Short, the research community was having greater difficulty recruiting new employees specifically trained to work in the field of energetics, and opportunities for specialized higher education for military scientists and engineers were becoming sparse. At the same time, the pioneers in energetics who were recruited after Sputnik began approaching retirement.

About two years ago, Dr. William W. Destler, Dean of UMCP's School of Engineering, came to Indian Head to speak about innovative programs at the University. That day, IHDIV, NSWC's Clark, himself a University of Maryland alumnus, and Kavetsky hosted a luncheon for Dean Destler. At the luncheon, Kavetsky recalls, Destler mentioned a cooperative agreement between UMCP and the Department of the Army.

"As he briefed us about the agreement, we became intrigued with the possibilities for a similar arrangement with IHDIV, NSWC," says Kavetsky. "We had become concerned about the long-term impact of the downsizing within DOD on our science and engineering staff's core competencies. We compared notes and realized that such a partnership might well be the answer to developing the next generation of energetic materials *and* the next generation of energetics experts. We knew that UMCP's top-notch Engineering School could bring tremendous resources to bear in that endeavor."

Clark was similarly struck by the potential for an alliance. "I had always thought that Indian Head was missing out on all the science and engineering capability in the area — there are five major universities in and around Washington, D.C. We just didn't know how to put an arrangement in place until we heard about the University's agreement with the Army."

The seed of the idea began to unfold more fully when Professor Armstrong took a year-long sabbatical, spent partly at Johns Hopkins University and partly at Indian Head. During that time period, Kavetsky and Clark began working on the details of an alliance, and eventually a request for proposals (RFP) was announced.

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40 YEARS

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Four universities and nine commercial firms responded to the proposal. But, according to Kavetsky, "The University of Maryland's contract proposal was head and shoulders above the rest." Besides, he notes, there were many obvious advantages to partnering with Maryland's own state institution, not to mention the fact that the partnership was a natural outgrowth of the many preexisting relationships among the scientists and engineers that had been forged over the years.

The contract to establish the CECD was executed on 29 September 1998. It covers a four-year period and is worth up to $4.98 million. Kavetsky credits Mark Eagles, Cooperative Agreement Advisor, and Penny Kennedy, Contract Administrator at IHDIV, NSWC for their hard work and dedication throughout the RFP and contracting process.

By January 1999, the first five technical instructions had been sent to UMCP — two for $50,000, each representing a one-year research effort; one for $3,000, representing a five-month effort; and two for $6,500 and $78,500, each representing a six-month effort.

The specific goals of the CECD, as framed in the cooperative agreement, include:

- Developing an internationally recognized energetics capability;
- Developing the next generation of Department of Navy energetics experts;
- Supporting DOD and non-military research priorities;
- Accessing world-class experts in energetics and related disciplines; and
- Sharing experts and facilities between the organizations.

Each party to the agreement has specific responsibilities. In general, IHDIV, NSWC and the University will each contribute expertise and facilities and will cooperate in research and curriculum development. IHDIV, NSWC will provide funding and other resources and will help define problems for inquiry by faculty and students. The University will offer academic and teaching opportunities to scientists and engineers at UMCP, Indian Head, and elsewhere.

At the signing ceremony, Short described this collaboration: "Using what might be called a distributed laboratory concept, we hope to entice students and professors to work on Navy and Department of Defense explosive and propellant problems. We might do this by suggesting problems that undergraduates could attempt to solve for credit in their senior design class. We might do it by funding professors and graduate students to do research on our behalf. In some cases, the university staff or students might team with people from Indian Head or come to Indian Head to use, or perhaps even operate, our facilities."

The Field of Energetics

CECD Director Armstrong has difficulty hiding his enthusiasm for the cooperative agreement and the future potential for energetic concepts development and education.

Energetics is a branch of the physical science of mechanics, which deals primarily with energy and its transformations. Energetics research is the underpinning of the development of explosives and propellants. The trick, according to Professor Armstrong, is to be able to understand and control energetic materials in such a way that they behave highly efficiently to accomplish the purpose for which they are intended.

