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GLENN L. MARTIN INSTITUTE OF TECHNOLOGY
A. JAMES CLARK SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

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Letter of Transmittal
October 15, 2018

Dr. B. Balachandran
Minta Martin Professor and Chair of Mechanical Engineering,
A. James Clark School of Engineering,
University of Maryland, College Park

Dr. George E. Dieter
Dean Emeritus, Professor Emeritus of Mechanical Engineering,
A. James Clark School of Engineering,
University of Maryland, College Park

Dear Bala and George,

Attached please find our report in PDF format on the "History of the Mechanical Engineering Department University of Maryland, College Park: 1894 to 2018". Due to its large file size I will separately deliver to you the same report in Word format on a memory stick. The Milestones document is a separate file, also attached. The documents consist of the following components.

1. The History
2. Appendix
   a) 1895 Curriculum
   b) 1895 Expenses
   c) 1950 Curriculum
   d) 1960 Curriculum
   e) 2018 Curriculum
   f) Mechanical Engineering Faculty Fellows
   g) Mechanical Engineering Chairmen, 1894-2018
   h) Department Laboratories
   i). Department Centers
3. Mechanical Engineering (1894-Present): Milestones

This work represents a review of the following sources:
UMD Publications Office Photos
John Consoli Photographs

UMD President's Office Archives
Engineering Pipeline Newsletters
The Diamondback/Triangle
The Washington Post archives
The Baltimore Sun archives
The Maryland Agricultural Announcements
The Frederick Post archives
Circular of the Maryland Agricultural College
Undergraduate Catalogs
Yearbooks
Other Digitized Materials from the online UMD Archives
College of Engineering records at UMD Archives
Personal photographs from Davinder K. Anand, Reinhard Radermacher, William Fourney
Various materials received from George Dieter and Balakumar Balachandran
Countless related websites

This document represents not only my efforts but a considerable amount of time from Dylan. He was responsible for reviewing all the material in the archives as well as much of the list above. The review led to the discovery of many historical facts that were even new to me and became the basis of our story. Of course, I was at least 53 years of that story.

With Bala's approval, I would like to suggest that we put all this on the Mechanical Engineering website under the title, "Rendezvous with History". I will have a number of additional pictures once we get help to put that together.

This work represents my final report on the 125 year history of our Department. This project has been both a trip down memory lane, as well as a significant challenge. Please feel free to use as much or as little as you want in the document for the College, and feel free to make any changes to suit your style or viewpoint. With this done, I need to move on with other pressing calls.

Best,

Davinder K. Anand
Professor Emeritus of Mechanical Engineering
Director, CECD.

Cc: Dylan Hazelwood

HISTORY OF THE
MECHANICAL ENGINEERING DEPARTMENT
UNIVERSITY OF MARYLAND, COLLEGE PARK
1894 TO 2018

Davinder K. Anand[1]

Dylan A. Hazelwood[2]

[1] *Professor Emeritus of Mechanical Engineering and Director, Center for Engineering Concepts Development*

[2] *Assistant Director, Center for Engineering Concepts Development*

HISTORY OF THE MECHANICAL ENGINEERING DEPARTMENT

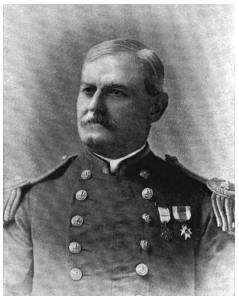
In 1856, a body of Maryland planters conceived and brought forth an institution, whose vitalizing principle was the realization that scientific research was necessary to the orderly development of the vocation of agriculture. Such an institution was incorporated according to the laws of Maryland in 1856, and the resulting Maryland Agricultural College (MAC) was established, which has been conferring degrees since its opening in 1859.

On October 6, 1859, the MAC opened its doors to 34 students. The traditional classical curriculum was augmented by the addition of a curriculum of the "Exact Sciences including Mathematics, Mensuration, Engineering and Construction, Mechanics and Astronomy." H.D. Gough, A.B. was named Professor, planting the seed which grew into the College of Engineering, of which Mechanical Engineering is a significant component.

The Morrill Land Grant Act in 1862 provided funds from the sale of federally owned western land to the states to endow colleges to teach "agriculture and the mechanical arts." This eventually was the way federal funds were used to assist in establishing Mechanical Engineering at MAC. The Engineering program was first established under President R.W. Silvester in 1892-1893, and was called "Rural Road Building, Farm Drainage or Farm Machinery" in an effort to soft pedal engineering and relate it to the needs of the farm community.

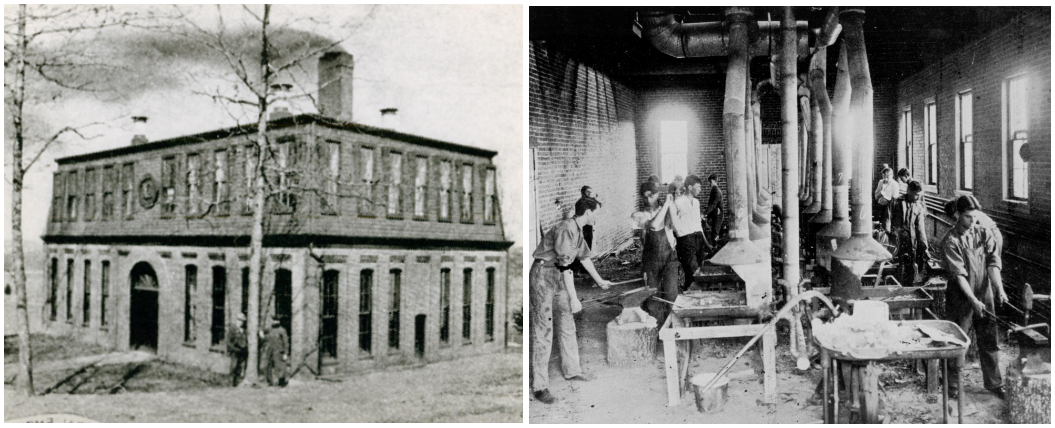
In June 1893 the Committee on Facilities for Instruction, as reported in the Proceedings of Trustees, recommended the creation of a Mechanical Engineering Department in the MAC, and provided $2,500 for facilities for instruction and $1,000 for a Mechanical Engineering instructor. The permanent four year curricula in Mechanical Engineering was then established in 1894.

Mechanical Engineering established *(1894-1940)*

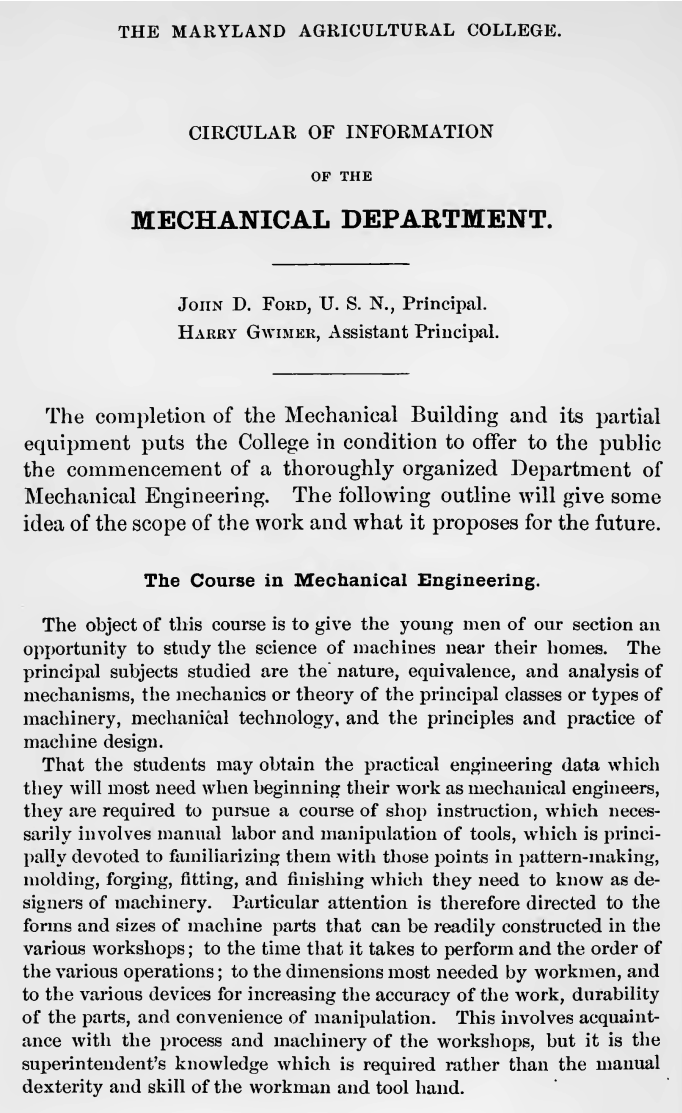


John Donaldson Ford

In February, 1894, at the request of President R. W. Silvester, the Secretary of the Navy detailed Lieutenant John Donaldson Ford, USN, Chief Engineer, to College Park to organize the Department of Mechanical Engineering at Maryland Agricultural College. Lieutenant Ford assumed the position with the title of "Professor of Mechanical Engineering" and mechanical drawing instruction was given to all classes in the College. The first four year curriculum was formerly introduced in 1894, and is shown in the Appendix. In the Fall of 1895 a pamphlet was issued for general distribution containing the course of study and practice. By late October 1895 a two-story red pressed brick building was completed to house the Department. This building contained two lecture rooms, a large drafting room, and rooms for woodworking, foundry practice, blacksmithing and machining.



The Mechanical Engineering Building circa 1900 (left), The blacksmithing room inside the building (right)



THE MARYLAND AGRICULTURAL COLLEGE.

CIRCULAR OF INFORMATION

OF THE

MECHANICAL DEPARTMENT.

JOHN D. FORD, U. S. N., Principal.
HARRY GWIMER, Assistant Principal.

The completion of the Mechanical Building and its partial equipment puts the College in condition to offer to the public the commencement of a thoroughly organized Department of Mechanical Engineering. The following outline will give some idea of the scope of the work and what it proposes for the future.

The Course in Mechanical Engineering.

The object of this course is to give the young men of our section an opportunity to study the science of machines near their homes. The principal subjects studied are the nature, equivalence, and analysis of mechanisms, the mechanics or theory of the principal classes or types of machinery, mechanical technology, and the principles and practice of machine design.

That the students may obtain the practical engineering data which they will most need when beginning their work as mechanical engineers, they are required to pursue a course of shop instruction, which necessarily involves manual labor and manipulation of tools, which is principally devoted to familiarizing them with those points in pattern-making, molding, forging, fitting, and finishing which they need to know as designers of machinery. Particular attention is therefore directed to the forms and sizes of machine parts that can be readily constructed in the various workshops; to the time that it takes to perform and the order of the various operations; to the dimensions most needed by workmen, and to the various devices for increasing the accuracy of the work, durability of the parts, and convenience of manipulation. This involves acquaintance with the process and machinery of the workshops, but it is the superintendent's knowledge which is required rather than the manual dexterity and skill of the workman and tool hand.

Fall 1895 Pamphlet on the new Mechanical Engineering Department

In August 1895, Professor Harry Gwinner, who had organized the Department of Practical Mechanics at the Mississippi Agricultural and Mechanical College, was elected Assistant Professor of Mechanical Engineering. He was at that time an erecting engineer with the Watts-Campbell Engine Co., of Newark, New Jersey.

By the Spring of 1896, the woodworking, foundry and blacksmith shops were practically equipped and instruction was given along the lines of practice, as well as theory. In July 1896, Lieutenant Ford was recalled by the Secretary of the Navy, and Professor

Gwinner was promoted to the vacancy. The Mechanical Engineering program was described as follows in the 1897 Maryland Agricultural College Announcement.

MECHANICAL COURSE.

Since the completion of the Mechanical Building and its equipment, no department of the College has done more efficient work. It was one of the declared purposes of the Federal Government in making its liberal endowments to the Land Grant Colleges to secure the establishment and the proper equipment of Departments of Mechanical Engineering in all such institutions. Under the efficient direction of Lieut. J. D. Ford, of the U. S. Navy, detailed at this College, the Mechanical Department was organized and the building erected and practically equipped. His successor, Prof. H. Gwinner, has completed the equipment of the department, and the mechanical course is now one of the most satisfactory and popular.

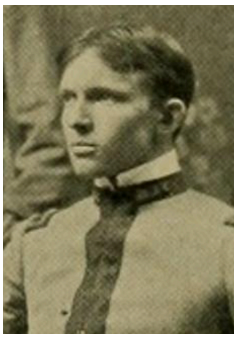
This course leading to the Degree of Mechanical Engineer, includes shop work in Wood and Iron, Foundry work, Forging, Mechanical Drawing, Hydraulics, Thermo-dynamics and Steam Engineering, Machine Design and Construction, Testing, Dynamo-Electricity and Electrical Engineering. The practical work is most thorough. The student is familiarized from the first with the use of all the tools and implements of wood and iron work. He is given daily practice in the shops, and is encouraged to develop whatever inventive talent he may have. Lecture and Text-book work in Theoretical Mechanics form part of the course. As yet no students have attained the Degree of M. E., as the Department has not yet completed its fourth year. It is believed, however, that students completing this course will have no difficulty in securing employment after graduation in the field of Mechanics and Electrical Engineering. The collateral branches of this course are Mathematics, Physics, Chemistry, at least one modern language, English, History and the principles of Citizenship.

John Hanson Mitchell

In 1898, John Hanson Mitchell (ME, 1898), the first recipient of a Mechanical Engineering degree, was selected to be an assistant to Professor Gwinner. In the same year a machine shop equipped with standard makes and types of tools was added for instruction.

Gwinner resigned in 1901, going to the Louisiana Independent Institute as Professor of Practical Mechanics, and Assistant Professor Mitchell was promoted to his former position. James C. Blandford (ME, 1899), who was then in the designing department of the Lackawanna Steel Company of Buffalo, New York, was selected to assist Mr. Mitchell.

Due to increased enrollment during 1903 and 1904, a one-story brick building was erected for the blacksmith shop and foundry. The equipment was increased from ten to sixteen forges, and a brass furnace and Millett core oven were added to the foundry as well as a ten-horsepower gasoline engine.



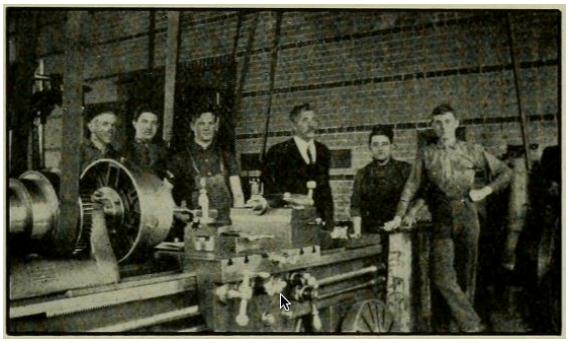
James C. Blandford

Several faculty changes occurred over the next two years. In academic year 1904-5 Professor Mitchell was given a year's leave of absence due to ill health, and Mr. J. C. Blandford was made Acting Professor of Mechanical Engineering. E. F. Garner (ME, 1903) and E. Stoll (ME, 1904), both Mechanical Engineering graduates of the MAC, were selected as additional instructors for drafting and shop work. During the same academic year Professors Blandford and Stoll resigned to enter Government employment in the Philippines. In February 1905 Professor Harry Gwinner, who was then a designer with the Chesapeake Iron Works, returned to the College and resumed his old position, Professor Mitchell having decided not to return. The student body grew steadily. The Mechanical Engineering Department had begun with one student, John Hanson Mitchell, who graduated in 1898. By 1903, there were 72 official Mechanical Engineering students, and 125 students receiving instruction in the Department.

Four Mechanical Engineering Students, (Millard Tydings on right)

In October 1906, Howard L. Crisp was selected for the instruction of freehand drawing, pattern work and molding. He had received diplomas from the Maryland Institute in Architectural and Mechanical Drawing, worked for the Mechanical Department of the Baltimore and Ohio Railroad, and was a graduate apprentice of local brass and iron founders and finishers for the Henry McShane Manufacturing Company of Baltimore, Maryland.

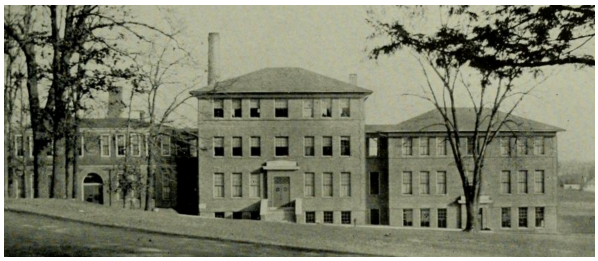
In 1907, Mr. Garner resigned to accept the position of Instructor of Descriptive Geometry and Machine Design at Cornell University, and he was succeeded by Mr. W. N. Michael (ME, 1902) of Baltimore Polytechnic Institute, and later of the Maintenance of Way Department, Ohio Division, Baltimore and Ohio Railroad. Ill health and a difference of opinion as to salary led Mr. Michael to resign. Mr. Fred. F. Mason, a graduate of Purdue University, succeeded Mr. Michael. Mr. Mason was especially strong in machine design, theoretical mechanics, and foundry work. Before joining the Department he was with the Southern Railway, at Princeton, Indiana.



Professor Gwinner with Students

In 1907 Mechanical Engineering students worked on and installed a forty horsepower automatic cut-off engine of the Atlas type which now furnished power to the pattern and machine shops. Also two new one-hundred horsepower return tubular horizontal boilers were added to the steam plant, and a brick smokestack, of hollow brick Alphon Custodus construction.

