



THE DEPARTMENT OF  
MECHANICAL  
ENGINEERING



**Center for Engineering Concepts Development (CECD)  
20th Anniversary Celebration and Middleton Luncheon**

**Kay Boardrooms and Rotunda  
Jeong H. Kim Engineering Building  
University of Maryland, College Park**

**April 17, 2019**

**Davinder K. Anand<sup>1</sup>**

**Dylan A. Hazelwood<sup>2</sup>**

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<sup>1</sup> *Professor Emeritus of Mechanical Engineering and Director, Center for Engineering Concepts Development*

<sup>2</sup> *Assistant Director, Center for Engineering Concepts Development*



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## 1. Comments: CECD 20<sup>th</sup> Celebration and the Middleton Luncheon, April 17, 2019



**Davinder K. Anand**  
Director

### *Welcoming remarks*

Good morning and welcome. In any well-planned event there is always a last minute surprise, and today is no different. As we were wrapping up our plans we received notice that our very own Senator Chris Van Hollen will join us in honoring Senator Middleton. Senator Van Hollen, thank you for being here, and a very hearty welcome to you. And now on with our program.

In the fall of 1998, Professor Ronald Armstrong, Professor William Fourny and I wrote a proposal to the Navy establishing the Center for Energetic Concepts Development. The name was coined by Ronald, who opined that this would allow us to develop new and broader concepts using energetic materials. I thought that it was an unusual and unwieldy name, but since he was going to be the Director, I went along with it. I do not recall Bill saying anything, but perhaps he has a comment. We signed a contract with the Navy in December 1998. The following year Ronald left for The Eglin Air Force Base as the Chief Scientist and I assumed the directorship. The rest, as they say, is history.

Today we celebrate 20 years of our existence as a center. Of the faculty and researchers we have supported, more than half of them are here with us today. With the typical busy schedule of these folks that is an achievement, and my thanks to them. I want to take particular note of Professor Elisabeth Smela. Elisabeth are you here? Well, I promised her a shout out that she is currently serving as the Jefferson Science Fellow at the US Department of State, but only if she came to the celebration. Elisabeth Smela ...promise delivered! By the way she also won this year's award for Women of Influence. We are very proud of her. In my remarks today I believe I speak for all my CECD colleagues and their very good works.

In planning this celebration my initial inclination was to select some interesting projects from our work and give detailed technical presentations to establish our bonafides. Let me show you a list for our first year projects, i.e. 20 years ago, shown on the first slide. (I know you cannot read this. Neither can I). But now imagine nineteen more years. I don't know how many here would want to know the details of how the addition of nanoaluminum as a minor additive can significantly lower the ignition temperature of certain materials. I could add an international flavor by adding the work of a renowned faculty member we supported overseas. He sent me this email just after last Christmas. The message said:

*Attached please find a reprint #796 on our work on penta-nitro-benzene.  
Happy New Year to all of you when it comes.*

I did not read the reprint carefully but I am sure most of us would not worry about this sort of thing. The point I make is that these are all good fundamental science and engineering activities that CECD has been supporting, and they rightfully belong in a conference or symposia of like-minded researchers. And we have supported many such meetings. But in this celebration, I wanted to take the high road, so to speak, and give you an overview of what we have done and are doing. You will see this in the next few slides.

I believe that many in this room have resumes that will fill many pages, as will our speakers'. I cannot do justice to them with just a few words to introduce our speakers. So I will just make a few personal comments.

Our first speaker, my good friend Chancellor William E Kirwan, was also the speaker at our 10<sup>th</sup> anniversary and I have known him for over 50 years, from when he was a faculty member in the Mathematics department. Since then he has been chairman of Mathematics, Vice President, President of the University and then he got lost for a couple of years in Ohio. We went and brought him back from Ohio, actually he was President there, as Chancellor of the University of Maryland System. A music lover, a tennis player, (Brit are you still playing?) and even a football star at the University in Kentucky. Who would expect a football player could be a Chancellor of a great University? I say this is a great country.

Our second speaker is Dr. Balakumar Balachandran, who is the Minta Martin Professor and Chair of the Department of Mechanical Engineering at the University of Maryland, having served since 2010. He previously served as Director of Graduate Studies and Associate Chair from 2006 to 2010. He is a noted researcher and the author of many papers and books in the area of nonlinear mechanics.

The third speaker will be Dr. Peter Chung, who is an Associate Professor in our Department and the Lead of the Energetics Group in the Center for Engineering Concepts Development. Prior to joining us he was the team lead in the Computational and Information Sciences Directorate at the U.S. Army Research Laboratory in Aberdeen, and also served on numerous prestigious scientific committees. He currently conducts research in areas related to phonons and machine learning, often at intersections with other areas.

The fourth speaker is Mr. Dylan Hazelwood, the Assistant Director of the Center for Engineering Concepts Development. He joined the Mechanical Engineering Department in 1998, directing information technology efforts until 2009, when he joined CECD. He has co-authored several books and manages the Center's innovative Engineering for Social Change program.

Dr. Robert Grimm, our fifth speaker, is Professor of Public Policy and Director of the newly established Do Good Institute, which has campus-wide participation. In just two years he has won wide national and international recognition for his Institute with his tireless and enthusiastic work. We have been very fortunate in having him work with us in developing a course for the Engineering students. Frankly, we stole his ideas and put the engineering stamp on it! What are friends for? He is a regular lecturer on Philanthropy and charitable giving in Engineering for Social Change and I am delighted to introduce him.

Dr. George Dieter, the sixth speaker, is Emeritus Dean of Engineering and a beloved member of our faculty. He has served as President of ASEE and his book on Design is used the world over. He has been a strong supporter CECD and our Engineering for Social Change program and I am most honored that he is here.

Dr. Michael Pecht, our seventh speaker, is the Director of the CALCE Electronics Products and Systems Center and The George Dieter Chair Professor of Mechanical Engineering. He is world-renowned in electronic packaging and safety issues and has generously worked with CECD for many years. I have known him since he arrived at UM and he is a very dear friend of mine. I am happy to see him here.

Our eighth speaker is a surprise speaker. A totally unexpected pleasure in this celebration was a phone call from Sen. Chris Van Hollen's Office accepting our invitation and honoring Senator Middleton. And now for an interesting tidbit. I met Representative Chris Van Hollen around a dozen years or so ago at a YMCA function where my wife served on the board, interestingly with Chancellor Kirwan. In a conversation he was having he said, to my surprise, that he was born in Karachi, Pakistan. I responded by informing him that I was born in Lahore in India. And after a pause said that at that time Karachi was still in India! We had a laugh and I was always impressed by his openness and forthrightness in connecting with people. He represents our state well and I am honored to have the second senator of Maryland, Senator Chris Van Hollen, here.

This luncheon, the Middleton Luncheon, honors our last speaker, whom I met in 1999. I received a call from Ronald Armstrong who was visiting the College of Southern Maryland, where Senator Middleton was also visiting. He invited me to come over for a photo opportunity. I drove to CSM and I must admit I felt kind of silly driving 40-some miles to have a photograph taken with someone I did not know. But here is the slide chronicling that first meeting with the good Senator. He was also the first politician that I had ever met. Needless to say, we connected. He has supported CECD and that support has been unwavering. He was also a part of our tenth celebration, and today we are proud to have this luncheon in his honor. He has been at the state Senate for 25 years working for the betterment of Maryland. Senator Middleton, many thanks to you.

### **After Lunch Remarks**

Well, when you have a glass of wine in hand it's kind of the right time to propose a toast. But before that a few comments.

You have heard where we have been, and the question is now where are we headed? No one can predict the future, but we plan to continue to experiment with new ideas in energetics that are benefitted by machine intelligence, and on the other side enlarge the scope of engineering for social change with specific emphasis on the impact and reach of engineering by all society.

Before the luncheon comes to an end, and on behalf of CECD, I would like to offer my sincere thanks to our speakers Senator Middleton, Chancellor Kirwan, Dean Dieter, Chairman Balachandran, Professor Pecht, Professor Grimm, Professor Chung and Mr. Hazelwood. I would also like to thank my engineering colleagues, guests from the Government, Mechanical Engineering staff, and my friends. A special shout to Inderjit Chopra, David Drumheller, Dan Tam,

Amy O'Donnell and Bob Kavetsky. Over the years two great record keepers were Peggy Brumfield and Lisa Davie. I am glad they are here. And my three colleagues in retirement: Bruce Berger, Patrick Cunniff and Ed Magrab. Hey, we have job openings in CECD in case you are looking for work.

The obligatory shout out goes to my wife Asha. We have been together 58 years, and I still think she is 39! Thanks for coming Asha. Also thanks to Michael and Anita Rice and Alexander Anand. Thanks for your support, but I think I may need more.

Now seriously, the toast.

This celebration is an acknowledgment of, and thanks for, the support and friendship that we have received from Senator Middleton since the inception of CECD. CHEERS

Finally, this celebration is a testament to the great work my colleagues and researchers are doing, working in partnership with State and Federal Governmental Agencies and industry in various fields of interest to CECD, and so important to the vitality of a University and the welfare of our State and Nation.... CHEERS

To have an event such as this requires the work of many. I want to thank our student interns, Nathan Raver, Andrew Lachman and Gaurav Kumar, as well as Fitzgerald Walker from our undergraduate office.

Thank you, drive home safely and God Bless.



*Welcome to the  
CECD 20<sup>th</sup> Anniversary Celebration  
and Middleton Luncheon*



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# *Welcome and Opening Remarks*

**Dr. Davinder K. Anand**

Professor Emeritus and Director, CECD,  
Department of Mechanical Engineering,  
University of Maryland, College Park





Welcome to our  
20<sup>th</sup> Anniversary  
Celebration and the  
Middleton Luncheon