Energetics has clear applicability to military R&D, including the development of explosives technology, undersea weapons, and pilot ejection devices. But, notes Armstrong, energetics concepts have numerous other applications as well (see Exhibit 1), such as space exploration, fire suppression, anti-terrorism, and cartridge-actuated devices such as door openers and automobile airbags. "Few people know that Indian Head is a leader in understanding and designing better airbag materials," Armstrong adds.

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Exhibit 1
Subject Areas Covered by the CECD Cooperative Agreement

- Continuous processing of formulated energetic/polymer composites
- Energetic crystal synthesis, structure, and ignition properties
- Environmental aspects of energetic materials and processes
- Combustion dynamics and performance
- Fire protection and related safety issues
- Life cycle and packaging considerations of electric systems
- Design against hazards
- Design, prototyping, and testing of small/miniaturized systems
- Simulation and analysis of various systems
- Mechanical properties characterization at the microscopic scale
- Novel and/or advanced formulating and processing methods
- Microelectromechanical systems (MEMS)

Energetics concepts draw on various disciplines, including mathematics, physics, chemical engineering, and mechanical engineering, all of which have strong departments at UMCP. Scientists and engineers working on energetics research try to analyze the internal structure of dense energetic materials in order to learn how to control their transformations. "The propellants that we currently understand and can control with confidence are relatively inefficient," says Armstrong.

The field of energetics has a "generational aspect," he adds. "As more experts in energetic materials retire, the challenge becomes how to maintain the expertise into the next century." As a vehicle for both research and education, the CECD holds the promise for bridging the generation gap in energetics.

Energetics Research and Education Dovetail

Dr. Anand, Chairman of UMCP's Mechanical Engineering Department, was also concerned about the future of energetics concepts development, which is the reason he put his full support behind the creation of the CECD. "As a result of shifts in expenditures and downsizing in government R&D labs, the research inventory in energetics was becoming depleted. Not many people are active in the field, yet the value of energetics for both military and nonmilitary applications is quite significant."

Anand notes that members of the university's mechanical engineering faculty are involved in "cutting-edge energetics technology," as are faculty members in allied disciplines (see Exhibit 2). Their work has sparked considerable interest at Indian Head, says Anand, and because of the already existing professional connections between the two organizations, the prospects for cross-fertilization of research are enormous.

Anand also looks forward to the educational value of the cooperative agreement, both for students at the university and for senior scientists and engineers at IHDIV, NSWC. "The Center gives us the opportunity to pioneer a new graduate-level program in energetics."

The cooperative agreement calls for UMCP to make a 20 percent in-kind reinvestment for the benefit of IHDIV, NSWC. According to Kavetsky, that investment will allow senior scientists and engineers from Indian Head to enroll tuition-free in advanced-level courses at UMCP, thus helping keep their expertise current. At the same time, notes Anand, senior scientists and engineers at Indian Head will teach and serve as advisers and mentors to students in the School of Engineering and other departments. UMCP's instructional television system (ITV) will be used to connect the students, faculties, and Navy Department experts, and eventually it will be open to private sector scientists and engineers as well.

Clark and Armstrong are also collaborating on a proposal to the National Science Foundation seeking an education grant to develop a national curriculum in energetics.

"The CECD's programs are not parochial or narrowly focused, and many of the University's departments will participate, including nuclear and materials, aerospace, chemistry, mathematics, physics, and mechanical engineering," Anand says. The CECD will give students the chance to work on "real energetics problems" and interact with the experts who have been pioneers in the field. In time, UMCP students who have successfully completed the graduate program in energetics will be hired by the government and private sector organizations — a major benefit to the university's student body.

IHDIV, NSWC's Clark, who is also on the board of advisors to the School of Engineering, is especially optimistic about the distributed lab concept, which gives Indian Head experts access to UMCP's facilities and equipment and vice versa. "Indian Head will gain greater recognition in the scientific community via joint research projects with University scientists."