During the summer of 1909 a new engineering building was completed. Owens and Sisco, Baltimore, were the architects; B. F. Smith Co. of Washington, D.C. were the contractors of the brick and carpenter work. The approximate cost of building the new structures was $30,000. These buildings were to house the Departments of Mechanical, Civil and Electrical Engineering. Additional facilities included a 26-inch single surface planing machine for the pattern shop, a cross compound Corliss engine of the condensing type, and a 100,000 pound metal testing machine for the Experimental Laboratory. Professor Gwinner reported at the time that "graduates of the



New Engineering Buildings, Mechanical Engineering on left

Mechanical Engineering and Civil Engineering courses of the MAC are splendid evidence of what splendid work we are doing."

The 1908-09 catalogue notes a new organization in Engineering, including the Departments of Civil Engineering, Electrical Engineering, and Physics under Professor T.H. Taliaferro. Mechanical Engineering remained a separate department, with little change in course content, until 1915, when it was included with Civil Engineering and Electrical Engineering in the newly formed Engineering Division.

Some interesting news of the early graduates of Mechanical Engineering published in the Alumni News of the time are as follows:

- Charles M. White (ME, 1913) was the only mechanical engineering graduate in 1913; the entire engineering graduating class numbered just nine men.
- Lee R. Pennington (ME, 1915) became an Administrative Assistant in 1929 to J. Edgar Hoover, Director of the Federal Bureau of Investigation.
- Millard E. Tydings (ME, 1910) became a successful and popular attorney, author, soldier, and state legislator, serving as a Democratic Representative and Senator in the United States Congress from Maryland. The September 1930 Alumni News noted that "Senator Tydings, although he received his B. S. degree in engineering at old M.A.C., has never used his scientific training except possibly for a survey of the political situation in the State. He did, however, continue his studies at the University of Maryland Law School in Baltimore, where he was awarded his LL. B. in 1913."
- George O. Weber (ME, 1933) was senior class president, and helped organize the Class of 1933 gift - Maryland's original bronze Testudo statue. He later served as Director of the Physical Plant at the University from 1946 to 1972. During his career, Weber oversaw the construction of Byrd Stadium, Cole Field House, and the University Golf Course.

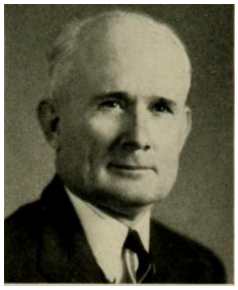
George O. Weber

In 1929, when Harry Gwinner became Professor of Engineering and Mathematics, J.N.G. Nesbit was named as the new Chair of the Department.

J.N.G. Nesbit

Early in 1936, the Engineers' Council for Professional Development (ECPD), which several years before had been created by the national engineering societies to act as the engineering accrediting agency, was requested by Engineering Dean S. S. Steinberg to visit the Departments of Civil, Electrical, and Mechanical Engineering to examine their curricula. Karl Compton, then President of the Massachusetts Institute of Technology, headed the committee that visited the University of Maryland. All three departments were accredited as a result of this visit, starting a sequence that has extended unbroken to this day.

The scope of Mechanical Engineering grew in 1938 when John E. Younger was appointed Chairman of Mechanical Engineering, following J.N.G. Nesbit's departure.



John E. Younger

Younger was the recipient of many honors and awards during his lifetime as a result of his pioneering work in the field of aircraft design, and his contributions to the field of aircraft structural design have had a profound influence on modern aviation. As a result, Aeronautical Engineering was introduced into the curriculum of the University of Maryland in the Fall of 1938 as an option in Mechanical Engineering. An Aeronautical Engineering laboratory was started in 1939, and soon was equipped for instruction and research into aerodynamics, aircraft design and construction, vibrations, metallurgy, and other branches of the science. Engineering graduates of the University of Maryland who majored in this option could be found in most of the major aircraft factories of the country, in the laboratories of the National Advisory Committee for Aeronautics, and in the laboratories of the Army and the Navy where many served as engineering officers.

War and Peace ***(1940 to 1960)***

In 1940, the Department had just two faculty members and three instructors. The wartime claimed many young men, and the enrollment dropped to the extent that by 1945 we only had two faculty, John Younger and Charles Shreeve, and no instructors. During that time the Department graduated the first class in the aeronautical option of Mechanical Engineering, and interestingly about 50 percent of the Mechanical Engineering class found positions in aircraft factories. In an effort to build a research base, Younger stressed the belief that the Government or private industry should sponsor research laboratories in the Nation's universities in order to develop new ways to build aircraft. In 1941, he brought the headquarters of the aviation division of the American Society of Mechanical Engineers (ASME) to campus.

After the war, Younger started to expand the faculty of the Department. He hired faculty with relevant engineering teaching experience and several assistants without any professorial rank. For example, he added John Flodin, Associate Professor, who was engaged for a number of years in engineering practice and taught for eight years at the University of Minnesota. Walton R. Read was hired as an Assistant Professor, having been a graduate of the U.S. Naval Academy and then receiving an M.S. degree from Columbia University. In addition to these professors he added Addison B. Eyler, Audley B. Leaman, Hugh L. Sinclair, Jr., and Robert K. Warner as Laboratory Assistants.

The demand for mechanical engineers was high, and the US Government was advertising for them in campus publications. “Mechanical and aeronautical engineers are continually needed by the Federal Service, announces the United States Civil Service Commission. Most beginning salaries are $2,980 or $3,640, plus overtime pay, although some positions are filled at higher salaries, and most positions are in Washington DC. Engineering experience is required for these positions, although appropriate education maybe substituted for part of the experience. Mechanical engineers are wanted to service ordnance engineers, heating and ventilation engineers and plumbing engineers, while aeronautical engineers are needed by the War and Navy Departments and by the National

Advisory Committee for aeronautics and the Civil Aeronautics administration. No written tests are required for these positions."

Many of our Mechanical Engineering graduates rose to prominent positions. An example was Jim Dingman (ME, 1922), who rose through the ranks and was ultimately elected Vice Chairman of the Board of AT&T in 1965, the parent company of Bell Laboratories, the nation's largest research organization. He was an important player in the development of the 170-pound Telstar satellite, whose launching as the first private venture in space opened the modern era of telecommunications, expanding telephone service and paving the way for cable television and other industries.

Tau Beta Pi, the national engineering honorary society, had been established at the University. Although this was a men's society, in March 1944 they paid tribute to female Mechanical Engineering student Miriam "Micky" Gerla, with a special woman's badge for excellence in engineering. Charles Spencer, National President of the honorary, made the presentation to Mrs. Gerla at a banquet held at the Terrapin Inn, before her initiation in the Old Library Lounge. Mrs. Gerla, described at the time as a 24-year-old housewife from Washington, was finishing her fourth year at the University with a scholastic standing of 3.9, and she was also an active member of various clubs and honoraries. She stated that she was attracted to the field because of her desire to "keep up with" her Tau Beta Pi husband, an engineer at the Washington Navy Yard. She was the second female student to be graduated from the engineering college on campus, with a B.S. in Mechanical Engineering with Aeronautical Option in 1944, and would later go on to serve as President of the Society of Women Engineers.

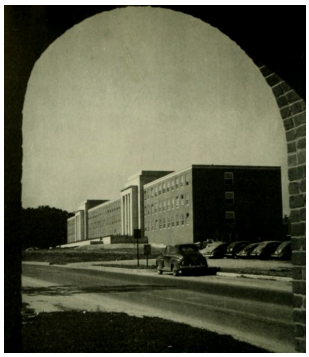
Miriam Gerla

Mechanical Engineering students in the laboratory

In 1945, Dr. Younger took leave of absence from the University of Maryland to go to the Wright Field Air Force Base, to initiate a research program for developing high-speed thin wings for jet-propelled aircraft. His most significant honor was the Spirit of St. Louis Gold Medal,

which was awarded in 1941 “for meritorious service in the advancement of aeronautics.” The previous recipients had been Daniel Guggenheim, Paul Litchfield, Will Rogers, and James Doolittle.

In 1947 Younger accepted a position in Brazil that offered an outstanding opportunity, both financially and professionally. His new job was the complete design and organization of a new technical college in Brazil, starting from scratch. Similarly, a decade later, Mechanical Engineering Professor John W. Jackson went on sabbatical leave in 1957 to Ankara, Turkey. There he assisted in the setting up of an engineering college at the Middle East Technical University.



The new Glenn L. Martin Engineering Building

In Fall of 1949, the aeronautical sciences option was separated as a discipline from the Mechanical Engineering Department and became the standalone Aerospace Department. In the same year, following a major donation of $2.5 million by aviation pioneer Glenn L. Martin, president of the Glenn L. Martin Company of Baltimore, four new buildings were erected for Engineering. In 1950, the Mechanical Engineering Department moved to the new Glenn L. Martin Engineering Building.

The Department had grown sufficiently in size and reputation that we established the Pi Tau Sigma honor society on the University of Maryland campus for the purpose of honoring outstanding seniors in the field of Mechanical Engineering. To be eligible for membership a senior was required to be in the upper third of their class, and have faculty approval. The Tau Mu Chapter was founded on our campus on April 14, 1956 to promote high ideals in the engineering profession and to create interest in Departmental activities.

Pi Tau Sigma Members in 1958

The Department had started to encourage faculty to have doctoral degrees. In 1959 Harold D. Cather and Clifford L. Sayre received grants from the "Helen B. and Charles M. White Fellowship and Loan Plan", established the previous year in connection with the Greater University of Maryland Fund, for completion of their doctoral degrees. In 1960 a former University tennis star, Jackson Yang (ME, 1958), began his teaching career as an instructor in the Department. He had been a top player on Maryland's 1957 ACC championship team, was working on his doctorate and at the same time doing some coaching for the tennis team.

Following John E. Younger's unexpected death in December 1958, Professor Charles A. Shreeve, who had been at the University since 1941, was selected to serve as the interim Chair of the Department. In 1960, the Board of Regents officially announced his appointment to head up the Mechanical Engineering Department.

Beginning of a New Era *(1960 to 1970)*

Charles Shreeve

In 1960, Charles A. Shreeve became Chairman of the Mechanical Engineering Department. He had received his B.Engr degree in 1935 at Johns Hopkins University, and his M.S. degree from the University of Maryland in 1943. He had been originally hired by University President H. C. "Curley" Byrd. "I'll hire you for one year," Shreeve recalled Byrd telling him. "We don't keep anybody from Hopkins for more than a year." He would go on to a long career on campus as Professor of Mechanical Engineering until his retirement in 1991. Professor Shreeve was assisted by Associate Professor Bernard Eyler in undergraduate affairs, and Professor John Jackson in graduate affairs.

Engineering student enrollment continued to increase during this period with Mechanical Engineering as a popular choice. The undergraduate curriculum continued to emphasize classical and fundamental Mechanical Engineering subjects (shown in the curriculum in the Appendix) but with limited student involvement in the design phase of their education. Unlike today, projects requiring teamwork were not common, however

faculty did have a large number of students work on one competitive design projects. A good example was the student project directed by Professors Sayre and Glass. The students were given one week to design, fabricate, and test an air-dropped container, intended to protect delicate instruments from the impact shock of a 16-foot drop to a concrete surface. The winner was Mechanical Engineering senior Ralph Freeny, with his cardboard container in the shape of an inverted pyramid. A December 1965 Diamondback issue reported on this experiment on the front page with the headline "Lays an egg: Engineering Project scores crash debut."

Clifford Sayre, demonstrating student egg containers

Until this time, the Department had been primarily involved in undergraduate teaching. The majority of the facilities in the Department consisted of teaching laboratories, which were state-of-the-art. However, like many other state universities, there was a push to enter a new era where graduate education and research would be emphasized. This required more space, more funding and a new breed of faculty.

In June 1965, Frederic T. Mavis, Dean of Engineering since 1957, stepped down and joined the Mechanical Department faculty to teach for two years before retiring. He was often spotted around the Department with his camera hanging around his neck. By now the Department had already entered a growth phase, bringing in new faculty with doctorates in large numbers. Overall, the decade saw significant growth in the professorial ranks. The Professors went from two to twelve, Associate Professors went from two to seven, and Assistant Professors from three to nine. The faculty with the rank of Instructor, however, dropped from thirteen to nine.

Frederick S. Billig

Faculty began to attract external funding to support their research activities and most of the research was conducted on an individual basis, but this period was also the beginning of collaborative research and several laboratories were established with this in mind. The doctoral and research program had started to develop rapidly in the department. A prominent Ph.D. in the Department was awarded in

1964 to Frederick S. Billig, who later received a patent for a supersonic combustion ramjet based on his Ph.D. thesis. He was a pioneer in the development of scramjet propulsion, subsequently receiving six additional patents involving design features of hypersonic vehicles.

The Department established two laboratories between 1966 and 1968 for research in materials as part of "central facilities" group, and several other research laboratories. They were in the areas of Electron Microscopy, X-ray Diffraction Holography, and Magneto Hydrodynamics.

The increasing demand for engineers with advanced degrees by the Government and industry, coupled with the need for the new research laboratories to be supported by dedicated graduate students, created an impetus to increase graduate enrollment. The 1966 campus catalog, in an effort to attract graduate engineers, advertised the following: "Adventure in Learning: There is an acute shortage of engineers with earned doctor's degrees. Able men and women *with gumption* will find challenging opportunities is they have such top-level preparation. … But the lifelong adventure in learning, which is the true characteristic of the well-educated man or woman, demands systematic mental exercise throughout life. Chance favors the prepared mind!" However, it also advised that "Preference is given to graduate students who are American citizens in view of the limitations of available funding."

During the 1960's the aerospace activities, originally nurtured in our Department and then broken off into an independent department in 1949, had close connections with our faculty. Since their offices were very close to Mechanical Engineering on the second floor of Glenn L. Martin Hall, there was a natural affinity between several faculty members. Professors Rivello, Corning and Sherwood were the most prominent Aerospace Engineering faculty that had a close relationship with Professors Shreeve, Allen, Jackson and Sayre. Several Mechanical Engineering students even worked part time for Professor Sherwood's small company, manufacturing lab-scale wind tunnels for teaching and research.

Several faculty were often involved in professional as well as civic activities. Of particular note is the fact that John Jackson was also the Chairman of the 1966 Peace Essay

Contest for the College Park Lions Club. The purpose of the contest, he said at the time, was "to focus people's attention on the desirability of searching for ideas and developing a plan toward making world peace a reality."

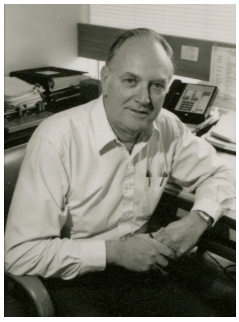
While the Department was growing rapidly, it was very cohesive. Professor Shreeve would arrange an annual picnic at a local park and invite the faculty and their families. Small committees would be appointed to not only plan the food, but also activities and small prizes for the children. It is something that many faculty and their families of that time still remember fondly. Toward the end of his term, he had a similar picnic, but at a historic mansion on the eastern shore that he owned and had restored. A delightful day and a beautiful sunset was a good way to end his term.

Building *(1970-1980)*

John W. Jackson

Charles A. Shreeve stepped down in 1970 as Head of Mechanical Engineering, and Dean Robert B. Beckmann appointed John W. Jackson as Acting Head of Mechanical Engineering. Under Jackson's tenure the Department continued to run smoothly. In 1971 Dean Beckmann appointed James W. Dally, P.E., Ph.D., as Chairman, and Jackson retired shortly afterwards.

Dally was internationally recognized for the development of experimental methods for studying dynamic fracture mechanics and stress wave propagation problems. To continue these activities, he established a state of the art Photomechanics Laboratory in the Department. The regular group consisted of Professors William Fourney, Donald Barker, R. J. Sanford, David Holloway and Takao Kobayashi. A regular research visitor was Hans Peter Rossmanith from Germany.



James W. Dally

Perhaps the most distinguished member of Dally's research group was George Irwin, appointed as Professor of Mechanical Engineering in 1972 and known widely as the father of Fracture

Mechanics. He developed test methods to determine the fracture toughness of metals such as high strength steel. At the University of Maryland, he was an essential part of a team that established the concept of crack arrest and crack arrest toughness. This was an important concept when considering the crack propagation in nuclear reactor heads and accidents due to loss of coolant. Irwin continued to accumulate national and international awards during his time in the Department, such as the 1975 French Society of Metallurgy Grand Medal, 1979 Frances J. Clamer Medal, the 1985 Tetmajer Medal of the Technical University of Vienna, the 1986 ASME Timoshenko Medal, and membership to the British Royal Society.

During his tenure, Dally appointed Associate Professor William Fourney as Director of the Graduate Program. He was also supported by Associate Professor Charles Hayleck in undergraduate affairs. Also, due to falling enrollment in Mechanical Engineering, a new baccalaureate program in Mechanical Engineering Technology was approved by the State Board of Higher Education in 1974. However in 1979, due to increased enrollments in Mechanical Engineering, the Technology Program was eliminated by the University Senate. James W. Dally stepped down as Chairman in 1975 to accept the position of Dean at Rhode Island, Kingston and Dean Beckmann appointed Patrick F. Cunniff as the new Chairman of Mechanical Engineering.

Patrick F. Cunniff

The Vietnam war, which had been ongoing for some time, had a significant impact not only on freshman enrollment numbers, which had significantly dropped, but also on the budget. The Engineering budget from the State of Maryland took a big hit, and alternate sources of funding became center stage. Cunniff took an active interest in securing significant research funding from the College's Minta Martin funds.