April 17, 2019

# It Started 20 Years Ago

TI No.	Date Signed	TI Title	Funding Provided (\$)	IH POC	UMCP POC	Start Date	Completion Date
98-1	30-Sep-98	MEMS Package Testing, Reliability and Failure Analysis	50,000	Michael Deeds, Code 4120B; Ph: 301-744-6783 Fax: 301-744-6719; MichaelDeeds@uwdesign.ih.navy.mil	Peter Sandborn; Ph: 301-405-3167 Fax: 301-314-9477; sandborn@calce.umd.edu	1-Oct-98	23-Jun-00
98-2	30-Sep-98	MEMS and Optical Fiber Based Energy Interrupter	50,000	Edward Litcher, Code 440C4; Ph: 301-744-6288 Fax: 301-744-6337; 440C4@mail.ih.navy.mil	Dr. S. Chen & Dr. D. DeVoe; Ph: 301-405-5206 Fax: 301-xxx-xxxx; schen97@eng.umd.edu	1-Oct-98	30-Jun-00
99-1	5-Nov-98	Microscopic Analysis of Fine Metal Powders	3,000		Dr. Lourdes Salamanca-Riba; Ph: 301-405-5220	9-Nov-98	30-Sep-99
99-2	21-Dec-98	Large-Displacement DRIE for S&A Systems	6,500	Lawrence Fan, Code 4410C; Ph: 301-744-6157 Fax: 301-744-6126; 4110C@uwtech.ih.navy.mil	Dr. Don DeVoe; Ph: 301-405-8125 Fax: 301-314-9477; ddev@eng.umd.edu	22-Dec-98	15-Jun-99
99-3	20-Jan-99	Continuous Process of BuNENA	78,588	Paula Loukas, Code 2320A; Ph: 301-744-1848 Fax: 301-744-4544; 2320A@biazzi.ih.navy.mil	Dr. Nam Sum Wang; Ph: 301-405-1910 Fax: 301-314-9126; nsw@eng.umd.edu	21-Jan-99	30-Dec-99
99-4	3-Mar-99	Support for Director of CECD	15,000	Lisa Davie, Code PM3A; Ph: 301-744-6331 Fax: 301-744-4187; DavieLM@ih.navy.mil	Dr. Ron Armstrong; Ph: 301-405-5291 Fax: 301-314-9477; rona@eng.umd.edu	3-Mar-99	30-Dec-99
99-5	26-Jul-99	Improving Sensitivity of Metastable Intermolecular Composite (MIC) Percussion Primers	24,950	Magdy Bichay, Code 5230E; Ph: 301-744-2359 Fax: 301-744-4881; bichaymm@ih.navy.mil	Dr. Alba Ramaswamy; Ph: 301-405-3671 Fax: 301-314-9281; albalal@eng.umd.edu	27-Jul-99	8-Sep-00
99-6	2-Sep-99	Support for the CECD	36,960	Bob Kavetsky, Code PM3; Ph: 301-744-6703 Fax: 301-744-4187; KavetskyRA@ih.navy.mil	Dr. Edward Magrab; Ph: 301-405-5287 Fax: 301-314-9477; ebmagrab@eng.umd.edu	2-Sep-99	30-Mar-00
99-7	2-Sep-99	Tomahawk Exploding Initiator Microanalysis	10,000	Tony Quebral, Code 5210C; Ph: 301-744-2312 Fax: 301-744-4881; quebralap@ih.navy.mil	Dr. Alba Ramaswamy; Ph: 301-405-3671 Fax: 301-314-9281; albalal@eng.umd.edu	2-Sep-99	30-Mar-00
99-8	15-Sep-99	NLW Microprocessor Control Unit	47,657	Tony Quebral, Code 5210C; Ph: 301-744-2312 Fax: 301-744-4881; quebralap@ih.navy.mil	Dr. Alba Ramaswamy; Ph: 301-405-3671 Fax: 301-314-9281; albalal@eng.umd.edu	16-Sep-99	8-Sep-00
99-9	15-Sep-99	Characterization of Ultrafine Powders by HRTEM	5,000	Lori Nock, Code 9210N; Ph: 301-744-4853; Fax: 301-744-4445; NockLA@ih.navy.mil (old: Nancy Johnson, Code 9410A; Ph: 301-744-2575 Fax: 301-744-4352; JohnsonNC@ih.navy.mil)	Dr. Lourdes Salamanca-Riba; Ph: 301-405-5220	16-Sep-99	31-Dec-02
99-10	15-Sep-99	Study of the Response of Sand with Air Voids to Explosive Loading	10,800	Les Taylor, Code 40P4, Ph: 301-744-6188, fax: 301-744-6267; taylorlc@ih.navy.mil	Dr. William Fournery; Ph: 301-405-1129 Fax: 301-314-9001; Four@eng.umd.edu	16-Sep-99	28-Sep-01

# CECD Partners



# Our Vision

The vision of the Center for Engineering Concepts Development (CECD) is to serve as a platform for **experimenting with new ideas** in engineering education, future technologies, research, and the impact of engineering on society.



# What Do We Do?

- Fundamental and Applied Research in Energetics
- Hold Symposia on current problems of interest (detonation, autonomy, computation-enabled materials discovery, data driven design, engineering for social change)
- Publish books in targeted areas of interest
- Engineering for Social Change Program

# Focus Areas Have Been

*Autonomy*  
*Sensor development*  
*Energetics informatics*  
*Virtual Environments*  
*Traumatic Brain Injury*  
*Energetic materials*  
*Engineering for Social Change*

# Special Projects

- Port Safety Studies for ONI after 9/11
- Traumatic Brain Injury simulation and animal studies
- Energetics symposium in Hong Kong
- International Detonation symposium in San Diego, Richmond, Idaho, San Francisco
- Energetics Technology Center (ETC)
- Introduced Engineering for Social Change Program (course, high school students summer program, outreach to CSM, ESC Fellows)

# By The Numbers

**\$32M+**

**50+**

**MS and PhD students**

**62**

**faculty**

**200+**

**projects**







UNIVERSITY SYSTEM  
*of* MARYLAND

**Dr. William "Brit" Kirwan**

Chancellor Emeritus,  
University System of Maryland (USM)

JAMES CLARK  
SCHOOL OF ENGINEERING



A. JAMES CLARK  
SCHOOL OF ENGINEERING

CECD

ESC



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# Dr. Balakumar Balachandran

Professor and Chairman  
Department of Mechanical Engineering,  
University of Maryland, College Park





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ENGINEERING**



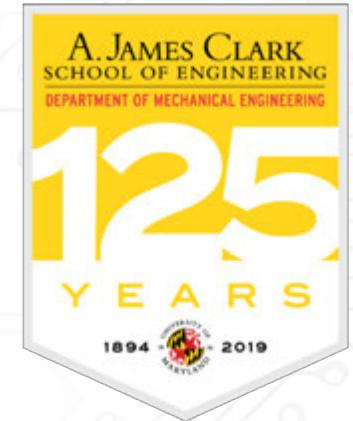
# Dr. Peter Chung

Associate Professor and Energetics Lead,  
Center for Engineering Concepts Development (CECD),  
Department of Mechanical Engineering,  
University of Maryland, College Park

# Energetics @ CECD: Past, Present, Future

Peter W. Chung

Department of Mechanical Engineering





**CECD**

**CENTER FOR ENERGETIC CONCEPTS DEVELOPMENT**

A Sampling of Past & Current Faculty Performers

D. Anand, R. Armstrong, S. Azarm,  
B. Balachandran, D. Bigio, H. Bruck, N. Chopra,  
P. Chung, C. Davis, A. Dasgupta, D. Devoe,  
B. Eichhorn, M. Firebaugh, M. Fuge,  
W. Fourny, S.K. Gupta, H. Haslach,  
J. Herrmann, G. Jackson, H. Milchberg,  
S. Milner, M. Pecht, A. Ramaswamy,  
L. Salamanca-Riba, P. Sandborn, L. Schmidt,  
J. Short, R. Sochol, M. Zachariah

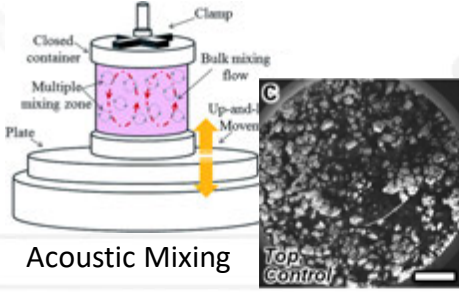
**CECD**



**CENTER FOR ENGINEERING CONCEPTS DEVELOPMENT**



CECD 1998-2018



Acoustic Mixing

Professional Master of Engineering Program

Graduate Certificate in Engineering Program

**ENERGETIC CONCEPTS**

**ONLINE**

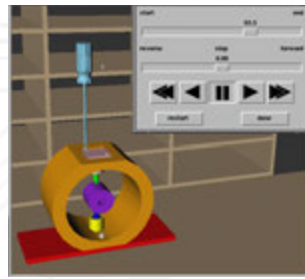
UNIVERSITY OF MARYLAND  
A. JAMES CLARK  
SCHOOL OF ENGINEERING

GRADUATE ENGINEERING DEGREES

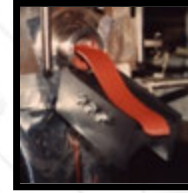


Assembly modeling and simulation in virtual environments

Operator instruction visualization using head mounted display



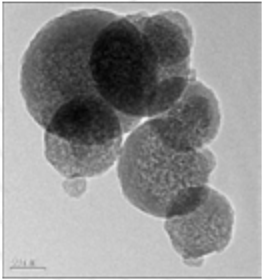
Continuous Extrusion of functionally graded composite energetics



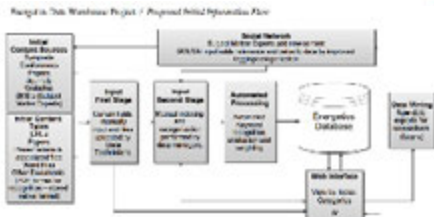
Tools for Improving Design Information Management



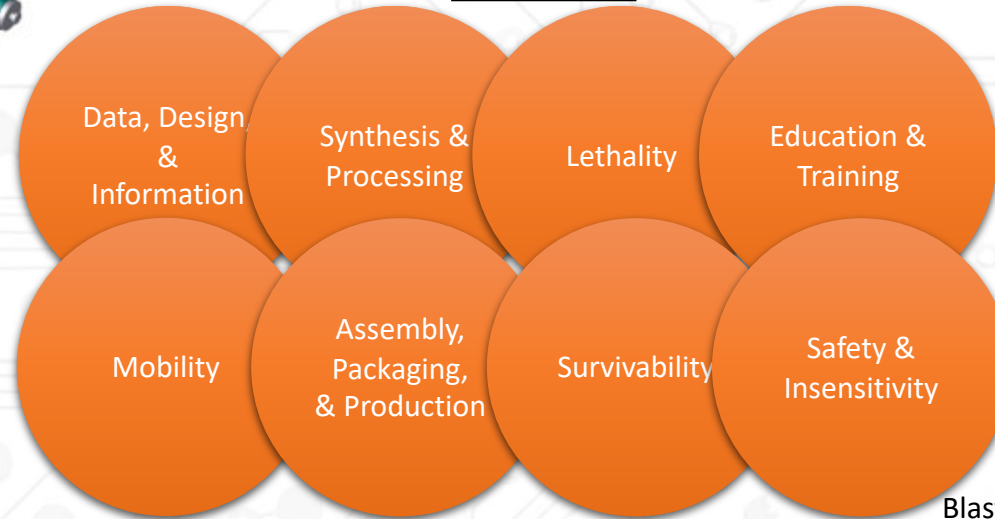
Hazard Assessment Tool for Commercial Maritime Flammable and Potentially Explosive Chemical Cargoes



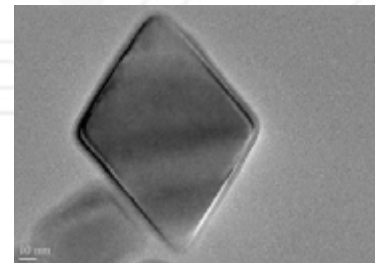
Nanoporous silica



Energetics Data Warehouse

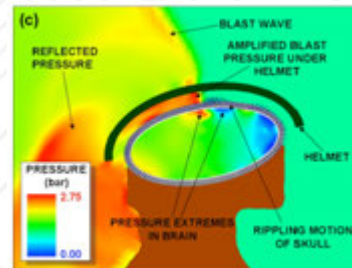


MicroElectroMechanical (MEMS) Reliability and Packaging

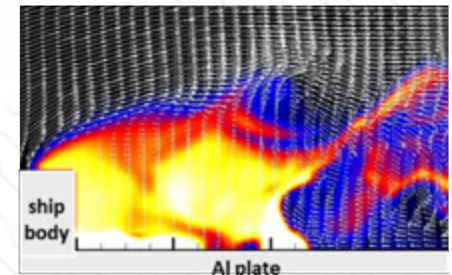
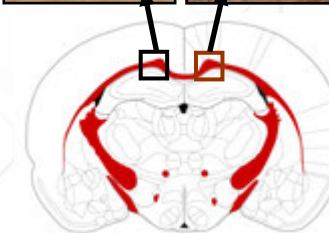