Through the CECD, the University and IHDIV, NSWC will make the most cost-effective use of their unique capabilities by sharing people, sharing lab space, and teaming on state-of-the-art science and technology problems. "We can build on what we have at Indian Head and the expertise housed at the university to create a vital energetics pro-

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gram in both the classroom and the laboratory," says Clark.

Exhibit 2
Ongoing Energetics Work at UMCP

When first tossing around the idea that eventually led to creation of the CECD, Chester Clark and Bob Kavetsky concurred that the University of Maryland could "bring tremendous resources to bear" on the R&D work being done at Indian Head. They were already well aware of the people and projects that make the UMCP a vanguard in the field.

To underscore the mutual interests of the two organization, Professor Armstrong identified some of the faculty members who are doing advanced work at the university and the projects that attracted IHDIV, NSWC's attention:

• Herman Ammon, Department of Chemistry and Biochemistry — prediction and measurement of energetic crystal structures;

• Stuart Antman, Department of Mathematics — mathematical techniques in modeling of shock wave structures;

• David Bigio, Department of Mechanical Engineering — continuous processing of propellants;

• Robert Briber, Department of Nuclear and Materials Engineering/Department of Chemical Engineering — radiation processing of energetic materials;

• William Fourney, Department of Aerospace Engineering — underwater explosions;

• Mark Lewis, Department of Aerospace Engineering, and Ashwani Gupta, Department of Mechanical Engineering — energetic fuel combustion studies;

• James Quintiere, Department of Fire Protection Engineering, and Marino diMarzo, Department of Mechanical Engineering — fire suppression;

• Donald DeVoe, Department of Mechanical Engineering — microelectromechanical systems (MEMS) research for miniaturized control of dynamic behaviors (in the limit as fast as occurs on a femtosecond time scale, that is, a thousandth of a millionth of a millionth of a second).

• Ronald Armstrong, Department of Mechanical Engineering — nanocrystalline properties of energetic materials, involving the properties of crystals a tenth of a millionth of a centimeter in size.

The Long-Range Vision

Eventually, the partners in the CECD envision creating a full-spectrum energetics capability that is in concert with Indian Head's vision of being the National Center for Energetics, in which a consortium of government laboratories and universities will participate, together with a national network of private entities. The payoff will be a national educational curriculum in energetics and a partnering mechanism for discovering more efficient energetic materials for a variety of military and civilian applications.

"Achieving recognition as the National Center for Energetics is our 'battle cry'," says IHDIV, NSWC's Kavetsky.

It is anticipated that, five years from now, the CECD will be a tri-service training center for full-spectrum energetics R&D and a destination for military, government, and civilian organizations seeking help in solving energetics-related problems. The Center will also be the hub of a national consortium of government laboratories and universities and a national network of private entities whose products employ energetics technologies.

As the National Center for Energetics, the CECD would also become the gatekeeper for all data and information related to energetics and a "virtual campus" for teaching the national energetics core curriculum to students at universities throughout the country. Also, by then, a "seamless teaming" of IHDIV, NSWC and UMCP is anticipated.

The CECD's associated business goals over the next five years include obtaining increases in funding, establishing a line item for the Center in the federal budget appropriations, increasing political support for energetics R&D, and diversifying the energetics product line (see Exhibit 3 for the IHDIV, NSWC team).

"If we are successful to the fullest extent of our dreams, we would find the University, Indian Head, and civilian organizations and agencies applying our skills jointly to solve both civilian and military problems associated with the use of propellants and explosives," notes CECD Co-Director Short.

"All of what we are saying and doing now is in support of these ultimate goals," Kavetsky adds.

Exhibit 3
The CECD Team at IHDIV, NSWC

The personnel who took the CECD seed and began to grow it are a diverse team at IHDIV, NSWC. They include:

Dr. James Short, Co-Director, CECD

Dr. Chester Clark, CECD Council Member

Bob Kavetsky, CECD Council Member

Lisa Davie, Government Programs Manager

Mark Eagles, Cooperative Agreement Advisor

Penny Kennedy, Contract Administrator

Editor's Note: Ms. Buzzell is a writer and principal in Adeptus Associates, a writing, editing, and publishing firm in Middletown, Maryland.