The Mechanical Engineering graduate and undergraduate curriculum had not been revised for over a decade, so Cunniff personally chaired two committees to "modernize" the curriculum. During this period, he was assisted by Associate Professor Charles Hayleck in undergraduate affairs and Professor Clifford Sayre on graduate education. The committees met every Friday for the entire semester, and made significant changes in the curriculum of the undergraduate and graduate program. As part of this modernization a

new course on the subject of ethics was added, to be taught by Stan Berman, a prominent attorney in Washington and a Departmental benefactor.

Clayton Dupree McKindra became the first African American to be receive a PhD in Mechanical Engineering. His advisor was Davinder K. Anand, and the degree was granted in December 1976. Also, the first female faculty member was hired in our Department during this period. Juliani Gatzoulus brought considerable experience as a Marine and mechanical engineer for the U.S. Navy and NOAA, and joined the Department as an Assistant Professor in 1980.

In Fall of 1979 the Department set up a learning center for undergraduate students in freshman and sophomore introductory courses. The idea, developed by Professor William Wockenfuss, was to staff the center with retired volunteers who were formerly employed at government labs in the area. By Spring 1984, nearly 2,500 student visits were reported, providing significant technical assistance to the student body.

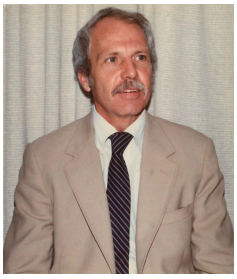
The Department had received a National Science Foundation grant to establish an Acoustics Laboratory supporting the work of Patrick Cunniff. Assistant Professor Chung Tsui also worked in the laboratory, and he was the first and only Assistant Professor to receive tenure at this rank. Departmental and Minta Martin funds were used to also establish a second laboratory. This was the Turbulence Laboratory, under the direction of newly hired Assistant Professor James Wallace. Significant Department of Energy funds were received by Professors Davinder K. Anand and Redfield W. Allen during this period to support research in solar energy.

Chung Tsui working in the Acoustics Laboratory

In 1979 Patrick Cunniff went on sabbatical leave, and Professor Clifford Sayre was appointed Acting Chairman. Upon Cunniff's return the Department moved temporarily to the Mill Building in 1981, to allow for the extensive renovation of the Engineering building during the latter part of this period.

Research Emphasis ***(1980 to 1990)***

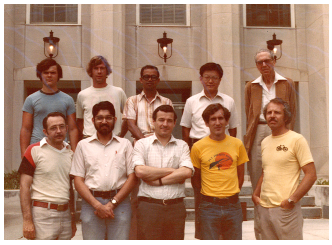
Patrick F. Cunniff stepped down as Chairman shortly after the Engineering building renovation started in April 1982, and returned to the Department as Professor to teach and engage in research in the area of Shock and Vibration. He hired George O'Hara, from the Naval Research Laboratory, as a Visiting Researcher to work with him. Dean George Dieter appointed William L. Fourney as Chairman of Mechanical Engineering in 1982. Under his term Professor Colin Marks and then Professor Frank Buckley served as Graduate Directors, and Associate Professor William Walston as Director of the Undergraduate Program. A pilot of a new computer-aided design course for undergraduate students was introduced by Professor Sayre in 1982. By Fall 1983, ENME 414 was approved and became a regular part of the curriculum, despite limited computer resources at the time.



William L. Fourney

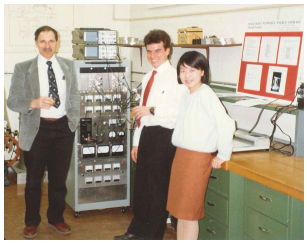
In 1984 the Department moved from their temporary space in the Mill Building back to Glenn L. Martin Hall after the building's $12M renovation. The move had been delayed by a storm in February 1983, when snow had collected inside the roofless building. While the Department was still in the Mill Building, former Chairman James Dally, who had left the Department for Rhode Island and had joined IBM, reapplied for, and was granted, an appointment to our Department as Professor to continue his work with the Photomechanics Laboratory.

A. J. Durelli, a true luminary in photoelasticity, also joined the Photomechanics Laboratory as a Visiting Professor in 1980. The interchanges between him and Max Frocht were legendary, and the two of them were responsible for a large share of the progress in photoelasticity in that era.



Photomechanics Laboratory

Consistent with the growth in research activity and production of advanced degrees, there was a steady growth in the reputation of Engineering at the University, both within the state and nationally. Beginning in 1985, several Mechanical Engineering faculties held joint appointments to engage in interdisciplinary systems research work in the newly created Systems Research Center, subsequently renamed the Institute for Systems Research in 1992. This growth was accomplished by a lot of hard work by very talented faculty and staff members. Along the way, there were a number of competitive opportunities to obtain federal grants to establish research centers of excellence, in which the Department was quite successful. To a large degree, the winning of these grants shaped the future direction of research in our Department. In 1981, Davinder K. Anand, having served as Program Director of the newly established manufacturing program at NSF, returned to the Department to set up a manufacturing laboratory. The Advanced Design and Manufacturing Laboratory (ADML) was equipped with state of the art numerically controlled milling and turning centers. The research directed by Anand and James Kirk was centered on machining and magnetic bearings, and was supported by Fairchild, NSF, and NASA.



Advanced Design and Manufacturing Laboratory

A major research effort was the Computer-Aided Life Cycle Engineering (CALCE) Center. Organized by Professor Michael Pecht and established in 1986, the CALCE Center had close interaction with industry in developing computer-aided design procedures for electronic circuit boards and other electronic devices. The centerpiece of Pecht's work was the introduction of the idea of 'Physics of Failure' in assessing the reliability of electronic circuits. The Center included electrical, mechanical, chemical and reliability engineers and computer scientists who formed an interdisciplinary team. In 1991, the name was changed to the CALCE Electronic Packaging Research Center (EPRC), following major funding from the National Science Foundation and the Maryland

Michael G. Pecht

Department of Economic and Employment Development's Business Resource Division and participating industries.


Reinhard Radermacher

Yet another exciting activity was the establishment of the Center for Environmental Energy Engineering (CEEE) in 1988, which focused on the ways to solve energy processing problems in a more environmentally benign fashion. Organized by Professor Reinhard Radermacher, during this period much of the Center's work was concerned with the search for new refrigerants for air conditioning applications. In Fall 1990 he received a $400,000 research grant for a project funded by the EPA, Whirlpool and ATOCHEN to design what he called the refrigerator of the future. Radermacher was quoted at the time as saying "We want to develop ozone-safe refrigerants and design a refrigerator that is considerably more energy-efficient than today's models."

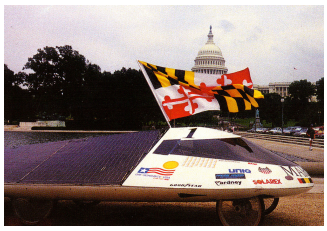
In April 1985 Department faculty and graduate students, under the guidance of Davinder K. Anand, were funded by Charles Jantho, Director of the campus physical plant, to determine ways to conserve energy on the campus. Professors Jackson, Gupta, diMarzo and Radermacher engaged in energy audits, examination of use of water absorption chillers, and improving the efficiency of steam generation facilities.

Chancellor John Toll recognized that by 1985 the time had come to satisfy a long-standing demand of the business community in Baltimore to establish an Engineering program at the University of Maryland-Baltimore County (UMBC). He placed the new program under the jurisdiction of the Dean of Engineering at College Park. UMBC Mechanical Engineering was formally established, and William L. Fourney became Chairman of the UMBC department while retaining his appointment at College Park. At UMBC he hired some fifteen new faculty and set up the structure of the Department. The relationship of our faculty and those at UMBC was very collegiate, and during the initial period of startup, College Park faculty often taught at both departments, depending upon the teaching needs of UMBC.

The Instructional Television System (ITV) at the College Park campus expanded its reach into Hagerstown and Western Maryland during Fall 1986. The Hagerstown program

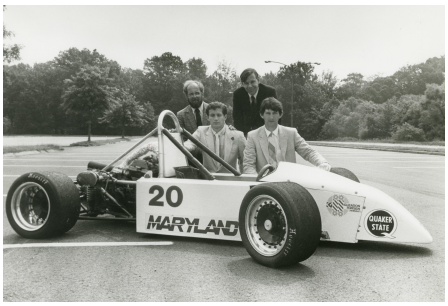
was designed to provide a bachelor's degree in Mechanical Engineering, and replaced a long-standing program that had been abandoned by The Johns Hopkins University.

Nationally sponsored design contests became a prominent student activity in the 1980s. Perhaps the most attention was given to the students of the American Society of Mechanical Engineers and the Society of Automotive Engineers, who started building and racing mini Baja dune buggies, then graduated to solar powered vehicles, then finally miniature formula race cars. The most publicized project at the time was the solar-powered vehicle "The Pride of Maryland", which finished third in the 1990 GM Sunrayce competition from Orlando to Detroit, and then went on to compete in both the World Solar Challenge in Australia and an invitation-only rally in Noto, Japan. The Department's long history of successful automotive projects is a tribute to Professor David Holloway, who was an active faculty advisor to many student design teams.



The Pride of Maryland Solar Car

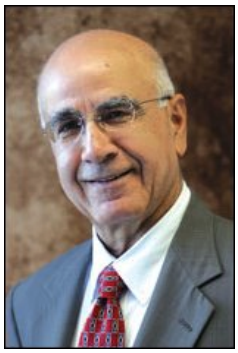
Holloway's former students work as automotive engineers at automotive manufacturers GM, Ford, Chrysler and Nissan. In an interview during this period, Holloway said "I really enjoy seeing my students grow and mature … The car competitions are a real confidence builder for them and I am exceedingly proud of what they've been able to accomplish-to design a car, to make it work and then, sometimes, to have it win. That's the crowning glory."



David Holloway and students with Formula race car

A student exchange program between the Department of Mechanical Engineering and the University of Applied Sciences in Mannheim, Germany was set up in Fall 1988. Initially administered by Professor Dirse Sallet, Professor Reinhard Radermacher took over the program in the early 1990's with support from Jane Fines, Director of Undergraduate Recruitment and Special Programs in the Clark School. As of 2018, the program is still ongoing and successful.

Significant Changes *(1990 to 2000)*



Davinder K. Anand

William Fourney stepped down as Chairman in 1991 to return to the faculty as Professor of Mechanical Engineering. Dean George Dieter appointed Davinder K. Anand as Chairman of Mechanical Engineering at College Park and UMBC in September 1991. Anand was also a Professor of Systems Research at that time, and resigned this position upon accepting the Chair of Mechanical Engineering. He appointed Professor Frank Buckley, and when Buckley retired then Professor James Wallace, as the Director of the Graduate Program. Associate Professor William Walston continued as the Director of the Undergraduate Program and upon his retirement in 1999, Dr. Sami Ainane took over the position. Between the period of 1998 and 2002 Professor Marino diMarzo and Ugo Piomelli served as Graduate Directors.

In late Fall 1991, the faculty went on a collegial two-day retreat to the Xerox Center in Virginia to prepare a strategic plan for the Department. Three major decisions were made. The first was to separate the Department of Mechanical Engineering at UMBC into an independent entity. The second was to recommend the decrease from 134 to 124 credits for the BME degree, and the third decision was made to strengthen the faculty. An important byproduct of the retreat was a sense of cohesiveness amongst the professoriate.

By 1991 CALCE, with Professor Michael Pecht as Director, was growing rapidly and had more than 20 industry sponsors. It was now designated as an NSF State/Industry/University Center and was renamed the CALCE Electronics Packaging Research Center (EPRC). He subsequently added three additional faculty over the next several years.

In 1992 construction started on the $1.2 million Manufacturing Building, located next to the new Neutral Buoyancy Laboratory built for NASA's zero-g experiments. Funds were provided by Mechanical Engineering, Electrical Engineering and the Minta Martin Endowment. Half of the building was to house our Manufacturing Laboratory, which consisted of a machining center, magnetic bearing, injection molding machine, and other small tools. The faculty participating in these laboratories were: Professors Anand, Kirk, and Magrab from the Mechanical Engineering Department and Professor Dana Nau from the Computer Science Department. The other half of the building was allocated for Aerospace Engineering research activities. Formal opening ceremonies occurred in 1995 with the presence of President William E. Kirwan and Dean George E. Dieter.

Opening Celebration of Manufacturing Building

In October 1991, IBM decided to stir up interest in universities concerning Total Quality Management (TQM), then a popular philosophy sweeping corporate management in the United States. They offered a grant competition for ideas of how universities could implant TQM concepts into their regular curricula. A firm requirement was that each proposal must involve both the colleges of Business and Engineering. Over 200 universities applied, and Maryland was one of the eight winners. The proposal was written by Professor Edward Magrab in Mechanical Engineering and Judy Olian in the Business School.

Awards were made on October 9, 1993. The grant provided approximately $1 million over three years plus free IBM PCs, which were in great demand at that time. The IBM-TQ program was an honors program where the students were selected after their freshman year. The curriculum involved fundamentals of product design, statistics for total quality, marketing and customer relationships, and good team behavior, followed up by two years of project work. The majority of the engineering students came from Mechanical Engineering, and Professor David Bigio was the chief contributor from the Department for many years.

The IBM funds were depleted by 1998, but based on the fine achievements of the students and the good feedback from industry, the University agreed to continue this with

University funds as one of the honors programs. The program was renamed QUEST (Quality Enhancement Systems and Teams). The curriculum continues pretty much as before but with a stronger emphasis on systems and an increased emphasis on decision-making. Student projects with local industries remain a major emphasis. Students with the College of Computing, Math, and Natural Sciences are eligible for admission. However, the majority of students continue to be from Business and Engineering, with Mechanical Engineering being by far the largest engineering component. Mechanical Engineering students view the QUEST Program as a substitute for Industrial Engineering, which is not part of our curriculum. From 2008 to 2018, Mechanical Engineering Professor Jeffrey Hermann was the main faculty member from Engineering in the QUEST Program.

In 1992 the Mechanical Engineering Department at College Park officially cut ties with the UMBC Mechanical Engineering Department, and Akhtar Khan was appointed as Chairman of Mechanical Engineering at UMBC. During that period Associate Professor Ioannis Minis was transferred from his appointment at UMBC to College Park.

In 1994, DeWALT (and parent company Stanley Black and Decker) began supporting the Department with donated materials, funds and time as a corporate partner for the newly created ENME 371: Product Engineering and Manufacturing undergraduate course. This was a new, hands-on design experience for Mechanical Engineering students that as of today is a required and successful course in the curriculum. A proposal was also made in 1992 to the College to revise the curriculum of the Mechanical Engineering Department such that 124 credit hours would be required for graduation. This was shortly approved and all of the Engineering departments made similar changes soon thereafter.

Faculty Retirement Gathering

There were significant changes in the faculty during this decade. A large number of faculty retired, including eight full Professors (Cunniff, Berger, Talaat, Armstrong, Marcinkowsi, Yang, Buckley, Kirk), one Associate Professor (Walston) and one Assistant Professor (Tsui). Our faculty added two full Professors, two Associate Professors and eighteen Assistant Professors. The result was a significant drop in the overall

professional experience of faculty members, but a significant increase in the introduction of several new areas of research and teaching in the department.

Professor C. D. Mote Jr., Chair of the Department of Mechanical Engineering at Berkeley, joined the University of Maryland in 1998 as both Professor of Mechanical Engineering and President of the University of Maryland College Park. He was an internationally recognized researcher in the field of biomechanics, and had built a reputation as a leading expert in ski equipment. In our Department, the refrain became "Vote for Mote" when the full professors voted for his tenure.

UMCP President C.D. Mote with President Clinton on our campus

Reinhard Radermacher and his CEEE laboratory were successfully inventing new ways to increase the efficiency of refrigerant systems. A particular patent of his was of interest to Samsung, and the Chairman negotiated its sale for $500,000. Half of the proceeds went to the Environmental Protection Agency (EPA), the sponsoring agency of the research, and the other half came to the Department. The other half was split between Radermacher, his student and the Department. This was the first patent the Department had ever sold. In 1995, the Department acquired a state of the art stereolithography machine in the Advanced Design and Manufacturing Laboratory. The machine, acquired from 3D Systems Inc. in Valencia, California, was for research on rapid prototyping and was reported on in the Washington Post in a profile of the laboratory.

Edward Magrab

An important grant from NSF/ARPA from 1994 to 1997 in the amount of 2.4 million dollars was spearheaded by Professor Edward B. Magrab, to introduce and institutionalize manufacturing education across much of the undergraduate curriculum. As a result, an integrated sequence of twenty new courses was created in advanced engineering materials, advanced electronic products, integrated product development, manufacturing operations management, and total quality. Many of these courses are still being offered today. These accomplishments were the efforts of over twenty faculty members from six Engineering departments, the Department of Computer Science, and the College of Business and Management. Concurrent with the grant, the Department revised

its four-year undergraduate curriculum in such a way that these new/revised courses became an integral part of it. In Fall 1996 computer programming was newly and broadly integrated into the Mechanical Engineering curriculum using the Mathworks' Matlab software, an effort lead primarily by Professor Magrab.

James Sirkis

During this period Professor James Sirkis established the university's Smart Materials and Structures Research Center (SMSRC). It was one of the largest of university-based efforts of its kind in the country. Sirkis and his student Harmeet Singh won the Physical Science Invention of the Year in 1996 for their "Fiber-Optic Three Strain Sensor". This was an advanced sensing device that could be used to detect deterioration in our nation's aging infrastructure, such as skyscrapers, bridges, utility plants and aircraft. In an article at the time, funding for smart structures research at the university reportedly topped $1.75 million annually – and the amount was reported as growing. "Every year I think it's going to drop and die," said Sirkis, "but every year it keeps getting bigger." Sirkis left the Department in 1999 to go into industry, and Amr Baz was appointed Director of the SMSRC. Baz also established the VR laboratory in the Meyers Building, which was off the main campus, housing an immersive projected virtual reality environment. As of 2018, the virtual reality laboratory is in the Kim Building, available to Mechanical Engineering faculty for research.