Aerosol grown single crystal nanoaluminum, with a 3 nm native oxide shell

Blast-Helmet-Brain Interactions

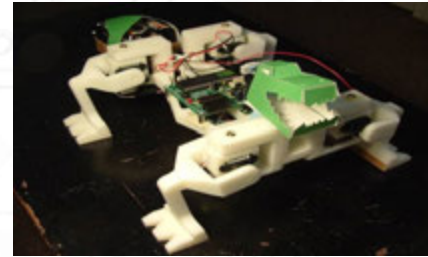


Blast Brain Injury



Propane fraction from vaporization of static pool

Robot Gaits



Blast Resistant Structure Design



# CECD: PHASE ONE

The Team: *D. K. Anand, R. Armstrong – Univ. of Maryland; R. Kavetsky, J. Short – ONR; C. Clark, L. Davie – NSWC, Indian Head Div.; and all PIs*



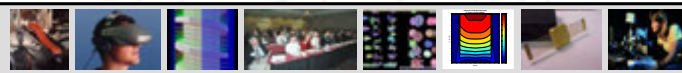
TI No.	TI Title	Funding Provided	IH POC	UMCP POC	Start Date	Completion Date
TI 98-1	MEMS Package Testing, Reliability and Failure Analysis	50,000	M. Deeds	P. Sandborn	1-Oct-98	23-Jun-00
TI 98-2	MEMS and Optical Fiber Based Energy Interrupter	50,000	E. Litcher	S. Chen/D. DeVoe	1-Oct-98	30-Jun-00
<b>TOTAL FY98 =</b>		<b>\$ 100,000</b>				



TI No.	TI Title	Funding Provided	IH POC	UMCP POC	Start Date	Completion Date
TI 99-1	Microscopic Analysis of Fine Metal Powders	3,000	L. Fan	L. Salamanca-Riba	9-Nov-98	30-Sep-99
TI 99-2	Large-Displacement DRIE for S&A Systems	6,500	L. Fan	D. DeVoe	22-Dec-98	15-Jun-99
TI 99-3	Continuous Process of BuNENA	78,588	P. Loukas	N. S. Wang	21-Jan-99	30-Dec-99
TI 99-4	Support for Director of CECD	15,000	L. Davie	R. Armstrong	3-Mar-99	30-Dec-99
TI 99-5	Improving Sensitivity of Metastable Intermolecular Composite Percussion Primers	24,950	M. Bichay	A. Ramaswamy	27-Jul-99	8-Sep-00
TI 99-6	Support for the CECD	36,960	R. Kavetsky	E. Magrab	2-Sep-99	30-Mar-00
TI 99-7	Tomahawk Exploding Initiator Microanalysis	10,000	T. Quebral	A. Ramaswamy	2-Sep-99	30-Mar-00
TI 99-8	NLW Microprocessor Control Unit	47,657	T. Quebral	A. Ramaswamy	16-Sep-99	8-Sep-00
TI 99-9	Characterization of Ultrafine Powders by HRTEM	5,000	L. Nock	L. Salamanca-Riba	16-Sep-99	31-Dec-02
TI 99-10	Study of the Response of Sand with Air Voids to Explosive Loading	10,800	L. Taylor	W. Fournery	16-Sep-99	28-Sep-01
<b>TOTAL FY99 =</b>		<b>\$ 238,455</b>				

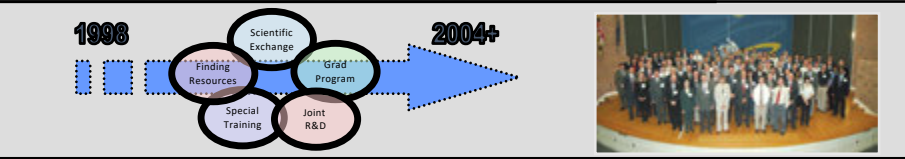
TI No.	TI Title	Funding Provided	IH POC	UMCP POC	Start Date	Completion Date
TI 00-1	Feasibility Study for Packaging of ASIC for IHD Circuit	30,000	A. Malkasian	A. Dasgupta	20-Oct-99	1-Mar-01
TI 00-2	A Framework for Multidisciplinary Design Optimization of Undersea Warheads with Multiple Targets and/or Sensors	200,000	A. Boyar	S. Azarm	8-Nov-99	12-Dec-00
TI 00-3	MEMS Packaging and Reliability Assessment	50,000	M. Deeds	P. Sandborn	1-Dec-99	30-Mar-01
TI 00-4	DRIE Microfabrication Technology for S&A Systems	14,000	L. Fan	D. DeVoe	1-Dec-99	22-Mar-01
TI 00-5	Support for the International Shock Wave/Dynamic Processes Workshop	16,100	S. Coffey	R. Armstrong	1-Dec-99	N/A
TI 00-6	Support for International 5-ISCIP Symposium	5,000	C. Clark	R. Armstrong	1-Dec-99	N/A
TI 00-7	Optomechanical Integration and Packaging of LIGA and DRIE S&A Systems	43,732	E. Litcher	D. DeVoe	18-Jan-00	2-Jan-01
TI 00-8	NSWC Product Area Coordinator and Business Process Reengineering Studies	52,310	S. Mitchell	R. Armstrong	2-Mar-00	3-Jul-00
TI 00-9	Support for Channeling Task	22,000	L. Taylor	W. Fournery	22-Mar-00	22-Jun-00
TI 00-10	Support for EXPLOMET	2,331	C. Clark	R. Armstrong	22-Mar-00	22-Jul-00
TI 00-11	Continuation of the Development of NLW Microprocessor Control System	27,500	P. Sturgill	A. Ramaswamy	14-Apr-00	14-Jul-00
TI 00-12	Molten Salt Oxidation - Reaction Chemistry and Environmental Verification	145,791	J. Salan	S. Buckley	19-Apr-00	31-Dec-01
TI 00-13	Improving Sensitivity of Metastable Intermolecular Composite Percussion Primers	27,500	M. Bichay	A. Ramaswamy	11-May-00	21-Dec-01
TI 00-14	Intergovernmental Personnel Assignment	137,280	S. Mitchell	R. Armstrong	5-Jun-00	4-May-01
TI 00-15	Continuous Process of BuNENA, Part II	20,000	P. Loukas	N. S. Wang	27-Sep-00	21-May-01
TI 00-16	Molten Salt Oxidation - Reaction Chemistry and Environmental Verification, Part II	45,000	J. Salan	S. Buckley	27-Sep-00	31-Dec-01
TI 00-17	Study of Small Column Insulated Delay Elements	16,500	P. Sturgill	A. Ramaswamy	1-Oct-00	20-Mar-01
<b>TOTAL FY00 =</b>		<b>\$ 855,044</b>				

TI No.	TI Title	Funding Provided	IH POC	UMCP POC	Start Date	Completion Date
TI 01-1	A Framework for Multidisciplinary Design Optimization-Based Design of Undersea Warheads w/Multiple Targets and/or Sensors	100,000	A. Boyar	S. Azarm	28-Nov-00	27-Nov-01
TI 01-2	Improving Sensitivity of Metastable Intermolecular Composite Percussion Primers	38,500	M. Bichay	A. Ramaswamy	28-Nov-00	27-Nov-01
TI 01-3	Support of the Standard Missile Program and Seminar Series	133,694	C. Fawls	D. Anand	2-Jan-01	21-Dec-01
TI 01-4	MEMS Package Architecture and Fiber Optic Plumbing	50,000	M. Deeds	P. Sandborn	12-Feb-01	30-Dec-01
TI 01-5	Time Phasing of Explosive Detonations for Obstacle Clearance	19,950	L. Taylor	W. Fournery	27-Mar-01	27-Sep-01
TI 01-6	Support for Channeling Task, Pt. II	5,700	L. Taylor	W. Fournery	27-Mar-01	22-Jun-01
TI 01-7	MEMS Multi-Chip Packaging and Integration of DRIE S&A Systems	50,352	L. Fan	D. DeVoe	10-Apr-01	20-Sep-02
TI 01-8	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform	100,000	A. Boyar	S. Azarm	10-Apr-01	31-Dec-01
TI 01-9	Development of Twin-Screw Extrusion Process for Fabricating Functionally Graded Energetic Materials	50,000	M. Gallant	H. Bruck	19-Apr-01	31-Dec-01
TI 01-10	Intergovernmental Personnel Assignment	216,000	S. Mitchell	D. Anand	2-Jul-01	31-Dec-02
TI 01-11	Compositional Studies of New Energetic Materials	87,000	A. Duong	D. Anand	16-Aug-01	28-Nov-03
TI 01-12	Characterization of Ultrafine Powders by HRTEM	5,500	V. Joshi	L. Salamanca-Riba	28-Sep-01	30-Jul-03
TI 01-13	Parachute Performance Investigation for IH Continuous Rod Warhead Delivery System	59,136	G. Chichirichi	R. Razenbach	28-Sep-01	28-Nov-01
TI 01-14	Initiation of Chemistry in Solid Explosives	118,434	T. Russell	D. Anand	1-Oct-01	30-Sep-02
TI 01-15	Confined Burn Facility - Environmental Measurements	25,000	T. Brennan	S. Buckley	28-Sep-01	28-Oct-02
<b>TOTAL FY01 =</b>		<b>\$ 1,059,266</b>				



TI No.	TI Title	Funding Provided	IH POC	UMCP POC	Start Date	Completion Date
TI 02-1	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform	25,000	A. Boyar	S. Azarm	20-Dec-01	18-Dec-02
TI 02-2	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform	217,500	S. Landsberg	S. Buckley	29-Jan-02	30-Jun-03
TI 02-3	Research and Development Support for Continuous Twin-Screw Processing of Propellants	376,100	C. Murphy	D. Anand	1-Apr-02	30-Sep-04
TI 02-4	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform - Ph. 2	100,000	A. Boyar	S. Azarm	4-Apr-02	3-Jan-03
TI 02-5	Measurement of Soil Stress Beneath Static Surface Loads	100,048	L. Taylor	W. Fournery	17-Apr-02	30-Jun-03
TI 02-6	Enhanced Bomb Effects for Obstacle Clearance	28,000	S. Landsberg	R. Bonenberger	1-May-02	30-Sep-03
TI 02-7	Manuscript Preparation	35,000	J. Short	D. Anand	16-Jul-02	15-Dec-04
TI 02-8	Quantitative Microstructural Characterization of Functionally Graded Inert Formulations for Energetic Materials Fabricated in a Twin-Screw Extrusion Process	25,000	F. M. Gallant	H. Bruck	22-Jul-02	31-Dec-02
TI 02-9	CEMIE Project for Second Generation Safe and Arm Device Research	30,000	L. Fan	D. DeVoe	23-Sep-02	15-Dec-04
TI 02-10	Confined Burn Facility Burn Chamber Corrosion and Corrosion Control Study	44,000	T. Brennan	A. Ramaswamy	23-Sep-02	1-Nov-04
TI 02-11	Effect of Burial on the Threat Posed by Anti Tank and Anti Invasion Mines	10,005	L. Taylor	W. Fournery	23-Sep-02	30-Jun-03
TI 02-12	Small Scale Tests and Analysis Support in FY02 - Phase II	20,000	S. Landsberg	W. Fournery	23-Sep-02	30-Sep-03
<b>TOTAL FY02 =</b>		<b>\$ 1,010,653</b>				