1996 Boeing Outstanding Educator Award Team

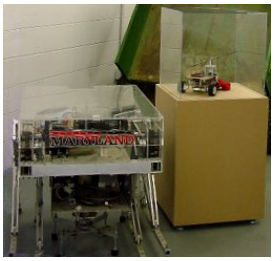
Under the leadership of Patrick Cunniff and Jim Dally, we received the 1996 Boeing Outstanding Educator Award, which carried a $50,000 award. The University and team members won the award over 30 other schools. The University of Maryland team was recognized for combining the traditional undergraduate engineering technical core studies with significant student exposure to product design, testing and manufacturing, teaming issues and business concerns associated with product development.

A vehicle for long term research and education collaborative activity was established with the signing of a five-year contract with the Naval Surface Warfare Center at Indian Head, Maryland. The result was the creation of the Center for Energetics Concepts Development (CECD) in 1998. The first Director of the Center was Professor Ronald Armstrong, who retired the following year. Subsequently Professor Davinder K. Anand became the Director of CECD. The Center was active in research pertaining to energetic materials, manufacturing cells, CAD/PAD devices, training in virtual reality, traumatic brain injury, informatics, system simulation and the formation and creation of an energetics technology research center in Southern Maryland. One of CECD's very prominent projects was working with the Office of Naval Intelligence and simulating the impact of accidents that would impact harbor safety during the 9/11 crisis of 2001.

Naval Surface Warfare Center/University of Maryland Contract Signing Ceremony

Student teams in David Holloway's automotive engineering laboratory continued to attract national attention. The university's hybrid electric vehicle, designed to run at an efficient 70 miles-per-gallon and also to reduce emissions, won over every other vehicle entry in all of the 10 categories at the Society of Automotive Engineers (SAE) 1994 Hybrid Electric Vehicle Challenge in Southfield, Michigan. This was but one of many prizes and accolades garnered by Holloway's students.

The Department made news in the Washington Post in 1993 when Lancelot, a student-built autonomous jousting robot, took first honors at the Japanese Robot Grand Prix in Tokyo. The robot-building was part of a course taught for the first time by Assistant Professor Gregory Walsh.



Walking Robot and "Lancelot" Jousting Robot

The course combined traditional scientific and technical training with significant exposure to product design, testing, manufacturing and team building. The students were the only

foreign team in the competition, and were able to beat out 110 other robots built by Japanese Mechanical Engineering student teams.

Associate Professor Linda Schmidt, the Clark School's director of student research, created the Research Internships in Science and Engineering, or RISE, program. This was a team-based educational intervention effort that sought to boost the number of women making careers in these high-tech fields. The program was supported in 1997 by a $900,000 grant from the National Science Foundation, with an additional $100,000 in funding from the Clark School.

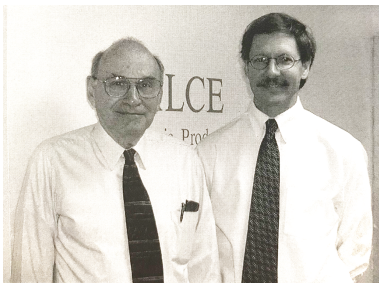
Gathering of Chairmen (from left Cunniff, Dally, Anand, Shreeve and Fourney)

A Mechanical Engineering program was established in Fall 1997 at Frostburg State University in Frostburg, Maryland, developed jointly by the University of Maryland, College Park (UMCP), and Frostburg State University (FSU). The program was designed to serve the students from the surrounding rural areas and thus to serve as a vehicle to enhance the economic development of the region. Initial enrollment was 39 students, taking higher-level Engineering courses delivered over interactive video from UMCP through the ITV group.

Settling In *(2000 to 2010)*

The Department held its First Annual Research Review Day at the University of Maryland's Inn and Conference Center on November 3, 2000. Over 100 attendees from industry, government, and academia were presented with an overview of the research being conducted in the Department through talks, poster presentations and videos. Attendees were welcomed by University President and Professor of Mechanical Engineering C. Daniel Mote, Jr. and Dean of the Graduate School William W. Destler. Over 60 research posters were showcased for this event, which included a luncheon and an afternoon of laboratory tours.

Our faculty continued to receive considerable professional recognition. In 2001, Professor Michael G. Pecht was chosen as the first George E. Dieter Professor of Mechanical Engineering, the first chaired professor in the Department. Most senior professors became fellows of various professional societies and received service awards, teaching awards and medals. Of special note was the awarding of the University of Maryland's President's Medal to Professor George Dieter in 2004. Young faculty members continued to receive NSF and DARPA Faculty awards, while Assistant Professor Satyandra K. Gupta received the Presidential Early Career Award for Scientists and Engineers (PECASE).



Dean George Dieter and Michael Pecht

An unusual Departmental robotic project, of interest to biologists, led to the discovery of a new twist in the mating ritual of Australia's amazing bowerbird. Students designed and built and deployed a feathered robot for their project, successfully simulating a real bowerbird. Their advisor, Assistant Professor Gregory Walsh, after watching videotapes of the birds in their Australian habitat said, "It was tricky but not terribly difficult. Robotics takes a lot of inspiration from nature. We built a sheet metal skeleton, and a taxidermist did the bird's exterior. We inserted a small computer to control the bird. Of course we called that the 'bird brain.'"

In the 2000 *FutureTruck* competition at the General Motors Desert Proving Ground in Mesa, Ariz., Mechanical Engineering students led by Professor David Holloway took a stock Chevy Suburban and successfully converted it to a hybrid by combining an electric motor with an ethanol-fueled smaller engine. The design netted the students top honors overall and in the off-road category.

Linda Schmidt

An important teaching grant was received in 2001 by Associate Professor Linda Schmidt from NSF in the form of a three year, $420,000 grant to support the Building Engineering Student Team Effectiveness and Management Systems (BESTEAMS) program. The program was a part of a multi-university (University of Maryland, U.S. Naval Academy,

Howard University, and Morgan State University) pilot project. The intent was to develop an integrated and longitudinal team-centered engineering curriculum model to improve learning in project team environments, involving students across their entire engineering education experience.

Davinder K. Anand stepped down as Chairman in 2002, and Dean Nariman Farvardin appointed Avram Bar-Cohen as Chairman of Mechanical Engineering in January 2002. Since the retirement of Professor Shreeve in 1970, only one outsider had occupied the Chair of Mechanical Engineering. That outsider was Professor James Dally, for a period of just four years. And now, after a 25 year period of internal candidates, an external candidate again occupied the position of Chairman. Professor Avram Bar-Cohen, whose interest was in heat transfer and electronics, brought a wealth of experience both in research and teaching from the University of Minnesota.

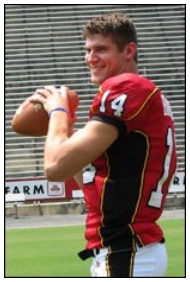
Avram Bar-Cohen

During his term, initially the Director of Graduate Programs was Professor Ugo Piomelli, who in 2006 was succeeded by Professor Balakumar Balachandran. In the undergraduate office, Dr. Sami Ainane left to Abu Dhabi to work under the Cooperative Education and Research in Energy Sciences and Engineering agreement with the Petroleum Institute, and was succeeded in 2007 by Associate Professor David Bigio.

Our student teams continued to enter and win a variety of awards in solar energy applications. Held regularly on the Mall in Washington, D.C., the Department of Energy's "Solar Decathlon" competition was to build a house which used solar energy to power everything in it. In the 2007 Solar Decathlon competition the LEAFHouse, an 800-square-foot solar-powered home, took 2nd place overall and won the People's Choice Award. The team consisted of five mechanical engineering students. The Human powered submarine team lead by Marjorie Erickson won first place for speed and second place overall at the Seventh International Submarine races, held in June 2003 at the Naval Surface Warfare Center, Carderock Division, in Bethesda, MD.

First Solar Decathlon House

Professor of Mechanical Engineering C. Daniel Mote, Jr., now the President of the University, had introduced the idea of having a Maryland Day inviting the general public onto the campus, and challenged every Department to showcase their achievements. In response to that we offered the idea of an "*Innovation Lab*" for Maryland Day in April 2004, and displayed several award-winning student projects. Some of the exhibits included the human-powered submarine, the walking and jousting robots, the winning solar-powered car 'Pride of Maryland', a model of the solar house and a human-powered vehicle.



Sam Hollenbach

To the delight of our football fans, in November 2004 Terps quarterback Sam Hollenbach, a Mechanical Engineering sophomore, threw for 164 yards in his first college start to give Maryland an impressive 13-7 victory over Wake Forest. He would go on to a successful college football career, signing with the Washington Redskins after college as an undrafted free agent. After graduation, Sam went to work as an engineer for popular sports company Under Armor.

Ali Mosleh

The Reliability Program in the Materials Engineering Department was transferred into the Mechanical Engineering Department and Professor Ali Mosleh was appointed as the Director of the Reliability Engineering Program in June 2004. He was also designated as the Director of the newly formed Center for Risk and Reliability (CRR), the research arm of the Reliability Engineering Program. He was appointed as Nicole Jurie Kim Eminent Professor in August 2005.

On the international side, a memorandum of understanding was established between the University of Maryland and The Petroleum Institute of Abu Dhabi to establish a Cooperative Education and Research in Energy Sciences and Engineering agreement in April 2006. Under the direction of Michael Ohadi, Sami Ainane and Avram Bar-Cohen, the agreement sought to enhance the collaborative educational and research activities in the field of energy sciences and engineering, and to enhance the undergraduate, graduate and continuing education programs of both establishments.

Professor David Holloway's automobile engineering class and laboratory continued to attract a large number of our students. The new advisor for the laboratory was Adjunct Associate Professor Gregory Schultz. The Terps Racing team won the Formula SAE West 2008 competition, held at California Speedway in Fontana, California. During the four-day event, the team placed first overall out of 83 teams from all over the world in the Formula SAE car contest.

In December 2009 the Center for Energetic Concepts Development (CECD) held the First Symposium on Cooperative Research on Traumatic Brain Injury, bringing together researchers from Mechanical Engineering, the Naval Surface Warfare Center at Indian Head and the University of Maryland Medical School. The studies were both analytical and experimental, and were primarily concerned with the impact of high g-force explosions. This particular research activity was closely tied to the Wounded Warrior program at the Naval Surface Warfare Center at Indian Head, and was relevant to our young warriors returning from the Iraq war.

The last notable event of the decade was the return of Professor C. Daniel Mote, Jr. to the Department of Mechanical Engineering in 2010, having served as President of the University for twelve years. Professor Avram Bar-Cohen took a leave of absence in 2010 to become a program director at DARPA, and Dean Darryl Pines appointed Professor Balakumar Balachandran as Acting Chairman of Mechanical Engineering.

Looking to the Future *(2010 -)*

The previous decade saw a consolidation of faculty and new research. The Department had settled down to a steady state with 703 undergraduate students and 292 graduate students, of which 188 students were pursuing a PhD. Dean Darryl Pines appointed Balakumar Balachandran as Chairman of Mechanical Engineering effective May 2011. Professor Balachandran received his doctorate from VPI and joined our department in 1993.

Although there was a normal level of turnover, the faculty leaving College Park went to prominent universities, attesting to the Department's enhanced reputation. Seven of our

faculty left to go to Mechanical Engineering departments in Georgia Tech, University of Southern California, University of California in Los Angeles, Carnegie Mellon, Colorado School of Mines and George Washington University. Two left to join the Bioengineering and Chemical Engineering departments at UMCP, and one returned to Chile.

Balakumar Balachandran

Balachandran appointed Professor Kenneth Kiger as the Director of Undergraduate Studies, and Professor Hugh Bruck as the Director of Graduate Studies. He also appointed Professor Donald DeVoe to the newly created position of Associate Chair of Research. The Department hired twelve faculty members, with specific emphasis on a few targeted areas. To support their activities in collaboration with faculty already on campus, several new laboratories were established. They were in the areas of robotics, health systems, energy systems, computation and big data.

Sarah Bergbreiter's Bioinspired Micro Robots

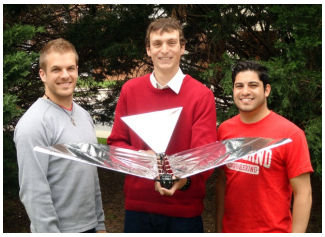
The faculty continued to receive accolades during this period. Most senior professors had become fellows of various professional societies and received service awards, teaching awards and medals. A significant number of entering young faculty members received NSF Faculty Early Career Development (CAREER) Awards. Associate Professor Sarah Bergbreiter received the Presidential Early Career Award for Scientists and Engineers (PECASE). Her work in bioinspired micro robotics throughout this period received significant outside attention.

We take particular note of our Professor C. Daniel Mote Jr., who is the most eminent Mechanical Engineering faculty member. He took leave of absence from the Department to become the 11th President of NAE in July 2013. He had numerous national and international awards and medals, attesting to his research, service and leadership.

Professor Ali Mosleh was elected to the National Academy of Engineering. Several other Professors were named to various chaired appointments, listed in the Appendix, and Professor Elisabeth Smela became the first female full Professor in the Department's history in July 2011.

Elizabeth Smela

The Department extended its reach into Southern Maryland in November 2012 when the University System of Maryland committed nearly $450,000 in base funding support. This created a partnership between the A. James Clark School of Engineering, the College of Southern Maryland, the Southern Maryland Higher Education Center (SMHEC) and the Naval Air Warfare Center Aircraft Division (NAWCAD). The objective of the partnership was to support a program that allowed students in Southern Maryland to receive an accredited University of Maryland Mechanical Engineering degree. Approximately 65 students who lived in Southern Maryland were expected to enroll on an annual basis. The program was a unique collaboration that allowed students who enroll to take classes at the SMHEC and have the opportunity to pursue internships at NAWCAD. In addition, technical subject matter experts on the base worked with students on capstone design projects.



Robo-Raven and Student Team

The Robo-Raven was a raven-sized flapping wing aerial vehicle platform that demonstrated outdoor flight with independent programmable wings and was first flown in April 2013. Robo-Raven's wing system was proposed for use in UAVs instead of propellers to make them more versatile. Developed by Professors Satyandra Gupta and Hugh Bruck along with students in the Maryland Robotics Center, the project was sponsored by ARL, AFRL, and NSF and gained national attention.

An interesting project was one of the world's first portable personal air conditioning systems, using a "smart" nozzle to track user's movements. This was sponsored by the Advanced Research Projects Agency-Energy (ARPA-E) through a three-year contract led by Professor Radermacher. The project, referred to as RoCo, or Roving Comforter, is an R2D2-like robot that can follow users around while delivering cool or warm air depending on the comfort needs of the user. The project is a collaborative activity including colleagues in CEEE, the Cluster for Sustainability in the Built Environment at the University of Maryland (CITY@UMD), and Oak Ridge National Laboratory.

RoCo Roving Comforter Robot

The undergraduate student body increased fifty percent over this period. The current curriculum, while providing the fundamental and basic courses of Mechanical Engineering, is consistent with ABET requirements. The students have ample opportunity to select a number of technical and non-technical electives, giving them a strong background to proceed in their chosen careers. The new electives span the range from design methods to computational tools to energy and the environment. A strong component of student activities is the design experience. Every semester a Design Day is set aside to showcase the capstone design projects of student teams. As an example, one student team worked with oyster farmers to build a system to detect dredges engaged in illegal oyster farm poaching using a hydrophone. This team won the Sustainability Award at Design Day in May 2018.


2018 Sustainability Award Winning Student Design Team

Our students also performed very well at external design competitions. A first place win was secured by our student team at the U.S. Department of Energy's inaugural Max Tech and Beyond Design Competition. This competition was for the design of ultra-low energy use appliances and equipment. The team won in August 2012, and again in September 2013 for their design of an efficient heat pump clothes dryer.

A large contingent of our students were members of the University of Maryland Hyperloop team, UMDLoop. The team formed to develop a prototype vehicle based on SpaceX CEO Elon Musk's vision for a new mode of transportation. They won the Performance and Operations Award and placed in the top five for overall pod design at the first ever SpaceX Hyperloop Pod Competition held in Hawthorne, California in 2017.

UMDLoop Team

A very special new course was added in collaboration with the School of Public Policy in Spring 2015, namely the technical elective Engineering for Social Change. The class introduces our students to the ideas of social change and social entrepreneurship through the intersection of concepts from both engineering and philanthropy. The course creates an environment where engineers have not only a social conscience, but also the skills and knowledge to build and work with organizations that are philanthropic or nonprofit. In cooperation with the Neilom Foundation, the course features a $10,000 grant award at the culmination of the semester.

Professor Smela was appointed as Associate Dean for Faculty Affairs in 2017, and left in 2018 to accept the Jefferson Science Fellowship with the State Department, with Professor Hugh Bruck taking over her position. Professor Abhijit Dasgupta then became the new Director of Graduate Studies and Associate Chair for Academic Affairs. Also in 2018, Professor Kenneth Kiger was appointed as Associate Dean of Undergraduate Programs, and Professor Jungho Kim took his position as Director of Undergraduate Studies in the Department, with Associate Professor Gary Pertmer as Co-Director.