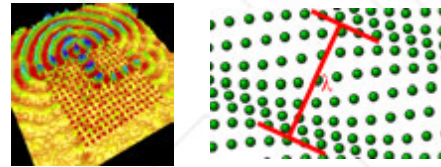
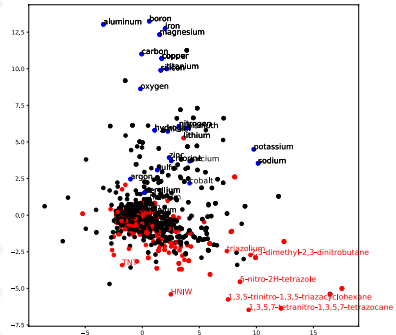
TI No.	TI Title	Funding Provided	IH POC	UMCP POC	Start Date	Completion Date
TI 03-1	Distance Learning Program	40,000	R. Kavetsky	D. Anand	23-Oct-02	22-Jan-03
TI 03-2	Initiation of Chemistry in Solid Explosives	23,823	T. Russell	D. Anand	23-Oct-02	22-Dec-02
TI 03-3	MISO Analytical Software Development Program	25,000	M. Lateulere	S. Buckley	4-Dec-02	28-Nov-03
TI 03-4	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform	90,000	A. Boyar	S. Azarm	18-Dec-02	28-Nov-03
TI 03-5	Intergovernmental Personnel Assignment	216,000	S. Mitchell	D. Anand	2-Jan-03	30-Sep-04
TI 03-6	Study of Small Column Insulated Delay Elements	16,500	P. Sturgill	A. Ramaswamy	24-Jan-03	30-Jun-03
TI 03-7	Dispersion of Aluminum Nanoparticles in Polymer Composites Using Twin Screw Extrusion Processing	25,000	C. Murphy	H. Bruck	10-Feb-03	30-Sep-04
TI 03-8	Continuation of Studies of Small Column Insulated Delay (SCID) Elements	11,000	P. Sturgill	A. Ramaswamy	7-Mar-03	1-Jun-04
TI 03-9	Effect of Burial On the Threat Posed by Anti Tank and Anti Invasion Mines	139,989	L. Taylor	W. Fournery	17-Apr-03	31-Dec-04
TI 03-10	Development of a Hopkinson Bar Experimental Setup for Dynamic Testing of Nanoenergetic Materials	59,956	B. Wilson	J. F. Cárdenas-García	17-Apr-03	30-Jun-04
TI 03-11	Fabrication and Design of Multifunctional Energetic Structures Using Gradient Architecture	60,008	B. Wilson	H. Bruck	17-Apr-03	31-Dec-04
TI 03-12	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform	40,000	A. Boyar	S. Azarm	1-May-03	31-Dec-03
TI 03-13	CAD/PAD Lean Manufacturing Implementation	85,000	S. Bumgarner	J. Herrmann	29-Apr-03	31-Dec-04
TI 03-14	Explosive and Material Safety in Harbors - Pt. 2	50,000	S. Landsberg	S. Buckley	29-Apr-03	30-Jan-04
TI 03-15	Continuation of Studies of Small Column Insulated Delay (SCID) Elements	38,500	P. Sturgill	A. Ramaswamy	2-Jun-03	11-Jun-04
TI 03-16	Support for Conference	4,000	R. Kavetsky	L. Schmidt	2-Jun-03	1-Feb-04
TI 03-17	Virtual Manufacturing Training Prototype	36,000	C. Clark	J. Herrmann	2-Jun-03	31-Dec-04
TI 03-18	Explosive and Material Safety in Harbors - Pt. 3	50,000	S. Landsberg	S. Buckley	1-Jul-03	30-Jun-04
TI 03-19	CAD/PAD Lean Mfg. Implementation - Pt. II	65,000	S. Bumgarner	J. Herrmann	1-Jul-03	31-Dec-04
TI 03-20	Support for Shock Wave Conference	20,000	S. Coffey	D. Anand	28-Jul-03	27-Jul-04
TI 03-21	Explosive and Material Safety in Harbors - Pt. 4	55,000	S. Landsberg	S. Buckley	4-Aug-03	30-Jan-04
TI 03-22	Design and Implementation of Lean Motor Loading Operation	46,519	P. Loukas	J. Herrmann	4-Aug-03	31-Oct-03
TI 03-23	Extrusion Die Fabrication	36,685	S. Richman	D. Anand	4-Aug-03	13-Feb-04
TI 03-24	A Pilot Project to Explore Applicability of Data Mining to Energetics Manufacturing	24,888	S. Prickett	S. K. Gupta	1-Oct-03	31-Dec-04
TI 03-25	Explosive and Material Safety in Harbors - Pt. 5	795,000	S. Landsberg	G. Jackson	1-Oct-03	31-Dec-04
<b>Total FY03 =</b>		<b>\$ 2,053,868</b>				



TI No.	TI Title	Funding Provided	IH POC	UMCP POC	Start Date	Completion Date
TI 04-01	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform	110,000	A. Boyar	S. Azarm	1-Jan-04	1-Nov-04
TI 04-02	Lean Battery Production Study and Design	12,794	C. Clark	J. Herrmann	22-Dec-03	31-Dec-04
TI 04-03	Lean Battery Manufacturing Facility Design	114,257	C. Clark	J. Herrmann	23-Feb-04	31-Dec-04
TI 04-04	Small Scale Buried Mine Testing	100,000	L. Taylor	W. Fournery	23-Feb-04	31-Dec-04
TI 04-05	Lean J147 RSD Retrofit Process	10,904	M. Ibrahim	J. Herrmann	25-Feb-04	31-Dec-04
TI 04-06	Multiple Criteria Optimization and Selection Using Warhead Design as a Platform	12,000	A. Boyar	S. Azarm	17-May-04	30-Sep-04
<b>Total FY04 =</b>		<b>\$ 359,955</b>				

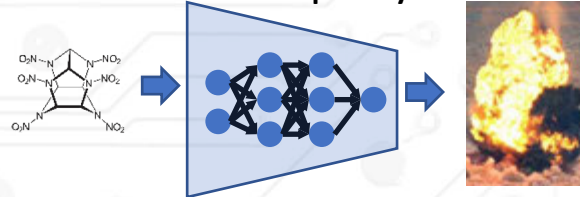
# ~~CECD Present~~ Modernization

## Natural Language Processing of Energetics Literature

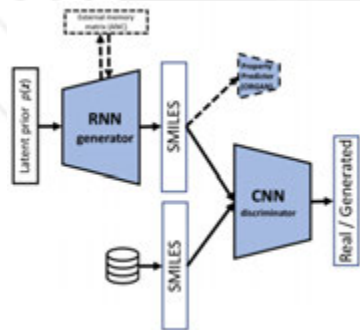


## Phonons in Energetics (Wave Matter Interactions)

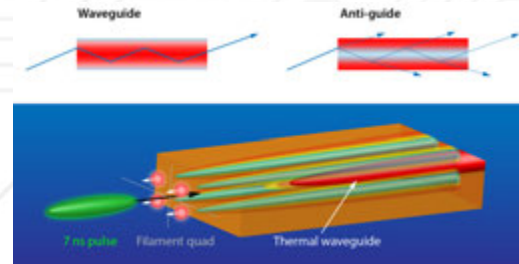
## Machine learning for Detonation Property Prediction



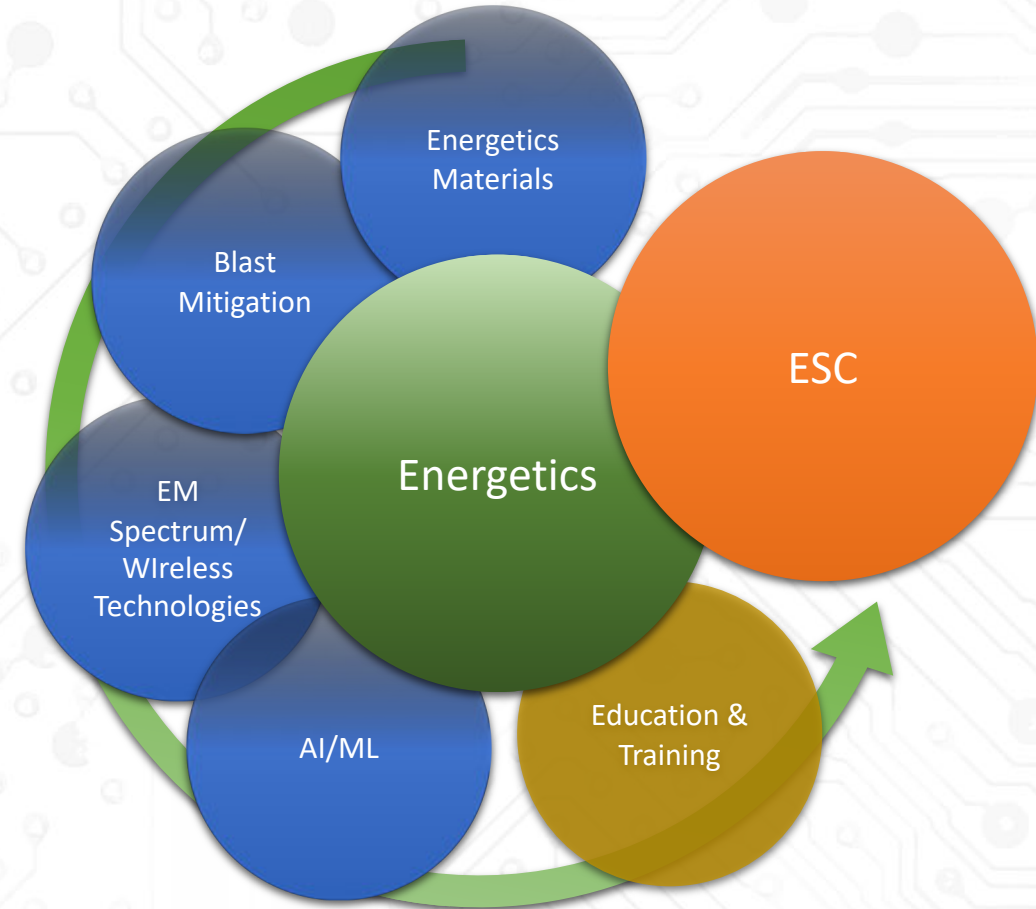
## Generative Adversarial Networks for Energetic Molecule Speculation



## Waveguides in air



(from American Physical Society)

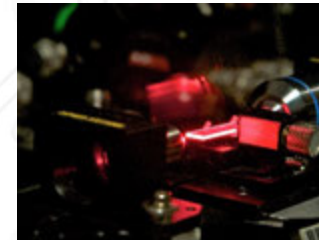
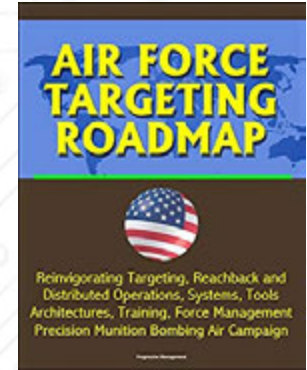


# Future of Energetics @ CECD

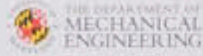
Where's my MI?