Today, the Department has an undergraduate student body of approximately 1200 students, a graduate student body of 300 students, 200 doctoral students, and a strong research base. The four Centers (CALCE, CEEE, CECD, CRR) and our laboratories are all working successfully on cutting edge research and generating new ideas for education of the engineer of the future. Further, we are guided by and well informed of futuristic trends and practices in industry, as well as other academic institutions, through our visiting committee that acts as an advisory board to the Chairman. As we move forward, the

Department is in a very strong position with faculty working in all the areas of contemporary and forward-looking Mechanical Engineering research designed to improve the lives of mankind. The Department is highly ranked, and is well positioned to meet the challenges of the 21st Century.

Appendix

1. 1895 Curriculum
2. 1895 Expenses
3. 1950 Curriculum
4. 1960 Curriculum
5. 2018 Curriculum
6. Mechanical Engineering Faculty Fellows
7. Mechanical Engineering Chairmen, 1894-2018
8. Department Laboratories
9. Department Centers
10. Mechanical Engineering (1894-Present): Milestones

1. 1895 Curriculum

THE MARYLAND AGRICULTURAL COLLEGE.

Schedule of the Course in Mechanical Engineering.

FRESHMAN YEAR.

First Term.	*Second Term.*
Solid Geometry.	Plane and Spherical Trigonometry.
Algebra.	General Chemistry.
General Chemistry.	Chemical Laboratory.
Chemical Laboratory.	History.
Rhetoric and English Composition.	French (or German).
French (or German).	Mechanical Drawing and Descriptive Geometry.
Mechanical Drawing.	Freehand Drawing.
Freehand Drawing.	Wood-turning.
Carpentry.	Military Drill.
Military Drill.	

SOPHOMORE YEAR.

First Term.	*Second Term.*
Principles of Mechanism.	Mechanism: Machinery, Machine Tools, Gear Teeth.
Drawing.	Drawing.
Pattern-making.	Pattern-work and Molding.
Analytical Geometry.	Differential Calculus.
Descriptive Geometry.	Physics.
Physics.	English Literature and Composition.
English Literature.	German.
American History.	Military Drill.
German.	
Military Drill.	

JUNIOR YEAR.

First Term.	*Second Term.*
Steam Engineering, Valve Gears.	Steam Engineering, Boilers.
Thermo dynamics.	Drawing, Design and Use of Surveying Instruments.
Drawing.	Engineering Laboratory.
Forging.	Chipping and Filing.
Integral Calculus.	Strength of Materials, Kinematics, and Dynamics.
General Statics.	Physical Laboratory.
Physics, Heat.	English Composition.
Physical Laboratory.	Specifications of Machines.
German.	German.
Military Drill.	Military Drill.

SENIOR YEAR.

First Term.	*Second Term.*
Steam Engineering.	Hydraulic Motors.
Hydraulics.	Engineering Laboratory.
Dynamics of Machines.	Machine-shop Work.
Machine Design.	Strength and Stability of Structures, Theory of Elasticity.
Engineering Laboratory.	English Composition.
Machine shop Work.	Drawing up Contracts.
Strength of Materials, Friction.	Iron and Steel Shipbuilding, Marine Engineering.
Metallurgy of Iron.	Thesis.
Heating and Ventilation.	
Elements of Dynamo Machinery.	
Locomotive Construction.	

In undertaking the course in Mechanical Engineering it should be borne in mind that of the subjects studied in the first and second years those most vital to success are Mathematics, Physics, and Drawing (including Descriptive Geometry). All the later professional work of the department is so completely dependent upon these branches that no student can expect to succeed in it without having mastered them.

The professional work of the course in Mechanical Engineering may be classified as follows:

(*a.*) Mathematics, Physics, and Applied Mechanics, given outside the department, the last including the study of and practice in testing the strength of materials.

(*b.*) Class-room work of the department proper.

(*c.*) Drawing.

(*d.*) Engineering Laboratory-work.

(*e.*) Shop-work.

(*f.*) Visits to engineering works and manufacturing establishments.

The work of the first year is mainly introductory.

In the second year the more essential subjects given outside the department are Analytical Geometry, Differential Calculus, and Physics. The department gives a course in the principles of mechanism and in the construction of gear teeth, followed by courses on the mechanism of machine tools and of machinery. In intimate connection with this, practice is given in making working drawings of parts of machinery from measurements and other drawings illustrating the class-room work. Instruction is also given in patern-making and molding at the shops.

2. 1895 Expenses

THE MARYLAND AGRICULTURAL COLLEGE.

EXPENSES.

We have three grades of students.

1. Regular Matriculates.
2. State Scholarship.
3. Day Students.

Charges for first class of students are:

1. $140 board for scholastic year.
2. $4 medical fee.
3. $6 for use of material in practical laboratory.
4. $5 annual deposit, security against damage to property.

Second class of students the same as above, with exception of board, which is $45 for scholastic year.

Third class of students pay no medical fee. Laboratory and annual deposit same as other students, and $24 tuition fee.

Methods of Payment.

For regular matriculates: Medical fee, deposit, laboratory, and $40 on board are paid on entrance; $40 November 15th; $40 February 1st; $20 April 1st.

For State students: Medical fee, laboratory, deposit, and $22.50 payable on entrance; $22.50 February 1st.

For day students: Deposit, laboratory fee, and $12 payable on entrance; $12 February 1st.

These charges cover all expenses for board, tuition, fuel, light, books, use of library, and gymnasium.

Room furnished with bedstead, chairs, table, mattress, washstand. The students furnish their rooms with the remaining necessary articles, which can be obtained at the institution at very reasonable rates.

Articles Needed.

Wash basin and pitcher.
6 towels.
3 pairs of sheets for single bed.
1 pair of blankets.
1 comfort.

2 bedspreads, which must be of uniform color, can be obtained from quartermaster's department.

1 drop-light for study, furnished with a Welsbach burner.

2 uniforms, costing $16.45, furnished by Baltimore house under contract.

Regulations to which Special Attention is Called.

1. Payments must be made as indicated.

2. The regulations are such as are believed to be conducive to the best interest of the College and young men committed to its care. Exceptions cannot be made for individual cases. PARENTS AND GUARDIANS WILL PLEASE NOTE THIS.

3. The $5 deposit is merely intended to cover destroyed property. Any student abusing College property and who is personally known will have the damage charged against his individual account. Property destroyed, where responsibility cannot be fixed to an individual, will be charged to this fund and will be distributed *pro rata* among the student body. All balances remaining at the end of the year will be returned with the final report.

4. Uniforms must be worn at all times during the scholastic year. Exception is made when students are engaged in athletic exercise.

5. Books of regulation are furnished students on entrance, and they are expected to closely observe the requirements.

All communications for information or business with the College should be addressed to the

PRESIDENT MARYLAND AGRICULTURAL COLLEGE,
COLLEGE PARK,
Prince George's County, Md.

Express Office:
COLLEGE STATION, B. & O. R. R.,
Prince George's County, Md.

3. 1950 Curriculum

Mechanical Engineering deals with the design, construction, and maintenance of machinery and power plants; heating, ventilation, and refrigeration; and the organization and operation of industrial plants.

BASIC CURRICULUM FOR ALL FRESHMAN STUDENTS
All freshman students are required to take the following curriculum during their first year:

Freshman Year	**Semester I**	**Semester II**
Eng. 1, 2—Composition and American Literature	3	3
Speech 7—Public Speaking	….	2
Math. 14—Plane Trigonometry	2	….
Math. 15—College Algebra	3	….
Math. 17—Analytic Geometry	….	4
Chem. 1, 3—General Chemistry	4	4
Dr. 1, 2—Engineering Drawing	2	2
Engr. 1—Introduction to Engineering	1	….
A. S. 1, 2—Basic Air Force R. O. T. C. (Men)	3	3
Physical Activities	1	1
Total	**20**	**20**

Sophomore Year	**Semester I**	**Semester II**
G. & P. 1—American Government	3	….
Soc. 1—Sociology of American Life	….	3
Math. 20, 21—Calculus	4	4
Phys. 20, 21—General Physics	5	5
Surv. 1—Plane Surveying	….	2
Dr. 3—Advanced Engineering Drawing	2	….
Shop 1—Machine Shop Practice	2	….
Shop 2—Machine Shop Practice	….	1
Shop 3—Manufacturing Processes	….	1
A. S. 3, 4—Basic Air Force R. O. T. C. (Men)	3	3
Physical Activities	1	1
Total	**20**	**20**

Junior Year – General Option	**Semester I**	**Semester II**
*Eng. 3, 4—Composition and World Literature; or	3	3
*Eng. 5, 6—Composition and English Literature	3	3
Math. 64—Differential Equations for Engineers	3	….
Mech. 2—Statics and Dynamics	5	….
Mech. 52—Strength of Materials	….	5
E. E. 51, 52—Principles of Electrical Engineering	4	4
M. E. 53—Metallography	….	3
M. E. 54—Fluid Mechanics	….	3
M. E. 100—Thermodynamics	3	….
Total	**18**	**18**

Junior Year – Aeronautical Option	**Semester I**	**Semester II**
*Eng. 3, 4—Composition and World Literature; or	3	3
*Eng. 5, 6—Composition and English Literature	3	3
Math. 64—Differential Equations for Engineers	3	….
Mech. 2—Statics and Dynamics	5	….
Mech. 52—Strength of Materials	….	5
E. E. 51, 52—Principles of Electrical Engineering	4	4
M. E. 53—Metallography	….	3
M. E. 55—Fluid Mechanics and Aerodynamics	….	3
M. E. 100—Thermodynamics	3	….
Total	**18**	**18**

Senior Year – General Option	**Semester I**	**Semester II**
Engr. 100—Engineering Contracts and Specifications	….	2
*H. 5, 6—History of American Civilization	3	3
M. E. 101—Heat Transfer	2	….
M. E. 102—Heating and Air Conditioning	3	….
M. E. 103—Refrigeration	….	3

M. E. 104, 105—Prime Movers	4	4
M. E. 106, 107—Mechanical Engineering Design	4	4
M. E. 108, 109—Mechanical Laboratory	2	2
Total	**18**	**18**

Senior Year – Aeronautical Option	**Semester I**	**Semester II**
Engr. 100—Engineering Contracts and Specifications	….	2
*H. 5, 6—History of American Civilization	3	3
Aero. E. 113, 114—Mechanics of Aircraft Structures	3	3
M. E. 101—Heat Transfer	2	….
M. E. 104, 105—Prime Movers	4	4
M. E. 106, 107—Mechanical Engineering Design	4	4
M. E. 108, 109—Mechanical Laboratory	2	2
Total	**18**	**18**

* A. S. 103, 104—Advanced Air Force R. O. T. C.—3 credits per semester may be
substituted.

A minimum of 159 credits are required for a degree.

4. 1960 Curriculum

Freshman Year	**Semester I**	**Semester II**
Composition and American Literature	3	3
Public Speaking	….	2
Elementary Mathematical Analysis	5	5
General Chemistry	4	4
Engineering Drawing	2	2
Basic Air Force R. O. T. C.	3	3
Physical Activities	1	1
Total	**18**	**20**

Sophomore Year	**Semester I**	**Semester II**
G. & P. 1 — American Government	3	….
American Civilization Elective Group I	….	3
Math. 20, 21 — Calculus	4	4
Phys. 20, 21 — General Physics	5	5
M.E. 20, 21 — Manufacturing Tools and Processes	1	1
M.E. 22, 23 — Statics and Mechanics of Materials	3	3
A.S. 3, 4 — Basic Air Science (men)	2	2
Physical Activities	1	1
Total	**19**	**19**

Junior Year	**Semester I**	**Semester II**
Eng. 3, 4 — Composition and World Literature; or	3	3
Eng. 5, 6 — Composition and English Literature	3	….
Math. 64 — Differential Equations for Engineers	4	4
E.E. 51, 52 — Principles of Electrical Engineering	3	….
M.E. 24 — Dynamics	2	….
Ch.E. 140 — Introduction to Nuclear Technology	3	….
M.E. 100 — Thermodynamics	….	3
M.E. 101 — Heat Transfer	….	3

M.E. 102 — Fluid Mechanics	….	3
M.E. 104 — Kinematics	….	2
Total	**18**	**18**

Senior Year	**Semester I**	**Semester II**
H. 5, 6 — History of American Civilization	3	3
M.E. 150, 151 — Heat Power — Chemical and Nuclear	4	4
M.E. 152, 153 — Mechanical Engineering Design	4	3
M.E. 154, 155 — Mechanical Laboratory	2	2
Technical Electives*	6	6
Total	**19**	**18**

*To be selected from the following group:
M.E. 156 — Heating and Air Conditioning (3)
M.E. 157 — Refrigeration (3)
M.E. 158, 159 — Applied Elasticity (3,3)
M.E. 160, 161 — Advanced Dynamics (3,3)
M.E. 162, 163 — Advanced Thermodynamics (3, 3)
M.E. 164 — Research (3)
M.E. 165 — Creative Engineering (3)
M.E. 166, 167 — Advanced Fluid Mechanics (3, 3)

5. 2018 Curriculum

Mechanical Engineering is the broadest of the engineering disciplines. It is concerned with the design, manufacture, and operation of a wide range of components, devices, or systems. The field comfortably encompasses applications ranging from micro-mechanical surgical systems to internal combustion engines for Formula One racecars or giant turbines for renewable energy wind farms. A fitting adage for the discipline would be ***turning ideas into reality***.

Freshman Year		**Semester I**	**Semester II**
MATH140	Calculus I	4	….
MATH141	Calculus II	….	4
CHEM135	General Chemistry for Engineers	3	….
PHYS161	General Physics	….	3
ENGL101	Introduction to Writing	3	….
ENES100	Introduction to Engineering Design *(**can be taken 1st or 2nd semester*)	3**	…
ENES102	Mechanics I (***can be taken 1st or 2nd semester)*	…	3**
	General Education Requirements	….	6
Total Credits		**13**	**16**

Sophomore Year		**Semester I**	**Semester II**
MATH206	Intro to Matlab	1	….
MATH241	Calculus III	4	….
MATH246	Differential Equations	….	3
PHYS260/261	General Physics	4	….
PHYS270/271	General Physics	….	4
ENES220	Mechanics II	3	….
ENES221		3	….
ENES232		….	3
ENME272	Computer Aided Design	….	2
	General Education Requirements	3	3
Total Credits		**13**	**16**

Junior Year		**Semester I**	**Semester II**
ENME331	Fluid Mechanics	3	….
ENME332	Transfer Processes	….	3
ENME350	Electronics and Instrumentation I	3	….
ENME351	Electronics and Instrumentation II	….	3
ENME361	Vibration, Controls, & Optimization I	….	3
ENME371	Product Engineering and Manufacturing	….	3
ENME382	Introduction to Materials Engineering	3	….
ENME392	Statistical Methods for Product and Process Development	3	….
ENGL393	Technical Writing	….	3
	General Education Requirements	3	….
Total Credits		**15**	**15**

Senior Year		**Semester I**	**Semester II**
ENME462	Vibration, Controls, & Optimization II		3
ENME472	Integrated Product and Process Development II	3	
ENME400	Machine Design	3	
ELECTIVES	Technical Electives	6	9
	General Education Requirements	3	3
Total Credits		**15**	**15**

A minimum of 120 credits are required for a degree.

Sample Elective Topics
Waste Technology
Bio-Inspired Robotics
Computer-Aided Design & Manufacturing
Packaging of Electronic Systems
Energy Conversion
Engineering Management

Environmental Engineering
Flexible Macro-electronics
Automotive Design
Micro-nano Robotics Manufacturing
Medical Robotics
Fiber Optics
Micro-Electro-Mechanical Systems
Nuclear Reactor Engineering

6. Mechanical Engineering Faculty Fellows

National Academy of Engineering Members

- **James W. Dally**, Professor Emeritus
- **George E. Dieter**, Professor Emeritus
- **Millard S. Firebaugh**, Professor of Practice
- **Robert E. Fischell**, Professor of Practice
- **Eugenia Kalnay**, Affiliate Professor
- **Jeong H. Kim**, Professor of Practice
- **Ali Mosleh**, Professor Emeritus
- **C.D. Mote, Jr.**, Professor and Former President, University of Maryland
- **Elaine Oran**, Affiliate Professor
- **Hratch G. Semerjian**, Visiting Professor

*The above individuals hold appointments in the Department of Mechanical Engineering at the title listed.