- **Energetics**
  - Beyond Impact & Shock
  - Platform Effects
  - Light-Wave-Matter Interaction
  - Machine-Intelligent Speculation & Synthesis
- **Machine Intelligence**
  - Tactical & ISR applications
  - Corp rear, service & support
  - Operations, management, budget, business
  - C-suite force multiplier
  - Force structure management



# Neilom Engineering for Social Change Award



## Assistive Technology

Students in the Fall 2016 Engineering for Social Change class voted to support the program proposal from nonprofit V-Linc, providing funds to support custom assistive technology solutions development as well as a biannual custom bike clinic with engineering student and professional volunteers.



## STUDENT'S VOICE

"Today's engineers must mindfully consider the impact their designs can have upon the world, and seek opportunities such as philanthropy and design thinking to make the world better for people and the planet." - M. Solomon

Engineering for Social Change  
at the intersection of education and technology



# Neilom Engineering for Social Change



## Unintended Consequence: Waste

Students in the Fall 2017 ESC class voted to support a program proposal developed by a student team together with the Oyster Recovery Foundation. The funds went to improving the collection, processing and reuse of oyster shells into the Chesapeake Bay, directly addressing runoff agricultural waste and improving water quality.



## STUDENT'S VOICE

... is about being present in the world and taking responsibility for their own situation. Don't attempt to solve their need upon them, instead listen...

... tive it is to bring engineering to the people. It focuses on predicting and preventing problems at the source of the problem.

Engineering for Social Change  
at the intersection of education and technology

Education and Technology



# Dylan Hazelwood

Assistant Director,  
Center for Engineering Concepts Development (CECD),  
Department of Mechanical Engineering,  
University of Maryland, College Park

# Engineering for Social Change (ESC) Program



# What is Engineering for Social Change?

- Engineering is not just engineering
- Impact of engineering on society, both **intended** and **unintended**
- We need well-rounded, global engineers
- Students want to make a difference!



# Engineering for Social Change Program

ESC Course  
ESC Symposium  
ESC Outreach  
ESC Fellows  
ESC Interns  
ESC Research

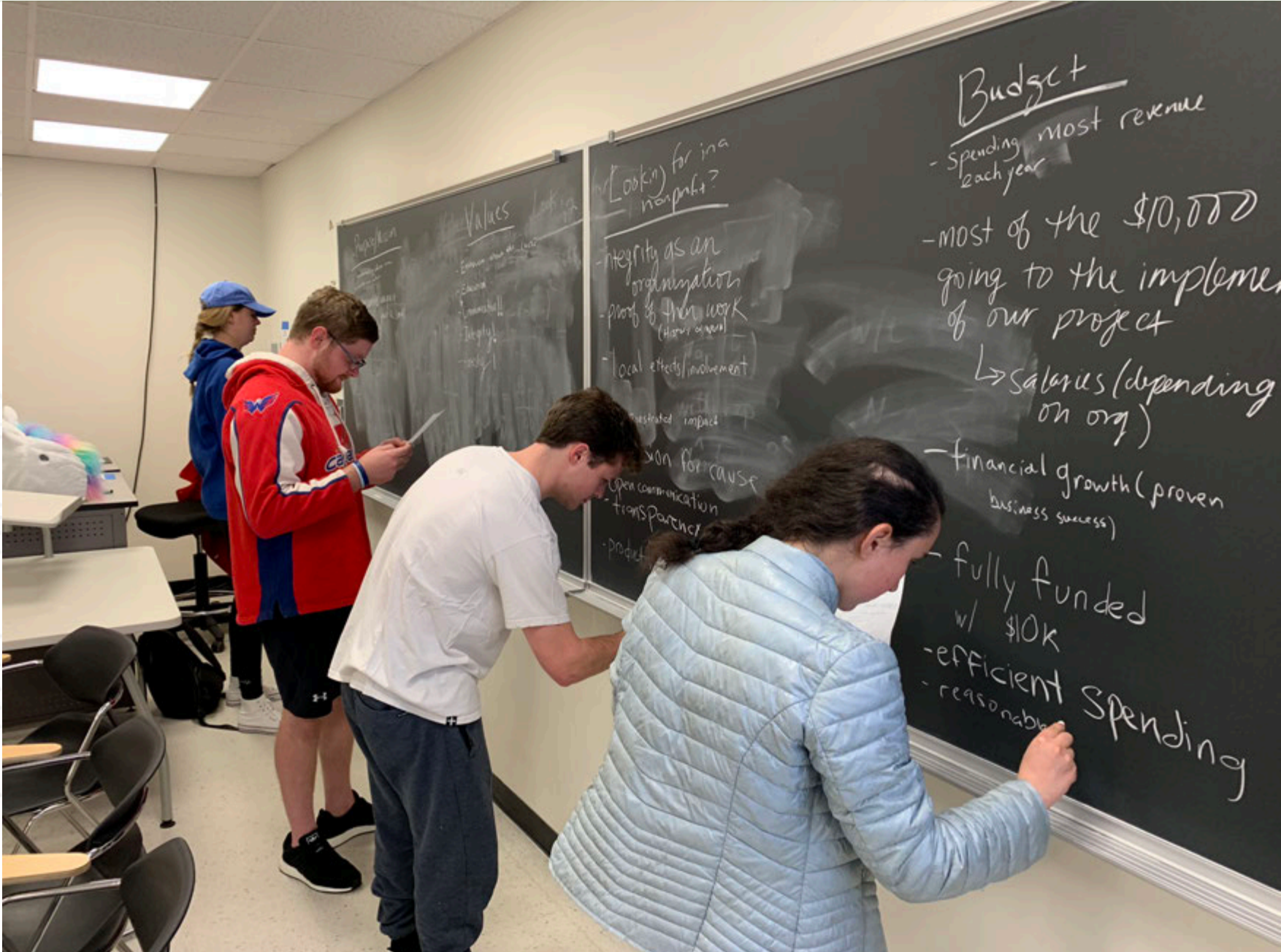


# Engineering for Social Change Course

Some of the  
unintended  
consequences  
of engineering  
successes



# Engineering for Social Change Course





**BEFORE**



**AFTER**



**AFTER MUCH LONGER**









# OYSTER RECOVERY PARTNERSHIP | ORP

*Restoring Our Oyster.  
Cleaning Our Bay.  
Preserving Our Future.*



# Fall 2018 ENME/ENES 467 Engineering for Social Change



**Winning  
Student Team**

**Pilot Breast Cancer  
Screening Clinic  
(AWCAA)**

# Engineering for Social Change Course

5 classes, ~200 students

MechE and beyond..

5 Projects

\$50,000 awarded

# Engineering for Social Change Symposium



# Engineering for Social Change Outreach



# CECD/ESC Fellows Program

Graduate Student support of \$25,000 for a research project with a positive social impact component.





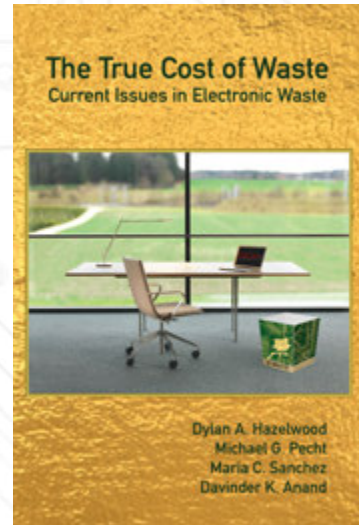
ESC Interns



# ESC Research: Electronic Waste



Estimated 150,000 tons of e-waste in Maryland per year, growing at 5%







SCHOOL OF  
PUBLIC POLICY

DO GOOD INSTITUTE

# Dr. Robert Grimm

Levenson Family Chair in  
Philanthropy and Nonprofit Leadership,  
Director, Do Good Institute  
School of Public Policy  
University of Maryland, College Park





THE DEPARTMENT OF  
MECHANICAL  
ENGINEERING



# Dr. George Dieter

Dean Emeritus, Clark School  
Professor Emeritus,  
Department of Mechanical Engineering,  
University of Maryland





THE DEPARTMENT OF  
MECHANICAL  
ENGINEERING

# Dr. Michael Pecht

Director, CALCE

George E. Dieter Chaired Professor,  
Department of Mechanical Engineering,  
University of Maryland, College Park

## FROM SCIENCE TO SEAPOWER

A ROADMAP FOR S&T REVITALIZATION

POSTSCRIPT 2010



Robert A. Kavetsky  
Michael L. Marshall  
Davinder K. Anand

## SIMULATION-BASED INNOVATION AND DISCOVERY

Energetics Applications



Edited by

Davinder K. Anand  
Satyandra K. Gupta  
Robert A. Kavetsky

## TRAINING IN VIRTUAL ENVIRONMENTS

A Safe, Cost-Effective, and Engaging  
Approach to Training



Satyandra K. Gupta  
Davinder K. Anand  
John E. Brough  
Maxim Schwartz  
Robert A. Kavetsky

## S&T Revitalization A New Look



Davinder K. Anand  
Lisa M. Frehill  
Dylan A. Hazelwood  
Robert A. Kavetsky  
Elaine Ryan





## Rare Earth Materials *Insights and Concerns*



Michael G. Pecht  
Robert E. Kaczmarek  
Xin Song  
Dylan A. Hazelwood  
Robert A. Kavetsky  
Davinder K. Anand

## Engineering for Social Change



*Davinder K. Anand  
Dylan A. Hazelwood  
Michael G. Pecht  
Mukes Kapilashrami*

*Engineering is not just Engineering*

## The True Cost of Waste Persistent Issues in Electronic Waste



Dylan A. Hazelwood  
Michael G. Pecht  
Maria C. Sanchez  
Davinder K. Anand

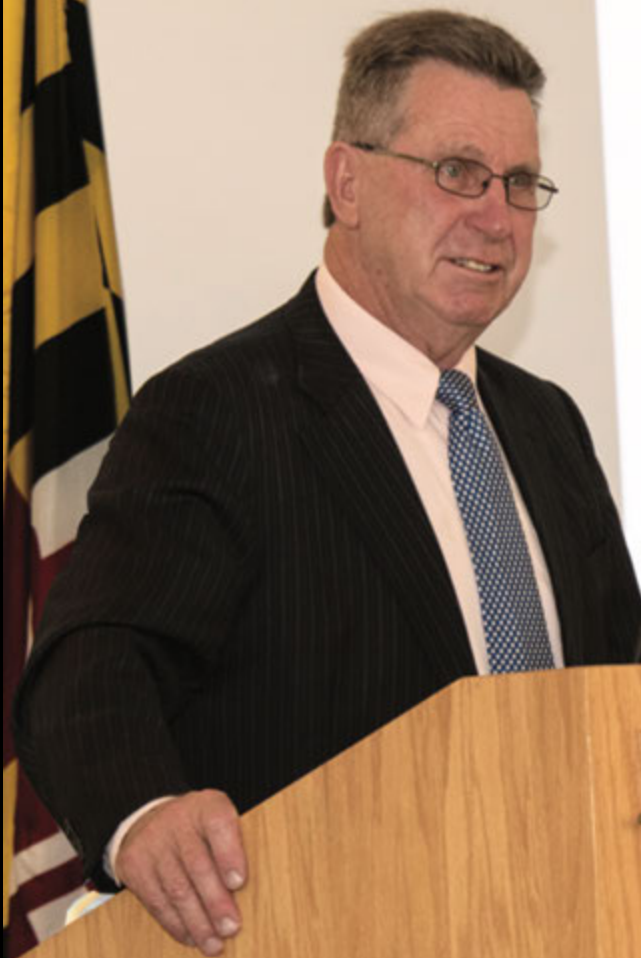


# The Honorable Chris Van Hollen

*United States Senator for Maryland*







# Entrepreneurship Challenge

## AGENDA

- 6:00 p.m. - 6:05 p.m.  
Introduction & Welcome  
Dr. Mary Beth Klinger  
Professor of Business, College of Southern Maryland  
Principles of Management (BAD 1210)
- 6:05 p.m. - 6:15 p.m.  
Opening Comments & Introduction of  
Maryland State Senator Thomas M. Middleton  
Dr. Davinder K. Arora, Director  
Dylan Hazelwood, Assistant Director  
Center for Engineering Concepts Development (CECD)  
Department of Mechanical Engineering  
University of Maryland
- 6:15-7:00 PM  
Student Presentations
- 7:00-7:05 PM  
Remarks  
Laurieley Gotthard



Middleton Lunch  
April 17, 2019



# The Honorable Thomas “Mac” Middleton

Senator from Charles County, Maryland

# Group Photo

## Middleton Luncheon in the Rotunda





*Celebrating the  
Twentieth  
Anniversary of the  
Center for Engineering Concepts Development*



*From energetics research to engineering education*

*Thomas "Mac" Middleton Luncheon*

*April 17, 2019*



*The 125th Anniversary of the  
Department of Mechanical Engineering,  
University of Maryland, College Park.*



## Our Vision

*Is* to serve as a platform for experimenting with new ideas in engineering education, future technologies, research, and the impact of engineering on society.