Chaired and Distinguished Professors

Balakumar Balachandran, Minta Martin Professor
John Baras, Distinguished University Professor
Avram Bar-Cohen, Distinguished University Professor
Amr Baz, Minta Martin Professor, Keystone Professor
George Dieter, Glenn L. Martin Institute Professor
James Duncan, Wilson H. Elkins Professor
Millard Firebaugh, Minta Martin Professor
Ashwani Gupta, Distinguished University Professor
Eugenia Kalnay, Distinguished University Professor
Mohammad Modarres, Minta Martin Professor
Ali Mosleh, Distinguished University Professor, Nicole Jurie Kim Eminent Professor
C.D. Mote, Jr., Regents Professor
Elaine Oran, Glenn L. Martin Institute Professor
Michael Pecht, George E. Dieter Chair Professor
Reinhard Radermacher, Minta Martin Professor
Katepalli Sreenivasan, Distinguished University Professor
Michael Zachariah, Patrick and Marguerite Sung Distinguished Professor

Innovation Hall of Fame Members

Reinhard Radermacher (**2001)** - Environmental and Energy System Applications
Robert E. Fischell (2002) - Biomedical Devices
Jeong H. Kim (2004) - Asynchronous Transfer Mode Switch for Wireless Communications
Alex J. Severinsky (2008) - Hyperdrive Hybrid Power System
Michael G. Pecht (2011) - Advanced reliability & prognostic methods for electronics
John Baras (2016) - Satellite Technology and Hybrid Networks

Professional Society Fellows

Davinder K. Anand, American Society of Mechanical Engineers (ASME)
Ronald W. Armstrong, American Society of Metals (ASM)
Shapour Azarm, American Society of Mechanical Engineers (ASME)
Balakumar Balachandran, American Institute of Aeronautics and Astronautics (AIAA), American Society of Mechanical Engineers (ASME)
Avram Bar-Cohen, Institute of Electrical & Electronics Engineers (IEEE), Honorary Fellow American Society of Mechanical Engineers (ASME)
John Baras, Institute of Electrical and Electronic Engineers (IEEE), Society for Industrial and Applied Mathematics (SIAM), American Association for Advancement of Science (AAAS)
Donald Barker, American Society of Mechanical Engineers (ASME)
Amr Baz, American Society of Mechanical Engineers (ASME)
Peter Bernard, American Physical Society (APS), American Institute of Aeronautics and Astronautics (AIAA)
David Bigio, Society of Plastics Engineers (SPE)
Hugh Bruck, American Society of Mechanical Engineers (ASME)
Aris Christou, American Physical Society (APS), Institute of Electrical and Electronic Engineers (IEEE)
Patrick Cunniff, American Society of Mechanical Engineers (ASME)
James Dally, American Society of Mechanical Engineers (ASME), Society of Experimental Mechanics (SEM), American Academy of Mechanics (AAM)
Abhijit Dasgupta, American Society of Mechanical Engineers (ASME), Society of Engineering Sciences (SES)
George Dieter, American Association for Advancement of Science (AAAS), American Society for Metals (ASM), American Society for Engineering

Education (ASEE), Minerals Metals and Materials Society of the American Institute of Mining, Metallurgical and Petroleum Engineering (AIME)
Marino di Marzo, American Society of Mechanical Engineers (ASME)
James Duncan, American Physical Society (APS)
William Fourney, Society for Experimental Mechanics (SEM), American Society of Mechanical Engineers (ASME)
Ashwani Gupta, American Institute of Aeronautics and Astronautics (AIAA), Society of Automotive Engineers (SAE), American Association for the Advancement of Science (AAAS), Royal Aeronautical Society, UK (RAeS), Honorary Fellow American Society of Mechanical Engineers (ASME)
Satyandra K. Gupta, American Society of Mechanical Engineers (ASME)
Bongtae Han, American Society of Mechanical Engineers (ASME), Society for Experimental Mechanics (SEM)
Yunho Hwang, American Society of Mechanical Engineers (ASME)
Eugenia Kalnay, American Association for the Advancement of Science (AAAS), American Geophysical Union (AGU), American Meteorological Society (AMS)
Jungho Kim, American Society of Mechanical Engineers (ASME)
Edward Magrab, American Society of Mechanical Engineers (ASME)
Patrick McCluskey, International Microelectronics and Packaging Society (IMAPS)
Mohammad Modarres, American Nuclear Society (ANS)
Ali Mosleh, Society for Risk Analysis (SRA), American Nuclear Society (ANS)
C.D. Mote, Jr., International Academy of Wood Science (IAWS), The Acoustical Society of America (ASA), American Association for the Advancement of Science (AAAS), National Academy of Inventors (NAI), American Academy of Mechanics (AAM), Honorary Fellow American Society of Mechanical Engineers (ASME)
Michael Ohadi, American Society of Mechanical Engineers (ASME), American Society of Heating, Refrigeration & Air Conditioning (ASHRAE)
Elaine Oran, American Society of Mechanical Engineers (ASME), Society of Industrial and Applied Mathematics (SIAM), American Physical Society (APS), Honorary Fellow American Institute of Aeronautics and Astronautics (AIAA)
Michael Pecht, Society of Automotive Engineers (SAE), American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronics Engineers (IEEE), International Microelectronics and Packaging Society (IMAPS), Chinese Academy of Sciences President's International Fellowship (CAS)
Reinhard Radermacher, American Society of Heating, Refrigeration & Air Conditioning (ASHRAE)
Donald Riley, American Society of Mechanical Engineers (ASME)

Peter Sandborn, American Society of Mechanical Engineers (ASME), Institute of Electrical and Electronics Engineers (IEEE)
R. J. Sanford, American Society of Mechanical Engineers (ASME), Society of Experimental Mechanics (SEM)
Linda Schmidt, American Society of Mechanical Engineers (ASME)
Jan Sengers, American Society of Mechanical Engineers (ASME), American Institute of Chemical Engineers (AIChE), American Physical Society (APS), American Association for the Advancement of Science (AAAS), World Innovation Foundation (WIF), International Union of Pure and Applied Chemistry (IUPAC), Honorary Fellow International Association for the Properties of Water and Steam (IAPWS)
James M. Wallace, American Physical Society (APS)
Miao Yu, American Society of Mechanical Engineers (ASME)

Professional Society Honorary Members

Avram Bar-Cohen, American Society of Mechanical Engineers (ASME)
Ashwani Gupta, American Society of Mechanical Engineers (ASME)
C.D. Mote, Jr., American Society of Mechanical Engineers (ASME)
Elaine Oran, American Institute of Aeronautics and Astronautics (AIAA)
Jan Sengers, International Association for the Properties of Water and Steam (IAPWS)

7. Mechanical Engineering Chairmen, 1894-2018

Name	Time Period
J. D. Ford	1894-1897
Harry Gwinner	1897-1903
J. Hanson Mitchell	1903-1904
J. C. Blandford	1904-1905
Harry Gwinner	1905-1928
J. N. G. Nesbit	1929-1938
John E. Younger	1938-1958
Charles A. Shreeve, Jr.	1959-1970
John W. Jackson	1970-1971
James W. Dally	1971-1975
Patrick F. Cunniff	1975-1979
Clifford L. Sayre, Jr.	1979-1980
Patrick F. Cunniff	1980-1982
William L. Fourney	1982-1991
Davinder K. Anand	1991-2002
Avram Bar-Cohen	2002-2010
Balakumar Balachandran	2010-Present

8. Department Laboratories

- Advanced Heat Exchangers
- Advanced Manufacturing Laboratory (AML)
- Ballard Power Systems Fuel Cell Laboratory
- Bioinspired Advanced Manufacturing (BAM) Laboratory
- Cluster for SustainabilITY in the Built Environment (CITY@UMD)
- Combustion Engineering Laboratory
- Computational Turbulence Laboratory
- Computational Research in Science and Technology Laboratory
- Design Decision Support Laboratory
- Design Assurance Techniques Laboratory
- Dynamics and Control Laboratory
- Dynamics Effects Laboratory
- Hybrid-System Integration and Simulation (HSIS) Laboratory
- Hydrodynamics Laboratory
- Informatics for Design Engineering And Learning (IDEAL) Laboratory
- Laboratory for Computational Research in Science and Technology
- Laboratory for Control and Information Systems
- Laboratory for MicroTechnologies
- Nanometrology Core Facility
- Maryland MEMS and Microfluidics Laboratory
- Medical Robotics & Equipment (MRE) Laboratory
- Maryland Microrobotics Laboratory
- Micro/Nanoscale Heat Transfer and Energy Conversion Laboratory
- Multiscale Measurements Laboratory
- Phase Change Heat Transfer Laboratory
- Product Innovation & Realization Laboratory Suite (PIRLS)

- SAE Projects Laboratory
- Simulation-Based System Design Laboratory
- Small Systems Laboratory
- Smart and Small Thermal Systems Laboratory
- Soft Matter, Interfaces, and Energy Laboratory (SMIEL)
- Systems Risk and Reliability Analysis (SyRRA) Laboratory
- Vibrations Laboratory

CALCE Laboratories

- Electronic Systems Cost Modeling Laboratory
- Environmental Conditioning & Acceleration Testing Laboratory
- Failure Analysis & Materials Characterization Laboratory
- Laboratory for Optomechanics and Micro/nano Semiconductor/Photonics Systems
- Material Analysis Laboratory
- Permanent Interconnects & Accelerated Testing Laboratory
- Software Development Laboratory
- Thermal Packaging of Electronic Systems (TherPES)

CEEE Laboratories

- Energy Laboratory
- Heat Pump Laboratory
- Small and Smart Thermal Systems Laboratory

9. Department Centers

Computer Aided Life Cycle Engineering (CALCE)

Identifying and addressing tomorrow's challenges today

As one of the world's largest academic research centers focused on the reliability, safety, and sustainment of electronic products and systems, the Center for Advanced Life Cycle Engineering (CALCE) is dedicated to conducting research to enrich the development and promote the advancement of electronic products and systems. In the past, CALCE has worked to help companies transition to new technologies and practices, which included transitions to plastic-encapsulated electronics (PEMs), surface mount technology (SMT), lead-free electronics, and the utilization of commercial consensus-based industry standards.

Dr. Michael Pecht and Dr. Michael Osterman, interviewed for an ABC News segment

As new materials and processes are introduced into components and substrates, their impact on product life cycle is being addressed at CALCE through testing and modeling using the principles of reliability science. For example, while conductive polymers enhance performance and alleviate well-known failure modes in sensors and capacitors, their

susceptibility to new failure mechanisms introduces new concerns. CALCE has developed the first available life models for some of these devices. Embedded and integrated electronics are enabling the miniaturization that is critical to many consumer electronics and military applications, but processes that are essential to this progress are introducing unexpected reliability risks that must be assessed and mitigated. Additional examples of CALCE's current forward-looking research areas include support for autonomous vehicle electronics, 3D printed electronics, and energy storage industries, including the supply chain and manufacturing.

Autonomous vehicles are becoming a reality and, in time, will be ubiquitous. In order for a fleet of self-driving vehicles to transport passengers and goods safely, they must operate on a continuous communication network. Professor Bongtae Han of CALCE is working to develop reliable automotive electronics, including sensors and micromechanics used in vehicle communications. Such devices will monitor vehicle health to predict required maintenance or estimate remaining life.

CALCE Consortium Meeting Attendees

3D printed electronics are becoming easier and cheaper to manufacture, but with their mass production, their safe and reliable integration into smart components and devices is a priority. These devices include an array of composites that can be implemented in products such as fabrics, wearables and health-monitoring systems and medical technology, which makes their reliability of paramount importance. Professors Abhijit Dasgupta and Siddhartha Das are currently developing virtual qualification tools and accelerated testing strategies for these complex, electromechanical devices and their interactions with complex interfaces.

Solid oxide fuel cells (SOFCs) are highly efficient chemical-to-electrical energy conversion devices that have enormous potential for advancing a new global energy strategy because of their near-zero emissions. Professor Michael Pecht, Dr. Diganta Das, and Dr. Robert Utter are working to improve the performance and reliability of SOFCs. CALCE's research will enhance understanding of their degradation modes and mechanisms, which will lead to durability improvements of these systems, making them more practical and economical.

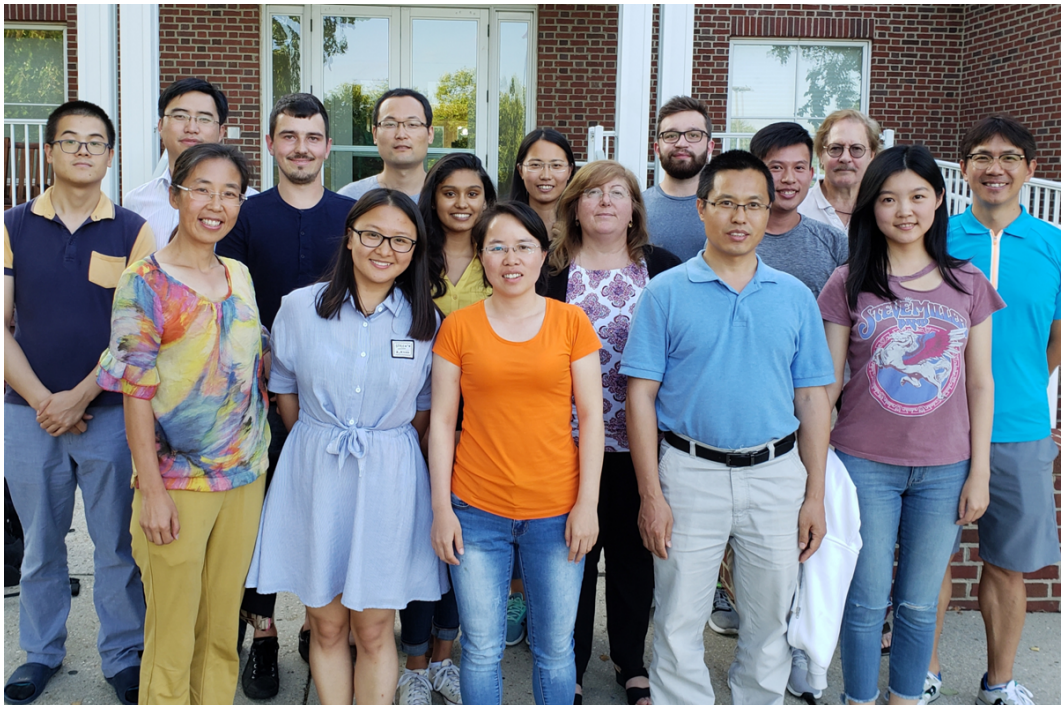
Dr. Michael Pecht and CALCE are awarded the University of Maryland's Corporate Connector Award

CALCE continues to research and model battery behavior to better predict their reliability and ensure their safety under the advisement of Prof. Pecht and Dr. Yinjiao (Laura) Xing. This includes developing improved methods, such as non-destructive computed tomography, to assess battery quality and identify defects and deformations. With the recent increased incidences of lithium-ion battery fires and explosions in popular devices such as smartphones, tablets, and e-cigarettes, understanding battery failure modes is a necessity to prevent future incidents. CALCE is also in the vanguard of the development of state-of-the-art battery management systems (BMS) for single- and multi-cell systems to provide accurate state of charge (SOC) and state of health (SOH) metrics that are essential in many applications, especially transportation.

To address the need for increased system availability and reduced operating costs, organizations across all sectors of industry are turning to prognostics and health management (PHM) to reduce test time, predict reliability, and foresee maintenance strategies to avoid unplanned downtime. The PHM team at CALCE, led by Prof. Pecht and

Dr. Myeongsu Kang, designs and implements these strategies. Practical applications of PHM for complex systems have been challenging due to the large number of possible failure modes, the inability to monitor system health directly or sufficiently, and the difficulties in processing huge volumes of data. CALCE is meeting these problems head-on through a combination of sophisticated data analytics solutions and the incorporation of reliability science principles and models into life prediction algorithms.

In the automotive arena, to prevent catastrophic failures in safety-critical parts of automobiles, CALCE has developed deep learning-based diagnostic models that enable feature learning to automatically find discriminative representations needed for classification from massive amounts of data derived from the field. Likewise, CALCE is working toward fleet-wide PHM solutions equipped for transfer learning, which is effective for capturing, leveraging, and sharing metrics and information between individual assets, their assigned fleets, and other fleets. Additionally, CALCE is conducting research on the development of a framework to integrate domain knowledge into machine learning for asset health management, with the goals of producing sufficient labelled data for machine learning via domain knowledge-based simulations and incrementally updating machine learning models by including human knowledge.



2018 CALCE Visitor Scholars and Students

Within the ever-evolving industries CALCE works to improve, many of the changes and advancements today concern the nature of the supply chain and value relations among the members of the supply chain. One of the most visible changes is the dispersion of the

supply, manufacturing, and testing points around the globe. CALCE has always worked with international industrial and academic partners, allowing it to monitor changes and react to them. It plays a role in monitoring and assessing supply chain issues, including identifying potential bad actors and fraudulent activities.

To learn more about CALCE's current and future endeavors and to participate in its research opportunities, visit www.calce.umd.edu.

Center for Environmental Energy Engineering

The University of Maryland established the Center for Environmental Energy Engineering (CEEE) in 1991, integrating the already well-established heat pump and refrigeration laboratories. Founded by A.J. Clark School faculty Keith Herold, David Holloway, Dirse Sallet Michael Ohadi (ENME), Gary Pertmer (ENNU), Reinhard Radermacher (ENME, director), and Jan Sengers (IPST), the center started with core expertise in thermodynamics and working fluid mixtures, enhanced heat transfer, and novel heat exchangers and heat pumping technology.

Since then CEEE faculty consistently developed research expertise in air-conditioning, heat pumping, enhanced heat transfer, and energy conversion systems. Early research emphasized absorption chillers and heat pumps, but soon branched out to include vapor compression systems with working fluid mixtures, including natural refrigerants, and thermoelectric and thermoelastic cooling and electrochemical compression, as well as small scale integrated cooling, heating and power systems.

The Advanced Heat Exchangers and Process Intensification (AHXPI) was the first CEEE consortium established in 1991 by Prof. Michael Ohadi with a focus on enhanced heat transfer in heat exchangers. The consortium attracted member companies from U.S., Europe and Asia and has successfully continued its many contributions since its establishment. Its most recent research projects focus on innovative designs, materials, and manufacturing techniques for enhanced heat transfer and thermal/fluid process intensification.

The Energy Efficiency and Heat Pumps (EEHP) followed in the early 1990's, with a particular research emphasis on emerging and natural refrigerants. It now includes many alternative cooling technologies and is led by research professor Yunho Hwang.

Throughout the 1990's Prof. Keith Herold led the Sorption Systems Consortium an industrially-funded consortium devoted to research and education within the broad sorption technology area. Led by Prof. Keith Herold, the focus of the consortium was on aqueous lithium bromide chiller technology.