## Our Mission

*Is* to undertake activities to benefit the economic welfare of the state of Maryland and the Nation by supporting symposia, special groups, courses and innovative activities of contemporary interest.

## **Program of Events**

CECD 20th Anniversary & Middleton Luncheon

*April 17th, 2019*

Jeong H. Kim Engineering Building  
University of Maryland, College Park



**11:00am – 11:30am**

Registration

**11:30am – 12:30pm**

Dr. Davinder Anand – *Welcome*

Dr. William Kirwan

Dr. Balakumar Balachandran

Dr. Peter Chung

Mr. Dylan Hazelwood

Dr. Robert Grimm

Dr. George Dieter

Dr. Michael Pecht

The Honorable Chris Van Hollen

The Honorable Thomas “Mac” Middleton

**12:30pm – 1:30pm**

Group Photograph

Lunch

**1:30pm**

Event Concludes



## *Our Speakers*



**The Honorable Thomas “Mac” Middleton** is a longtime supporter of the Center for Engineering Concepts Development and the University of Maryland. “Mac” Middleton served in the Maryland State Senate from 1995 to 2019, representing Maryland's District 28 in Charles County. In 2018, Middleton's name was added to the U.S. Route 301 Potomac River bridge, making it officially the Governor Harry W. Nice Memorial/Senator Thomas “Mac” Middleton Bridge.



**The Honorable Chris Van Hollen** has served as United States Senator from the State of Maryland since November 2016. Since 2003 to 2017, he held the position of U.S. Representative for Maryland’s 8th congressional district, where he served as a member of the Democratic leadership and was elected by his colleagues to be the Ranking Member of the House Budget Committee.



**Dr. W. E. “Brit” Kirwan** is a national leader in higher education. He led the University of Maryland, College Park campus three times, first as acting Chancellor in 1982, then again in 1988, and as the 26th President from 1989 to 1998. He then became the 12th President of The Ohio State University for a period of four years, and then returned to serve as Chancellor of the University System of Maryland from 2002 to 2015.



**Dr. Balakumar Balachandran** is a Minta Martin Professor and Chair of the Department of Mechanical Engineering at the University of Maryland, having served since 2010. He previously served as Director of Graduate Studies and Associate Chair from 2006 to 2010. He is a noted researcher and author of many papers and books in the area of nonlinear mechanics.



**Dr. George Dieter** is an ardent supporter of CECD's Engineering for Social Change program. He is Professor Emeritus of Mechanical Engineering and Glenn L. Martin Institute Professor of Engineering, as well as Dean Emeritus of the Clark School, having served from 1977 to 1994. He is also a member of the National Academy of Engineering, and served as President of ASEE from 1993 to 1994.



**Dr. Michael Pecht** is the George E. Dieter Professor of Mechanical Engineering and the founder and Director of CALCE (Center for Advanced Life Cycle Engineering) at the University of Maryland. CALCE is a world leader in reliability testing, failure analysis, supply chain management, and prognostics technologies and methodologies. He was inducted into the Innovation Hall of Fame in 2011 for pioneering innovations in advanced reliability and prognostic methods for electronics.



**Dr. Peter Chung** is an Associate Professor in the Department of Mechanical Engineering at the University of Maryland, having joined in 2013. He serves as the Energetics Leader in the Center for Engineering Concepts Development. From 2003 to 2013, he served as Team Leader for Interdisciplinary Computational Sciences and Engineering in the Computational and Information Sciences Directorate at the Army Research Laboratory at Aberdeen Proving Ground.



**Dr. Davinder K. Anand**, Professor Emeritus of Mechanical Engineering Department, joined the University of Maryland faculty in 1965. His primary interest in research and teaching has been control systems. He served as the Chair of Mechanical Engineering from 1991 to 2002, and then became the Director of the Center for Engineering Concepts Development from 1999 to present. He formed the nonprofit The Neilom Foundation in 2013 to help young people at the intersection of health, education and technology.



**Mr. Dylan Hazelwood** serves as the Assistant Director of the Center for Engineering Concepts Development. He joined the Mechanical Engineering Department in 1998, directing information technology efforts until 2009, when he joined CECD. He has co-authored several books and manages the Center's innovative Engineering for Social Change program.



**Dr. Robert Grimm** is the Levenson Family Chair in Philanthropy and Nonprofit Leadership and Director of the Do Good Institute. The Do Good Institute is housed in the School of Public Policy at the University of Maryland. It is a campus-wide hub that provides education, opportunities and resources to develop the next generation of nonprofit leaders, social innovators and civic-minded students and alumni. He works closely with CECD to enhance the Engineering for Social Change program.

## History of the Center for Engineering Concepts Development (CECD)

The formerly-named Center for Energetic Concepts Development (CECD) was established at the University of Maryland, College Park, as a cooperative research activity between the Naval Surface Warfare Center Indian Head Division (NSWC-IHD) and the University of Maryland, College Park. In response to a proposal from Professors Ronald Armstrong, Davinder K. Anand and William Fourney, an agreement was signed in 1998 which included research, graduate education, technology transfer, and exchange of technical personnel. The period of performance was five years, and the founding Director was Professor Ronald Armstrong.



*Signing Ceremony for the Center for Energetic Concepts Development agreement.*

Upon signing the agreement, NSWC awarded \$50K to CALCE and shortly after that in 1999 Professor Armstrong retired and left to go to Eglin Air Force Base, Florida as Senior Scientist in the Munitions Directorate. Professor Davinder K. Anand became the director, and continues to serve in this role in 2019. Dr. James Short, who formally worked at NSWC-IHD and then the Office of Naval Research (ONR), became the Deputy Director.

For the next two years small grants came to CECD until the incidents of terrorism in the US on September 11, 2001. A few days after the incident the Office of Naval Intelligence (ONI) awarded \$3M to establish a project supporting NSWC and CECD to investigate the safety of harbors. This gave impetus to additional funding from a variety of sources over the next sixteen years. Research support was received from the State of Maryland, the Naval Surface Warfare Center

Indian Head Division (NSWC-IHD), the Office of Naval Intelligence (ONI), the Office of Naval Research (ONR), Army Research Laboratory (ARL), Air Force Office of Scientific Research (AFOSR), National Science Foundation (NSF), Department of Housing and Urban Development (HUD), Lawrence Berkeley National Laboratory (LBNL), Los Alamos National Lab (LANL), Arete Associates, NCI Information Systems, Iktara and Associates and the Sandia National Laboratories (SNL). In addition, we received support from ONR for equipment purchase for a Micro-Electro-Mechanical-Systems MEMS Laboratory in the Department (Professor Don Devoe), and two Young Investigator Awards from ONR (Professors Hugh Bruck and Steven Buckley). All the agreements included a significant cost share from the University of Maryland.



*From left: Senator Thomas “Mac” Middleton, Elaine Ryan, Davinder Anand, James Short, Ronald Armstrong, Joseph Shannon, Robert Kavetsky.*

The vision of CECD was to become the preeminent National Center concerned with the science and manufacturing of energetic materials and products for national defense and security, and further, to train the next generation of scientists and engineers working in energetics through its graduate educational and research programs. Research in Energetics comprised not only the traditional work in formulations, but manufacturing and packaging of the energetic material, as well. This included the entire gamut of engineering, design, test and evaluation, prototyping, and in some cases, manufacture of the product itself. At Indian Head this ranged from large packages to small cartridge actuated and propellant actuated (CAD/PAD) like devices. CECD faculty and students were engaged in



a number of these activities, which included: Energetics materials, Functionally Graded Materials, MEMS Components and Packaging, Nano Particles and Systems, Design Knowledge Archiving and Retrieval, Lean Manufacturing, Optimization and Design, Data Mining and Informatics, Combustion Systems, Port Safety, and Visualization in Virtual Environments.



*Strategic planning at NSWC Indian Head*

As part of the Center's outreach activities CECD established a graduate program in 2009, in addition to the traditional programs already offered by the Department. This new program was for the degree of Professional Master of Engineering in Energetic Concepts. A certificate program was also offered in Energetics beginning in 2012, consisting of four unique courses in the field. As of 2018, 31 Masters' degrees and 7 Graduate Certificates in Energetic Concepts were awarded through this program.

While several engineers and scientists worked together upon specific products, five appointments in CECD were targeted to achieve very specific goals. They include the following:

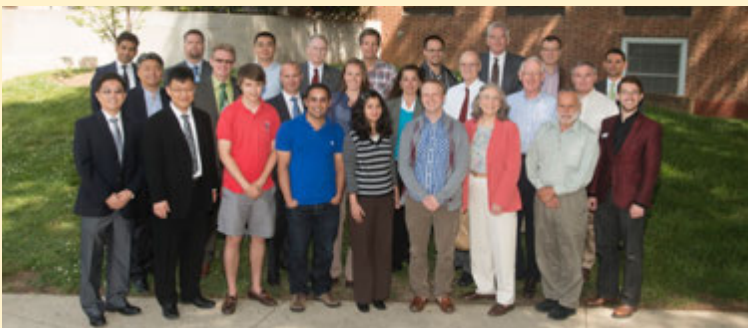
- Robert Kaczmarek was appointed as Senior Visiting Research Scholar in Mechanical Engineering for one year.
- Robert Kavetsky was appointed as senior scientist in Mechanical Engineering for one year.
- William Cocimano was appointed as a Senior Research Scientist with CECD, and worked with NAVSEA in Washington DC.

- Dr. Jerry W. Forbes was appointed as an Adhoc Visiting Professor of Mechanical Engineering at the University of Maryland.
- Dr. Thomas M. Klapötke, Professor of Mechanical Engineering from the Ludwig Maximillian University (LMU) in Munich, Germany, was appointed as Visiting Professor of Mechanical Engineering and Chemistry.

CECD hosted several symposia and lectures as part of our continuing activities, both here and abroad. These included topics such as Energetics, Traumatic Brain Injury, Critical Materials, Automation, Computation Enabled Materials Discovery, Data Driven Design, and Engineering for Social Change. The largest symposium we organized and supported was the International Detonation Symposium over a period of 16 years. These symposia, with an average of 350 attendees, were held in San Diego in California, Richmond in Virginia, Coeur d'Alene in Idaho and San Francisco in California.