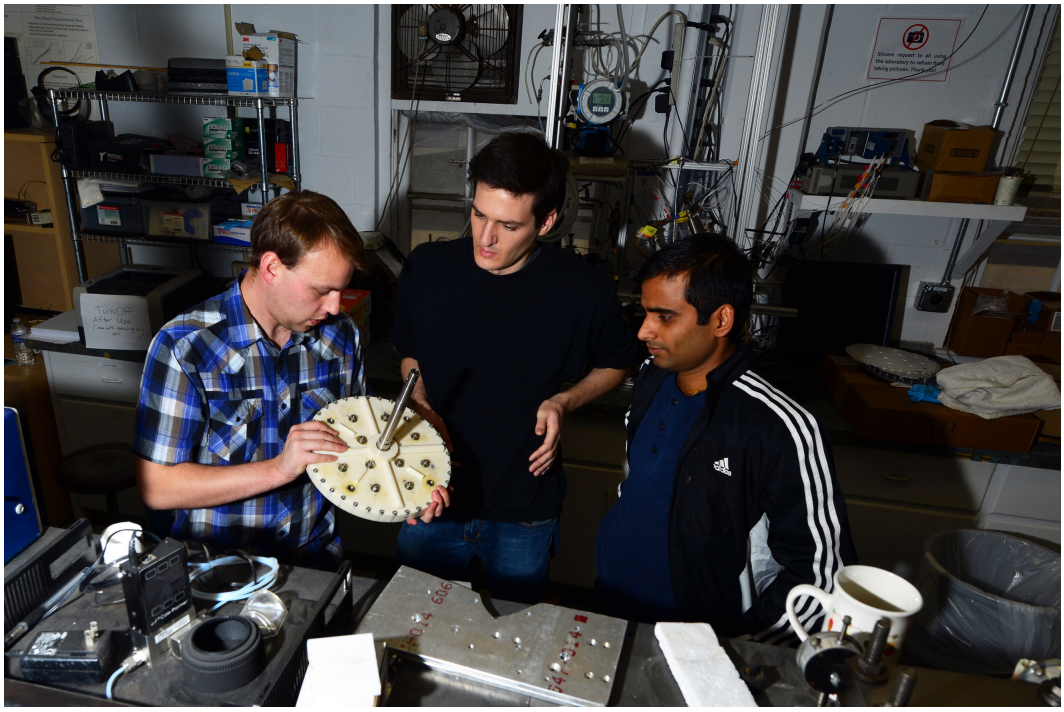
Since 2000 CEEE has embarked on the systematic development of design software for such heat exchangers and air-conditioning, refrigeration and heat pumping systems under the umbrella of MOC, the Modeling and Optimization Consortium, which is led by Research Scientist Dr. Vikrant Aute. CEEE software is now in use in more than 70 companies worldwide, with over 1,000 users, leading to rapid product development. A single successful optimization in a mass-produced component results in immediate and considerable cost savings and improved efficiency. CEEE Sponsors describe it as the industry's leading Vapor compression and heat exchanger design software.

Center for Environmental Energy Engineering research has resulted in nearly 800 publications, 22 patents, five books, and hundreds of invention records.

Advanced Heat Exchangers and Process Intensification Consortium (AHXPI)

AHXPI research has led to the development of passive and active heat transfer enhancement techniques for singe phase and phase change heat transfer processes. Most recently the consortium has utilized innovative design topologies and advanced manufacturing techniques such as additive to introduce record high heat transfer

coefficients without high pressure drops—something that was not possible with traditional techniques. Projects include innovative utilization of micro channels for two-phase flow evaporation and condensation, development of process intensification technologies for gas purification and moisture removal applications; development of near source/embedded cooling systems for high efficiency cooling of microelectronics and other applications, development of high performance, low cost, and durable metallic, polymer, and composite heat exchangers, and the development of EHD-enhanced process intensification devices.



AHXPI Lab students – from left to right: Students David Hyman, Stefan Bangerth (now Dr. Bangerth), and Ratnesh Tiwari at work the Small and Smart Lab Thermal Systems Laboratory in the old Potomac Building in 2017.

Energy Efficiency and Heat Pumps Consortium (EEHP)

The EEHP group encompasses research in the area of heat pumps, air-conditioners, and refrigeration systems using conventional approaches such as vapor compression, and absorption and adsorption systems, as well as novel technologies such as electrochemical compression, thermoelastic cooling, nanoemulsion based absorption and dehumidification systems, and sorption energy storage.

A particularly strong area of expertise is system integration leading to new concepts such as thermoelectrics enhancing vapor compression, separate sensible and latent cooling, Tandem cycle for refrigerators, two and multi-stage systems and personal air-conditioning technologies that reduce or eliminate building cooling/heating loads. EEHP has leading expertise in refrigerant mixtures and natural working fluids such as CO_2, ammonia and hydrocarbons. We built the first CO_2 hot water heat pump in the United States.

We achieved energy savings and emission reductions in integrated cooling-heating-and-power systems and micro-grids. EEHP developed novel renewable energy powered cooling and power system concepts, such as the world's most efficient hybrid solar cooling concept and a new low cost plate heat exchanger for ocean thermal energy conversion. Latest research in EEHP includes the optimization of microgrids for stationary and ship-board applications.

Modeling and Optimization Consortium (MOC)

The MOC consortium develops tools for the design of systematic optimization of thermal systems. We develop component-based, highly flexible and user-friendly simulation packages for components, systems and subsystems — such as CoilDesigner, VapCyc, PHESim, and others. The unique strength of this effort is the inclusion of optimization routines — allowing the systematic search for better systems using gradient-based and/or heuristic approaches.

Board of Visitors

Accomplished leaders from throughout the HVAC industry serve on the CEEE Board of Visitors. These distinguished professionals guide the operation of the center, project management and execution, research project selection, roadmap development, patent policy and educational efforts. Currently, the companies on the board are represented by Emerson Climate Control, Daikin Industries, Mahle Behr Troy, General Electric, Johnson Controls, Sanhua, and Trane/Ingersoll Rand.

Major Recent Projects

In December 2014 the CEEE research team launched a federally-funded research project designed to create personal technologies for keeping individuals comfortably cool or warm, while shrinking the energy needs of the buildings they occupy. The $2.5 million award through a new Advanced Research Projects Agency-Energy (ARPA-E) program entitled DELTA, or Delivering Efficient Local Thermal Amenities. The program supports research to develop technologies that can regulate temperatures of building occupants, rather than of the overall building, dramatically reducing the building's energy consumption and associated emissions.

The ***Robotic Personal Conditioning Device*** team, led by Center for Environmental Energy Engineering Director and Minta Martin Professor of Engineering Reinhard Radermacher with co-PIs Professor Jelena Srebric and Research Scientist Dr. Vikrant Aute, is aimed at developing a mobile platform to provide personalized cooling to individuals. The platform contains a small, battery-powered, high-efficiency vapor compression heat pump that provides localized air conditioning as needed during the day while dumping stored heat and recharging batteries at night. The highly portable nature of the platform and accompanying sensor and control system will allow it to be optimally placed to improve personal comfort and reduce the energy required to cool buildings.

UMD RoCo Crew – From left to right: GRA Daniel Dalgo, Faculty Specialist Jan Muelhbauer, GRA Yilin Du, Research Assistant Professor Jiazhen Ling, CEEE Director Dr. Reinhard Radermacher, Research Scientist Dr. Vikrant Aute, and Professor Jelena Srebric demonstrate RoCo at the ARPA-E Summit in 2016.

In January 2015 the U.S. Energy Department's Advanced Research Projects Agency-Energy (ARPA-E) awarded two University of Maryland (UMD) research teams more than $5 million in funding to improve power plant cooling technologies.

Novel Microemulsion Absorption Systems for Supplemental Power Plant Cooling aims at developing an absorption cooling systems for power plants which utilizes a novel microemulsion liquid absorbent. Led by Department of Mechanical Engineering Professor Bao Yang, the project's UMD co-principal investigators include Professor Michael Ohadi and Minta Martin Professor Reinhard Radermacher, who is also the director of Maryland's Center for Environmental Energy Engineering (CEEE). The team will also work with partners at Stony Brook University, the Electric Power Research Institute, WorleyParsons Group and Rocky Research.

Novel Polymer Composite Heat Exchanger for Dry Cooling of Power Plants is a three-year project funded project by the U.S. Department of Energy, ARPAE division. The project targets improving power plant cooling technologies through the development and application of new composite heat exchangers that use a low-cost, high conductivity

medium encapsulated in a polymeric material that is highly durable, low cost and has a high resistance to corrosion.

Led by Professor Ohadi, UMD's team included Professor Hugh Bruck, the late Research Scientist Dr. Serguei Dessiatoun, and Research Scientist Dr. Amir Shooshtari, who served as co-PIs, along with Professor Joshua Pearce at Michigan Technological University, Dr. Arun Muley at Boeing Research and Technology, and Dr. Justin Zachary at ExperTech Engineering Corporation. The teams serves as a consultant for power plant feasibility studies and the link between the project and the power plant community.

Carrier Center of Excellence

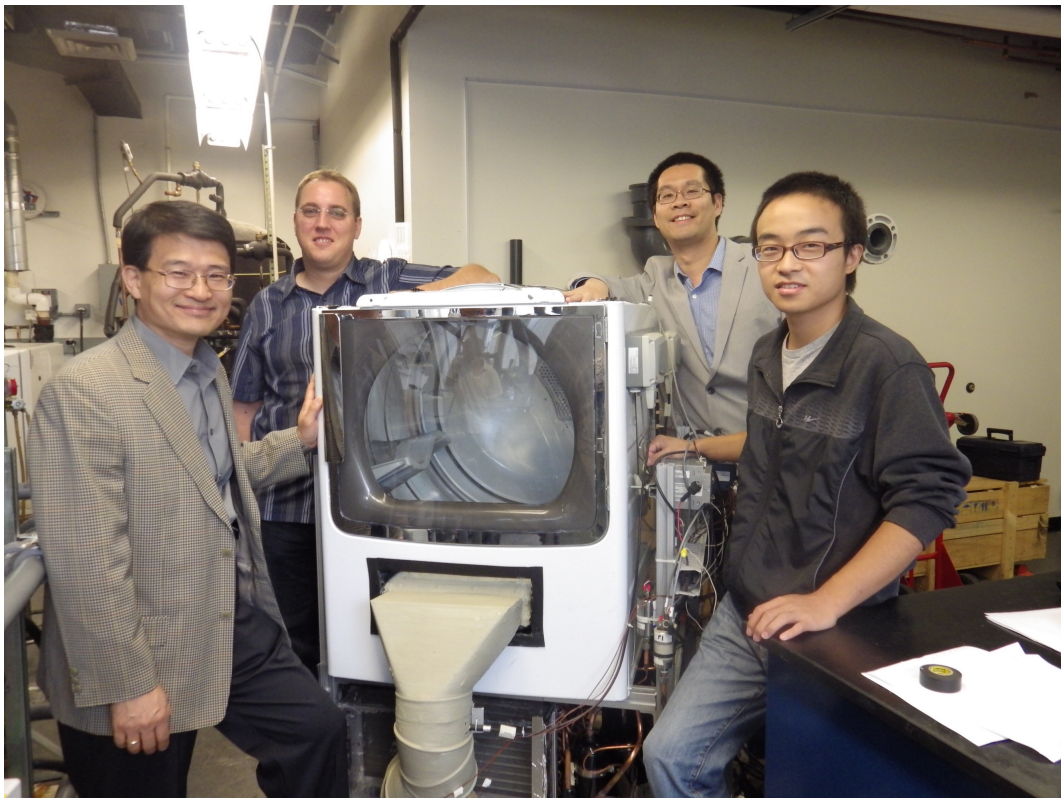
In December 2016 the University of Maryland announced plans to establish a new research center of excellence with **United Technologies Corporation's** commercial businesses, UTC Climate, Controls & Security and Otis, which leads to scientific advancements for safer, smarter and more sustainable building technology and climate controls systems design. As of August, UTC has committed $2M to UMD research projects concerning energy efficiency and nonflammable refrigerants.

The Center for Environmental Energy Engineering spearhead this research and collaboration which support research projects for two departments in the A. James Clark School of Engineering -- the Department of Mechanical Engineering and Fire Protection Engineering. The team plans to grow to include additional projects in the coming years with the main focus being the development of nonflammable natural refrigerants.

Students

Through its graduate education program, CEEE educates a new generation of creative, team-oriented engineering professionals who will be future leaders in their fields. Students present their research to sponsors at semi-annual consortium meetings and the event also provides them with excellent networking experience. CEEE faculty are found working in academia, industry, and government laboratories all over the world. As of August 2018, the center has graduated 89 Ph.D. students and 143 master's degree students.

Student teams led by CEEE faculty have won two Department of Energy Max Tech and Beyond awards for design of highly energy efficient appliances. In 2012, **Dr. Yunho Hwang** led a mechanical engineering student design team to first place at the U.S. Department of Energy's inaugural **Max Tech and Beyond Design Competition**. The team's energy-efficient "Separate Sensible and Latent Cooling" residential air conditioning system used dedicated systems for sensible and latent cooling that could reduce energy consumption by as much as 30 percent. In 2013, the team (again led by Dr. Hwang) won the program's design competition for ultra-low energy use appliances and equipment. The team developed a heat pump clothes dryer that is nearly 59% more efficient than a traditional electric dryer.



MaxTech Dryer – from left to right: Dr. Yunho Hwang (Research Professor and team advisor), Jan Muehlbauer (Faculty Specialist), Dr. Jiazhen Ling (Research Assistant Professor), and Tao Cao (student team leader, now Dr. Cao).

CEEE students and faculty have also been active in the four University of Maryland **Solar Decathlon Completion** house design entries, as well as the **Igor I. Sikorsky Human Powered Helicopter Competition** design project.

Many students have won **fellowships and awards**, to include several winning the Engie (previously GDF Suez/Trigen) Chuck Edwards Memorial Fellowship, ASHRAE travel grants, ASHRAE scholarships, and numerous Best Paper Awards to honor exceptional research presented at conferences. In 2015 Ph.D. student **Suxin Qian** was the recipient of the Ann G. Wylie Dissertation Fellowship. The award supported Qian's research in "Development of Thermoelastic Cooling and Heat Pump Systems", which utilizes shape memory alloys to provide cooling as well as heat-pumping. His ground-breaking research develops new approaches to implementing thermoelastic cooling technology.

Roco Maryland Day – Graduate student Yiyuan Qiao demonstrates RoCo, CEEE's robotic mobile personal cooling device at Maryland Day in 2018.

Former CEEE students serve on the engineering faculty in higher education throughout the world.

1. Abdullah AlAbulKarem (Ph.D., 2013), King Saud University, Saudi Arabia
2. Ali Al-Alili (Ph.D., 2012), Petroleum Institute, Abu Dhabi
3. Vikrant Aute (Ph.D., 2010), University of Maryland, USA
4. Lorenzo Cremaschi (Ph.D., 2002), Auburn University, USA
5. John Hartsog, (MEng 2013), U.S. Naval Academy, USA
6. Yunho Hwang (Ph.D., 1997), University of Maryland, USA
7. Dongsoo Jung (Ph.D. 1988), Icha University, South Korea
8. Hoseong Lee (Ph.D. 2012), Korea University, South Korea
9. Jiazhen Ling (Ph.D. 2011), University of Maryland, USA
10. Ethan Lust (MEng, 2008), U.S. Naval Academy, USA
11. Sunil Mehendale (Ph.D. 1998), Michigan Technological University, USA
12. Andrew Mueller (MEng 2010), U.S. Naval Academy, USA
13. Suxin Qian (Ph.D., 2015), Xi'an University, China
14. Milind Rane (Ph.D., 1991), Indian Institute of Technology, India
15. Amir Shooshtari (Ph.D., 2004), University of Maryland, USA

16. Ratnesh Tiwari (Ph.D., 2015), University of Maryland, USA
17. Steven Treado (Ph.D., 1987), Penn State, USA

Currently 33 graduate students are advised by CEEE faculty, working on a range of cutting-edge topics ranging from robotic cooling to electrochemical compression, novel composite heat exchangers, and modeling of vapor compression systems and software, to name a few. Our students come to us from all over the world and go on to work in the best research labs, energy companies, and HVAC manufacturers in the world. Some have even come back to us as UMD faculty.

CEEE Grads – From Left to right: CEEE students Mohamed Beshr, Tao Cao, and Daniel Bacellar are delighted to receive their Ph.D.'s at graduation ceremonies in December 2016.

Spin-off Companies

Research in CEEE led to the formation of three companies. Mobile Comfort and Optimized Thermal Systems were founded by Dr. Reinhard Radermacher. Mobile Comfort received $1.5 million in startup funds to bring the Roving Comforter resulting from the abovementioned ARPAe DELTA project. Optimized Thermal Systems provides software development and consulting services in the area of heat pumping, refrigeration and air-conditioning systems, their components and their integration into building technology and other applications. These start-ups are now supporting 12 Maryland jobs.

Advanced Thermal and Environmental Concepts (ATEC) was founded in 1999 by Dr. Michael Ohadi. In its history it has attracted substantial external funding form both private companies and government institutions in diverse projects involving advanced heat exchangers, process intensification, and energy efficiency enhancement. ATEC is the past recipient of Small Business Company of the year from state of Maryland.

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. In response to a proposal from Professors R. Armstrong, D. K. Anand and W. 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.

Center for Energetics Concepts Development agreement signing ceremony

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 as director in 2018. 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.

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.