*CECD Autonomy Symposium - From left: Dylan Hazelwood, James Short, Balakumar Balachandran, Davinder Anand, Millard Firebaugh, John Bohanan, Darryll Pines.*



*CECD Computation Enabled Materials Discovery Symposium.*

The first CECD Research Review Day was held on May 21, 2003. It was attended by the Honorable Kumar P. Barve, the Majority Leader in the Maryland House of Delegates, Steven Mitchell, Technical Director at Naval Surface Warfare Center Indian Head (NSWC-IH) and almost fifty scientists and engineers from UMD and the Navy.



*CECD's first Research Review Day was held in 2003 at the University's Inn and Conference Center.*

In recognition of the fact that the Southern Maryland region had a long history of contribution to the field of energetics development, CECD proposed the establishment of South Maryland Initiative for Energetics Capability Development in 2004. The base at Indian Head had been a leader in Navy ordnance development and testing for over 100 years. The need for this initiative arose from two pressing requirements, both critically linked to U.S. national security. The first was the imperative to regenerate the energetics professional workforce. The second was the essential need to develop ever more sophisticated systems in a timeframe that will ensure our national security.



*MOU Signing Ceremony: US Congressman Steny Hoyer; US Senator Paul Sarbanes; Robert Kavetsky of ONR; MD Senator Thomas "Mac" Middleton; Charles County Commissioners President Wayne Cooper. Seated: Capt. Joseph Giaquinto, Commander, NSWC-IHDIV; Professor Davinder Anand, Director, CECD; Ms. Ann Smith, Dean of Career & Technical Education, College of Southern Maryland.*

The Southern Maryland Initiative for Energetics Capability Development would meet emerging national needs by expanding and enhancing the mission of the Center for Energetic Concepts Development (CECD) at the University of Maryland and the establishment of the Energetics Technology Center (ETC). The initiative was funded by ONR, and ETC was founded with headquarters in La Plata, MD. ETC was developed to conduct applied research and technology development largely in Charles County Maryland facilities in partnership with the College of Southern Maryland and selected industry/technology institutions nationwide. The Center was formally established with a public ribbon cutting in La Plata, Maryland by Senator Barbara Mikulski on October 12, 2006.



*Ribbon cutting ceremony for the Energetics Technology Center in La Plata, MD. Attendees included Maryland Senator Barbara Mikulski and Senator Paul Sarbanes.*

On December 14, 2008, CECD celebrated its achievements in advancing the field of energetics and training the next generation of energetics experts. CECD hosted the celebration of our tenth year with University of Maryland Chancellor William Kirwan and Senator Thomas “Mac” Middleton as the keynote speakers.



*Chancellor William Kirwan addresses the attendees at CECD's 10th anniversary.*



*CECD celebrates its 10<sup>th</sup> anniversary with guests from campus, government, industry and beyond.*

By 2014 CECD had expended almost \$30M supporting over 250 projects funded by NSWC, ONR, ONI, NSF, ARL, AFOSR, HUD and the State of Maryland. Faculty from eleven University Departments and Schools were supported by CECD.

CECD has supported over 100 students for Masters and PhD degrees. The students, however, were under direct control of the faculty members whom we funded. In addition, we awarded 31 Masters' degrees and 7 Graduate Certificates in Energetic Concepts.

With seventeen years of successful activities behind us, CECD entered a new era. While Dr. Anand continued as Director of CECD, Professor Peter Chung became the lead on all of our activities in energetics. Dylan Hazelwood formally became the Assistant Director and CECD now became the **Center for Engineering Concepts Development**. Rear Admiral (Ret.) Millard Firebaugh was appointed Minta Martin Professor of Practice and Dr. James Short became senior analyst. We received additional support from the Federal Highway Administration (FHWA) to support the activities of Dr. Short. As part of his duties he also became the editor of the Journal of Energetics. While we continued our work in energetics, we established a group in Engineering for Social Change (ESC). The relationship with NSWC and ARL continued, as did the support from the State of Maryland.

The Energetics research under the guidance of Professor Peter Chung consisted of signing a CRADA with ARL, continuing our research in energetics, which included the topics of computation enabled materials discovery, acoustic mixing, machine learning, and participating in the Gordon conference. This work is being supported by NSWC, ONR, ARL, NSF, ETC and the State of Maryland.

The Engineering for Social Change (ESC) Program was developed in conjunction with the School of Public Policy. ESC is defined as the examination and mitigation of the unintended consequences of engineering on society. The program is comprised of the following components, namely; An innovative undergraduate course addressing the mitigation of the unintended consequences of engineering; Graduate research fellows; Undergraduate interdisciplinary teams; Collaboration with a community college within the State; An intern program with the Do Good Institute, and finally, the Engineering for Social Change book series. At the end of the year the program hosts an annual meeting and reception celebrating the successes of our students.

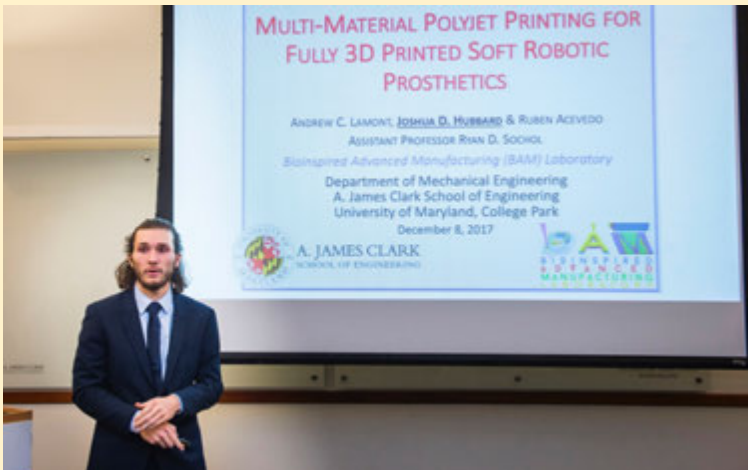


*Engineering for Social Change students, Dean Pines, faculty and staff of Mechanical Engineering and the School of Public Policy celebrate the Neilom Foundation grant to V-Linc, a local nonprofit working in assistive technology.*

The successful Engineering for Social Change course was developed in conjunction with the Drs. Robert Grimm and Jennifer Littlefield of the School of Public Policy. As of 2019, 191 students from across the Engineering college had taken the course, and \$50,000 had been awarded to local non-profit organizations on behalf of the Neilom Foundation, CECD's non-profit partner in ESC. This unique course sought to inculcate in our students an appreciation of the social change engineering creates and how both for-profit and non-profit organizations can act as catalysts.

The ESC Fellows initiative was designed to support the work of a graduate student in the Department with a grant of \$25,000. The projects selected by a committee were chosen as those that showed the most promise in creating positive social change. CECD supported the following projects:

- *Automated Palpation For Breast Lumps Using a Piezoresistive “Smart Bra”*, **Advisors:** Hugh Bruck, Elizabeth Smela, Miao Yu.
- *Probing Water-Holey-Graphene Interactions for Removing Lead from Water and Oil-Water Separation*, **Advisor:** Siddhartha Das.
- *Multi-Material Polyjet Printing for Fully 3D Printed Soft Robotic Prosthetics*, **Advisor:** Ryan Sochol.
- *Acoustic Waves for Non-Contact Removal of Chemical Hazards*, **Advisor:** Peter Chung.
- *A Comparison of Water Quality and Energy Efficiency in two neighboring Maryland Counties*, **Advisor:** Jelena Srebric.
- *Explosive Wellbore Fracturing*, **Advisor:** William Fourney.



*Student Joshua Hubbard, working under Professor Ryan Sochol, presents on the ESC Fellows work on soft robotics.*

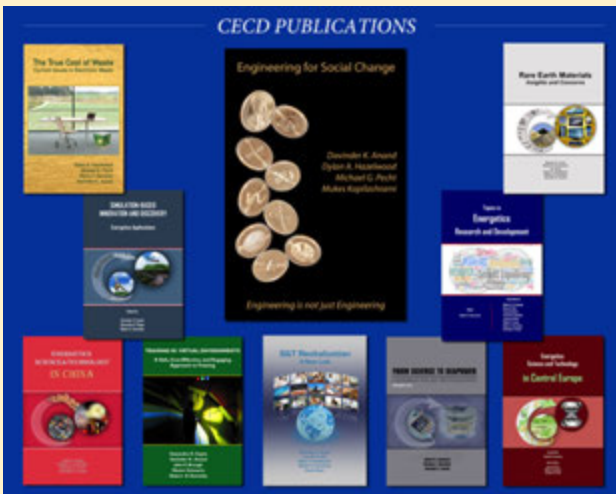
Continuing a long-standing relationship with the College of Southern Maryland (CSM), CECD reached out in 2015 to establish an offshoot of the ESC course held at the University of Maryland. This course emphasized the mitigation of unintended consequences through social entrepreneurship. The engagement of CSM students in developing team projects with local nonprofit organizations was highly successful. Student teams competed, and a panel of judges selected the most effective nonprofits and projects in the Southern Maryland community. After moving to CSM’s newly formed Entrepreneur and Innovation Institute, this experiment expanded to a second campus in Spring 2018. After three impressive cycles, reaching dozens of local

nonprofits, many CSM students and a variety of community members, the successful program then transitioned to being fully run by CSM as a permanent part of the curriculum.



*CECD Outreach efforts culminate in the Entrepreneurship in Southern Maryland Challenge at the College of Southern Maryland.*

A book, entitled “Engineering for Social Change: Engineering is Not Just Engineering” was authored in 2016 by members of both CECD and CALCE to encapsulate the ideas underpinning the ESC program. Almost 200 copies of this book have been provided for free to students undertaking the course, and hundreds of others circulated to the research and education community throughout the world. CECD has a long history of publishing books in niche areas of interest, having published eight previous titles.





In 2018, CECD started a new experimental program in the area of electronic waste, and invited local high school students to engage in that learning experiment by participating in a waste tracking project. The students spent the summer learning about how electronic waste is handled, where it ends up around the world, dismantling broken electronics and placing tracking devices inside the items. They then worked to deploy these items to waste transfer stations, stores, and nonprofits throughout Maryland.



*CECD's high school interns engaged in dismantling electronic waste items for tracker placement.*



*Electronic Waste Project Review. From left: Fitzgerald Walker, Balakumar Balachandran, Terry Island, Henry Haslach, Davinder Anand, Rushil Shah, Katheryn Wang, Mya Mitchell, Sandra Yen, Dylan Hazelwood, Kenneth Kiger, Peter Chung, Andrew Latchman.*

With twenty years behind us we have an optimistic outlook for CECD, and consistent with our vision we will continue to experiment in new frontiers and niche areas of research and education.

## CECD-supported Faculty

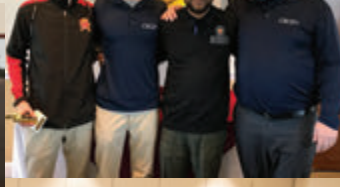
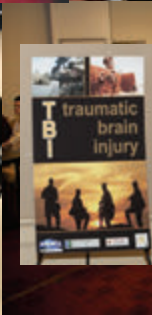
<b>Department</b>	<b>Faculty</b>
Mechanical Engineering	Ronald Armstrong, Shapour Azarm, Balakumar Balachandran, Amr Baz, David Bigio, Robert Bonenberger, Hugh Bruck, Steven Buckley, Jaime Cardenas-Garcia, Steven Chen, Nikhil Chopra, Peter Chung, William Cocimano, Siddhartha Das, Abhijit Dasgupta, Jaydev Desai, Donald DeVoe, Millard Firebaugh, Jerry Forbes, William Fourney, Mark Fuge, Satyandra Gupta, David Han, Henry Haslach, Jeffrey Hermann, Gregory Jackson, Mukes Kapilishrami, Robert Kavetsky, Kenneth Kiger, Thomas Klapotke, Maija Kukla, Edward Magrab, Michael Pecht, Peter Sandborn, Alba Ramaswamy, Janice Reutt-Robey, Maria Sanchez, Linda Schmidt, James Short, Elizabeth Smela, Ryan Sochol, Jelena Srebric, Miao Yu, Michael Zachariah.
Aerospace Engineering	Mark Lewis, Derek Paley, Kenneth Yu
Fire Protection Engineering	Jim Milke
School of Public Policy	Robert Grimm, Jennifer Littlefield
Chemical and Biomolecular Engineering	Bryan Eichhorn, Nam Sum Wang
Materials Engineering	Lourdes Salamanca-Riba
Electrical Engineering	Thomas Antonsen, Arthur Popper
Computer Science	Ashok Agrawala
College of Education	Matthew Miller
Department of Sociology	Jerald Hage
University of Maryland School of Medicine	Gary Fiskum and Rao Gullapalli

*Center for Engineering  
Concepts Development (CECD)*

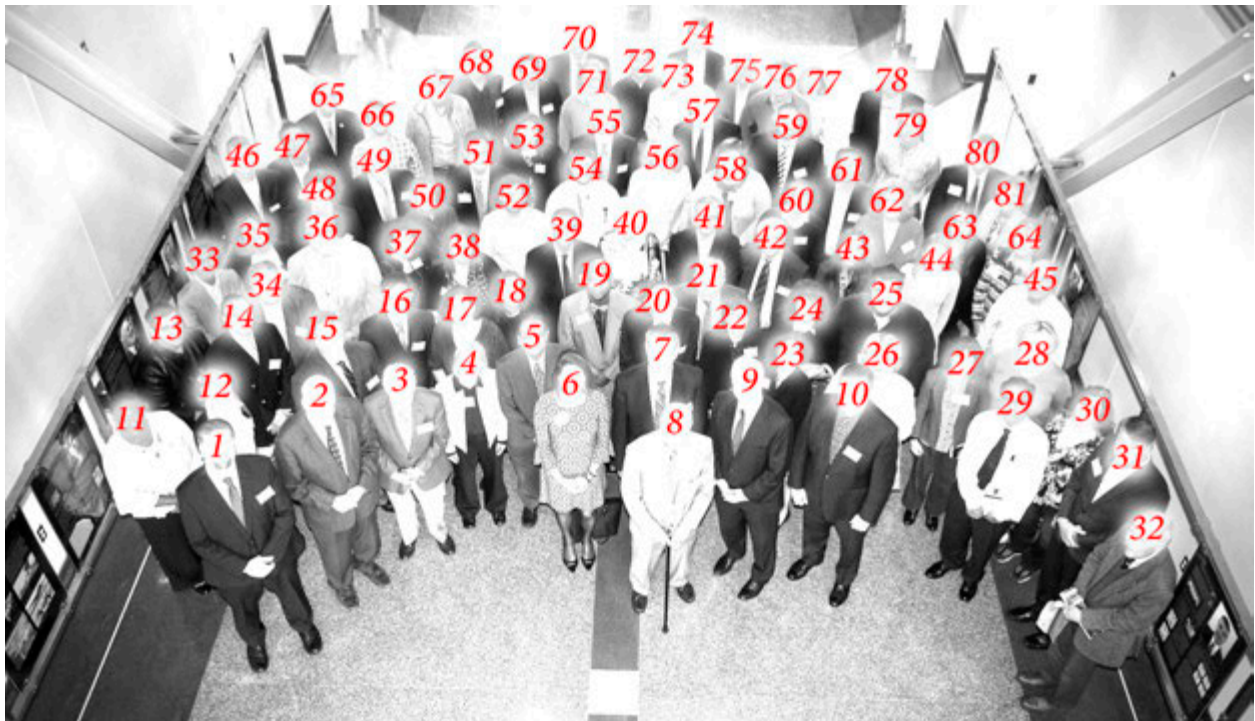
Department of  
Mechanical Engineering,  
University of Maryland,  
College Park, MD 20742

Phone: (301) 405-5434

*[www.cecd.umd.edu](http://www.cecd.umd.edu)*



#### 4. Pictures from the Event



## CECD 20th Anniversary Celebration and Middleton Luncheon Attendees

(Please refer to photos on previous page)

<b>1</b>	Mr. Dylan Hazelwood	<b>30</b>	Ms. Gina Speaks	<b>59</b>	Mr. Jeb Brough
<b>2</b>	Dr. William Kirwan	<b>31</b>	Mr. Brian Darmody	<b>60</b>	Mr. Vincent Nguyen
<b>3</b>	Dr. Patrick Cunniff	<b>32</b>	Dr. Bruce Berger	<b>61</b>	Dr. Jungho Kim
<b>4</b>	Dr. Elizabeth Smela	<b>33</b>	Mr. Andrew Latchman	<b>62</b>	Ms. Amy O'Donnell
<b>5</b>	Dr. Balakumar Balachandran	<b>34</b>	Dr. Patrick McCluskey	<b>63</b>	Ms. Juana Hurtado
<b>6</b>	Ms. Susan Lawrence	<b>35</b>	Ms. Joy Shen	<b>64</b>	Dr. Mary Beth Klinger
<b>7</b>	Senator Thomas Middleton	<b>36</b>	Dr. Jerry Forbes	<b>65</b>	Dr. David Drumheller
<b>8</b>	Dr. Davinder Anand	<b>37</b>	Ms. Tammie Garstecki	<b>66</b>	Dr. Mark Fuge
<b>9</b>	Hon. Chris Van Hollen	<b>38</b>	Ms. Lisa Schuetz	<b>67</b>	Dr. Edward Magrab
<b>10</b>	Mr. Michael Rice	<b>39</b>	Dr. Sami Ainane	<b>68</b>	Dr. Ken Kiger
<b>11</b>	Ms. Danette Boone	<b>40</b>	Ms. Peggy Brumfield	<b>69</b>	Dr. Michael Ohadi
<b>12</b>	Ms. Evan Crierie	<b>41</b>	Dr. Nikhil Chopra	<b>70</b>	Mr. Robert Kavetsky
<b>13</b>	Mr. Yonaton Saadon	<b>42</b>	Dr. Inderjit Chopra	<b>71</b>	Dr. Michael Pecht
<b>14</b>	Dr. George Syrmos	<b>43</b>	Dr. Miao Yu	<b>72</b>	Dr. Michael Azarian
<b>15</b>	Mr. Stephen Meade	<b>44</b>	Ms. Sara Ludewig	<b>73</b>	Dr. Henry Haslach
<b>16</b>	Mr. Daniel Tam	<b>45</b>	Mr. Majid Aroom	<b>74</b>	Dr. Jeffrey Herrmann
<b>17</b>	Dr. Kerry Clark	<b>46</b>	Dr. Don DeVoe	<b>75</b>	Dr. Abhijit Dasgupta
<b>18</b>	Ms. Erin Chen	<b>47</b>	Dr. Siddhartha Das	<b>76</b>	Mr. Thomas Luginbill
<b>19</b>	Mr. Fitzgerald Walker	<b>48</b>	Mr. Nathan Raver	<b>77</b>	Ms. Ania Picard
<b>20</b>	Dr. George Dieter	<b>49</b>	Mr. Todd Skipper	<b>78</b>	Dr. William Fourney
<b>21</b>	Dr. Stephen Lubard	<b>50</b>	Dr. Aris Christou	<b>79</b>	Dr. Derek Paley
<b>22</b>	Ms. Penny Komsat	<b>51</b>	Dr. Peter Chung	<b>80</b>	Mr. Michael Middleton
<b>23</b>	Ms. Heidi Sweely	<b>52</b>	Mr. Daniel Wysling	<b>81</b>	Dr. Eileen Abel
<b>24</b>	Ms. Anita Rice	<b>53</b>	Dr. Maria Sanchez		Dr. David Bigio
<b>25</b>	Mr. Alexander Anand	<b>54</b>	Mr. Andrew Lamont		Dr. Hugh Bruck
<b>26</b>	Mrs. Asha Anand	<b>55</b>	Dr. Robert Grimm		Mr. Gaurav Kumar
<b>27</b>	Dr. Lourdes Salamanca-Riba	<b>56</b>	Dr. Ruth Doherty		Dr. Ryan Sochol
<b>28</b>	Ms. Kimberely Frye	<b>57</b>	Dr. William Wilson		
<b>29</b>	Dr. Diganta Das	<b>58</b>	Ms. Lisa Davie		



*From left: Davinder K. Anand, Lisa Davie*



*From left: Dylan Hazelwood, Senator Thomas "Mac" Middleton, Davinder K. Anand*



*From left: Professor Emeritus Edward Magrab, Professor and Dean Emeritus George Dieter, Professor Emeritus Patrick Cunniff, Chairman Balakumar Balachandran, George Syrmos*



*From left: USM Chancellor Emeritus William Kirwan, Senator Thomas "Mac" Middleton*





*From left: Ruth Doherty, Kerry Clark, Jeb Brough*



*CECD Director Davinder Anand addresses the crowd*



*Dylan Hazelwood covers the finer points of Engineering for Social Change*



*Do Good Institute Director Professor Robert Grimm speaks about collaboration with CECD*



*Professor and Dean Emeritus George Dieter addresses the crowd*



*Director of the CALCE Center Professor Michael Pecht addresses the crowd*



*Senator Chris Van Hollen addresses the assembled guests*



*Senator Thomas "Mac" Middleton speaks about his colleague, Senator Chris Van Hollen*



*Senator Thomas "Mac" Middleton talks about his long history with the CECD*



*From left: Senator Thomas "Mac" Middleton, George Dieter, Mike Middleton*



*Professor Davinder Anand proposes a toast to the gathered guests*



*From left: Professor Davinder Anand, USM Chancellor Emeritus William "Brit" Kirwan*



*Professor and Dean Emeritus George Dieter with Professor Robert Grimm*



*From left: Chairman Balakumar Balachandran, Susan Lawrence, Senator Thomas "Mac" Middleton, Mike Middleton, Professor Michael Pecht*



*After a wonderful lunch, the crowd listens carefully as Professor Anand thanks all*



*Professor Davinder Anand and Senator Thomas "Mac" Middleton*





*From left: Chairman Balakumar Balachandran, Dylan Hazelwood, Mike Middleton, Susan Lawrence, Professor Davinder K. Anand, Senator Thomas “Mac” Middleton, Professor Michael Pecht, Professor and Dean Emeritus George Dieter*



*From left: Nathan Raver, Professor Jungho Kim, Senator Middleton, Professor Don DeVoe*



*From left: Daniel Tam, Professor Davinder Anand, David Drumheller*



*From left: Amy O'Donnell, Professor Davinder Anand, Stephen Meade*



*From left: Kerry Clark, Professor Davinder Anand, Professor Peter Chung*



*From left: Professor Inderjit Chopra, Professor Davinder Anand, Professor Nikhil Chopra*



*From left: Jeb Brough, Professor Davinder Anand, Dylan Hazelwood*