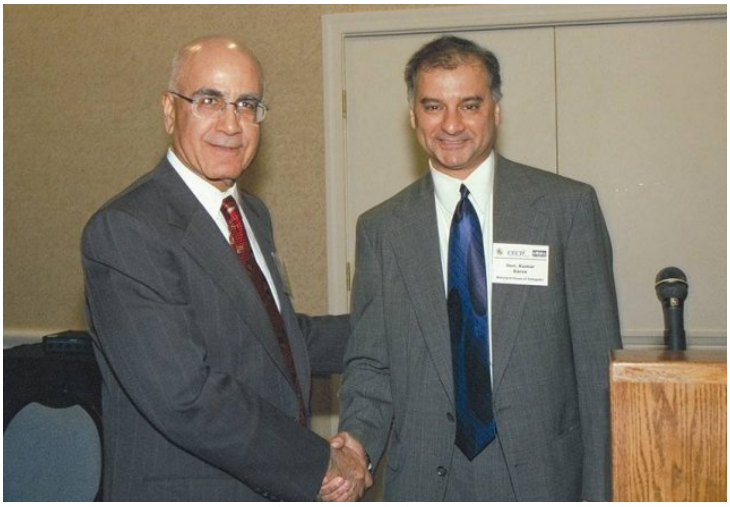
As part of the Center's outreach activities CECD established a graduate program in 2009, in addition to the traditional programs already offered by the Department. This new program was for the degree of Professional Master of Engineering in Energetic Concepts. A certificate program was also offered in 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.

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, Steve Mitchell, Technical Director at Naval Surface Warfare Center Indian Head (NSWC-IH) and almost fifty scientists and engineers from UM and the Navy.



Davinder K. Anand (CECD) and Delegate Kumar Barve

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; N-STAR Director Bob Kavetsky; MD Senator Mac Middleton; Charles County Commissioners President Wayne Cooper. Seated: Capt. Joseph Giaquinto, Commander, IHDIV/NSWC; Prof. Dave Anand, Director, CECD; Ms. Ann Smith, Dean of Career & Technical Education, College of So. Maryland. April 25, 2005.

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

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.

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 Kirwin and Senator Mac Middleton as the keynote speakers.

CECD celebrates its 10th 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 (see Table 1, which includes all the faculty supported as of this writing).

From left: Dylan Hazelwood (CECD), Maryland Representative Steny Hoyer, Davinder K. Anand (CECD), Delegate John Bohanan.

CECD did not keep an exact count of the graduate students we supported. However, a good estimate, based upon the monies given to the faculty, indicates that we have supported over 100 students for Masters and PhD degrees. The students, however, were under direct control of the faculty members whom we funded and the accounting would have been their individual responsibility. In addition, we awarded 31 Masters' degrees and 7 Graduate Certificates in Energetic Concepts.

The Post-2015 Period

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.

Students in the CECD Engineering for Social Change Course, Dean Pines, Faculty and Staff of Mechanical Engineering 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 School of Public Policy. As of 2018, 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.

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. Pictured in the front row from left, Dylan Hazelwood (CECD), Bill Hitte (SBDC), Eileen Abel (CSM), Davinder Anand (CECD), Maryland Senator Thomas 'Mac' Middleton, CSM President Bradley Gottfried.

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. This book was provided for free to students undertaking the course. CECD has a long history of publishing books in niche areas of interest, having published eight previous titles.

Table 1. CECD-supported Faculty

Department	Faculty
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 Risk and Reliability

Introduction

The Center for Risk and Reliability (CRR) has a long history at the University of Maryland, and has evolved since its inception in the early 1980's. Starting in Fall 1983 Professors Roush and Modarres started offering related courses in risk and reliability under the Nuclear Engineering Program. Later in 1985, then Dean George Dieter established the Center for Reliability Engineering (CRE) to develop an interdisciplinary research and a formal graduate program in the College of Engineering. The graduate program in Reliability Engineering (RE) formally started in Fall 1989 at the Department of Chemical and Nuclear Engineering. In the meantime, in the mid-1990's another center called the Center for Technology Risk Studies (CTRS) was established by Professors Modarres and Mosleh to integrate risk-related research resources at the University of Maryland. Later in Fall 2003 when the RE program and its faculty joined the Department of Mechanical Engineering, the CRE and CTRS were combined into the current CRR to focus on both system reliability and risk assessment and management under a single center.

As an umbrella organization CRR draws expertise from the A. James Clark School of Engineering's various academic departments and offers cutting edge research on methods and tools used in reliability engineering and risk analysis of mechanical and other complex systems. It covers applications to complex structure, systems and processes used in space, defense, civil aviation, nuclear energy, petroleum, medical device, information systems, and civil infrastructures. CRR is the research arm of the Reliability Engineering Educational program—the largest and most comprehensive M.S. and Ph.D. degree granting program in the U.S. It provides research leadership in the development of fundamental risk and reliability science and exploring new frontiers in safety, security, risk and reliability studies that includes applications of Risk Management, Big data from Sensor and Data Analytics, Prognostics and Health Management of Complex Systems and Structure, and Resilience Engineering.

Research Contributions

Broad areas of the current research at CRR include: Development of Tools for Hybrid Systems Reliability (Systems of Hardware, Software and Human); Entropic-Based Reliability Science, Empirically-Based Probabilistic Physics of Failure of Systems and Structures; Probabilistic Risk Assessment (PRA) of Energy and Space Systems; Bayesian Data Analysis, Deep Learning and Predictive Analytics; Uncertainty Characterization and Assessment; Human Reliability and Risk Assessment of Socio-Technical Systems; Software Reliability and Cybersecurity Risk Analyses; Hazard Analysis and Risk Analysis of Natural Events; Healthcare Systems Risk Management and Medical Device Reliability; Risk- and Performance-Based Design and Maintenance; and Hybrid Systems Integration and Simulation.

Over its long history CRR has developed, organized and published a large number of technical resources that includes three leading research laboratories, databases, software tools, textbooks, workshops, symposia, scholarly papers, and seminars. Currently, CRR has 15 faculty members, additional affiliate members from various engineering departments, and a larger group of graduate students and postdocs. Its faculty are internationally-recognized and highly respected scholars that include three members of the National Academy of Engineering, and two who hold prestigious endowed professorships.

Over its history CRR has been instrumental in developing cutting edge research, data gathering, development of techniques and tools for application to various areas of risk, safety, resilience and reliability. Examples of its major accomplishments include:

1. A Department of Energy funded Light Water Reactor Operator Information System Development research that as the first major project of the CRE (before it changed its name to CRR), was a $2M effort over a three-year period in the mid-1980's. At the time this was the largest research grant received by the University of Maryland's College of Engineering. The result was an integrated risk modeling approach and knowledge management tools and techniques that included all phases of nuclear system operations from inception to decommissioning. For over 30 years since its completion, the methods, tools and publications of this project continue to make major impacts.

2. An NRC funded Collaborative Research on Risk-Informed Applications to Inspections and Regulation in Nuclear Plants was another example of a major CRR involvement from 1998-2008. This project involved over 10 intense projects involving regulatory developments and decision making with consideration of risks including, Uncertainty Consideration in Risk-Informed and Regulatory Decision Making, Development of a Probabilistic Pressurized Thermal Shock model, and Development of a Physics-Based Probabilistic Risk Assessment of Fires. Results of these studies continue to positively impact the nuclear industry.

3. A major cooperative agreement with the U.S. department of Navy's NAVAIR over a 10-year period from 2003-2013 involved over 15 projects amounting to a multi-million-dollar research funding in the CRR. These studies involved development of methods and tool for probabilistic physics of failure (PPoF) to assess aging and development of non-destructive testing and Prognosis and Health Management (PHM) of airframes. The cooperative agreement later evolved into a broader relationship with the A. James Clark School of Engineering to offer multiple annual seed funding for faculties of the Clark School, and an undergraduate educational collaboration between Mechanical Engineering Department and NAVAIR which continues to date, and many faculty members and students have benefited from it.

4. A cooperative agreement between CRR and the USDA and another one with FDA in the early 2000's resulted in multiple projects involving assessment of risk and

development of tools for the "Farm-to-Table" risk assessment. Methods and tools were developed which proved highly beneficial in assessment, prevention and mitigation of foodborne hazards and outbreaks.

5. Many individual research projects with the nuclear, aerospace and transportation industries, NSF and ONR have resulted in numerous reliability science and engineering tools, techniques and publications. In particular recent projects funded by the ONR focused on the development of a new paradigm for description of materials damage, degradation and failure on the basis of a fundamental science described by the 2nd law of thermodynamics. These developments have shown a direct relation between fundamental sciences (i.e., laws of thermodynamics and statistical mechanics) and probabilistic reliability and risk assessment techniques that minimizes the use of traditional field data or empirical reliability testing-based methods. These studies have also opened the door for more effective uses of data science and fundamental laws of physics as applied in PHM.

Risk and Reliability Information Dissemination

Other scientific contributions from CRR over its history have been the organization of several very important workshops to disseminate and encourage risk and reliability methods. Examples of these include:

- 25th Reliability Engineering Anniversary Symposium: Promise of a Discipline: Reliability and Risk in Theory and Practice, College Park, MD, April 2, 2014.
- Nuclear Safety Workshop, (Organized for the Department of Energy), Rockville, MD September 2012.
- Societal Safety Goal Workshop, Organized for the Institute of Nuclear Energy Science and Technology (INEST) of the Idaho National Laboratory, College Park, MD, March 2012.
- Advances in Small Modular Reactor Symposium along with the University of Maryland Energy Research Center, April 29, 2011.
- Integrated Uncertainty Analysis, developed for the U.S. Nuclear Regulatory Commission, May 19-20, 2009, Annapolis, MD.
- International Workshop on Software & System Engineering (IWSSE), Istanbul, Turkey, September 5-9, 2004.
- First and 2nd Workshop on Use of Risk Information in Government, Inn and Conference Center, College Park, MD, March 6-7, 2001 and Dec. 10-12, 2003, respectively.
- 1st to 6th International Functional Modeling Workshops, in Italy, Denmark, U.S. (Washington, D.C.), Greece, France, U.S. (College Park) during 1997-2002.

Data Bases, Tools and Techniques

As part of its mission and as the result of its research, CRR has developed multiple databases, tools and techniques. Examples include:

- Databases and data analysis tools: (1) Bayesian methodology for analysis of imprecise and uncertain data, data from homogenous and non-homogenous populations, and failure data as a function of physical phenomena, (2) methods for elicitation and use of expert opinion, (3) software reliability data analysis algorithm, and (4) development of data collection and analysis software ReDCAS (for Ford Motor Company) , CCDAT (for EPRI), and CCF (for INL and NRC), and the ReDCAS for software reliability analysis (For Texas Instrument and NSA).

- Human reliability methods: Development of IDA, cognitive model as a second-generation Human Reliability Assessment method (support by the NRC and the Ship Research Institute of Japan), the HITLINE approach (supported by EPRI and the Ministry of Social Affairs of the Netherlands) and a hybrid method for use in PRAs combining features from HCR, SLIM, and IDA (funded by BG&E).

- Organizational factors: Development of the Alpha factor model for incorporating the effects of operation and maintenance into PRAs and a framework for the analysis of performance indicators (funded by NRC). These methods are widely in use today by the nuclear PRA practitioners.

- Software reliability: Development of software quality, reliability predication, and safety methods for software testing for NSA.

- Maintenance Effectiveness: Development of MEMORES software tool for implementation and evaluation of NRC's maintenance rule and other performance data, modeling and integration of PoF in measuring maintenance effectiveness and quality (under GSE Corp. and GE R&D funding).

- Advanced PRA methodologies: Development of dynamic PRA research sponsored by combinations of NRC, EPRI, NASA, and Air Force have resulted in (1) full scale dynamic probabilistic analysis techniques, (2) integration of the thermal-hydraulic system code, RELAP, with the dynamic PRA software ADS-IDAC, (3) dynamic PRA of the TITAN IV launch vehicle, (4) dynamic PRA of a Small Modular Reactor.

- Integration of deterministic-probabilistic methods for decision making: Development of a combined thermal-hydraulic, fracture mechanic, and probabilistic analysis (PA) approach and tool for nuclear plants for addressing safety concerns in advanced reactors, and for Pressurized Thermal Shock (PTS) analysis.

- Integrated deterministic-probabilistic analysis of fire related risks: Development of simple logic-based modeling of fire hazard analysis to identify risk-significant nuclear plant areas.

- A multi-year effort funded by a number of organizations including Empire State Electric Energy Research Corp and Taiwan's Institute of Technology and Research Inc. (ITRI) led to an Internet-based CRR tool called PARITY for risk-based analyses including, risk-based maintenance and test optimization, on-line maintenance and regulatory compliance assessments.

- PRA methodology and software development for the Space Shuttle and International Space Station applications: Resulted in development of QRAS (Quantitative Risk Assessment System) software platform. Among the innovative features of QRAS are automatic generation of event trees from event sequence diagrams and a powerful mathematical kernel for explicit inclusion of physical models (e.g., stress induced failures) into PRA models.

- National air transportation security risk methodology development, sponsored by FAA. The generic framework developed under this project provided a basis for the airport security review effort underway by FAA contractors.

CRR Laboratories

CRR's three major research laboratories are Cybersecurity Quantification (CQ), Hybrid Systems Integration and Simulation (HSIS), and Probabilistic Physics of Failure and Fracture (PPoFF). While the CQ lab is a leading computer-based cybersecurity simulation, the HSIS and PPoFF are well equipped experimental labs for human performance simulation and PPoF model developments, respectively.

In particular, the PPoFF lab is a major lab equipped to perform accelerate reliability testing with MTS uniaxial fatigue testing machines, Digital Image Correlation (DIC) and other microscopy approaches to fatigue damage modeling, Acoustic Emission (AE) testing, creep testing, corrosion testing and environmental chambers for accelerated testing of systems based on Salt/Hot/Cold/Humidity/Cyclic environments.

10. Mechanical Engineering (1894-Present): Milestones

1862: The Morrill Land Grant Act provided funds from the sale of federally owned western land to the states to endow colleges to teach "agriculture and the mechanical arts."

1893: The Committee on Facilities for Instruction, as reported in the Proceedings of Trustees, recommended the creation of a Mechanical Engineering Department in the MAC and provided $2,500 for facilities for instruction and $1,000 for an instructor of Mechanical Engineering.

1894: Lieutenant John Donaldson Ford, USN, Chief Engineer, assumed the position with the title of "Professor of Mechanical Engineering" at the MAC and mechanical drawing instruction was given to all classes in the College.

1894: The first four-year curriculum was established for Mechanical Engineering at the Maryland Agricultural College, and a circular was sent announcing this in 1895. J. D. Ford was the first Chairman. The first freshman was admitted. The first baccalaureate degree in Mechanical Engineering was conferred in 1898.

1895: A two-story red-pressed brick building was completed to house the Department. This building contained two lecture rooms, a large drafting room, and rooms for wood working, foundry practice, blacksmithing and machining.

1896: Lieutenant Ford was recalled by the Secretary of the Navy, Professor Harry Gwinner, who had organized the Department of Practical Mechanics at the Mississippi Agricultural and Mechanical College, was elected Assistant Professor of Mechanical Engineering.

1901: Professor Gwinner resigned, going to the Louisiana Independent Institute as Professor of Practical Mechanics, and Assistant Professor John Hanson Mitchell was promoted to the vacancy.

1903: There were 72 students of Mechanical Engineering, and 125 students receiving instruction in the Department.

1904-5: Professor Mitchell was given a year’s leave of absence due to ill health, and Mr. James C. Blandford was made Acting Professor of Mechanical Engineering.

1905: James C. Blandford resigned to go to the Philippines and Professor Gwinner, who was then a designer with the Chesapeake Iron Works, returned to the College and resumed his old position as the leader of the Mechanical Engineering Department.

1909: A new engineering building was completed, at an approximate cost of $30,000. These buildings were to house the Departments of Mechanical, Civil and Electrical Engineering.

1910: Millard E. Tydings (ME, 1910) would go on to become a successful and popular attorney, author, soldier, and state legislator, serving as a Democratic Representative and Senator in the United States Congress from Maryland. The September 1930 Alumni News noted that "Senator Tydings, although he received his B. S. degree in engineering at old M.A.C., has never used his scientific training except possibly for a survey of the political situation in the State. He did, however, continue his studies at the University of Maryland Law School in Baltimore, where he was awarded his LL. B. in 1913."

1913: Charles M. White was the only mechanical engineering graduate in this year; the entire engineering graduating class numbered just nine men.

1915: The new Engineering Division was formed, where Mechanical Engineering was included with Civil Engineering and Electrical Engineering.

1929: Lee R. Pennington (ME, 1915), became an Administrative Assistant to J. Edgar Hoover, Director of the Federal Bureau of Investigation.

1929: When Professor Gwinner became Professor of Engineering and Mathematics, J.N.G. Nesbit was named as the new Chair of the Department.

1933: George O. Weber (ME, 1933), as senior class president, helped to organize the Class of 1933 gift—Maryland's original bronze Testudo statue. During his career as Director of the Physical Plant on campus, Weber oversaw the construction of Byrd Stadium, Cole Field House, and the University Golf Course.

1936: The Engineers' Council for Professional Development (ECPD) accredited the B.S. program in Mechanical Engineering, starting a sequence that has extended unbroken to this day.

1938: Following J.N.G. Nesbit's departure, John E. Younger was appointed Chairman of Mechanical Engineering. He was the recipient of many honors and

awards during his lifetime as a result of his pioneering work in the field of aircraft design. His contributions to the field of aircraft structural design have had a profound influence on modern aviation. As a result, aeronautical engineering was introduced into the curriculum of the University of Maryland in the fall of 1938, an aeronautical engineering laboratory equipped in the following year.

1940: The Department had just two faculty members and three instructors.

1941: Chairman Younger brought the headquarters of the aviation division of the American Society of Mechanical Engineers (ASME) to campus. He was also awarded the Spirit of St. Louis Gold Medal "for meritorious service in the advancement of aeronautics."

1944: Tau Beta Pi, the national engineering honorary society, had been established at the University. Although this was a men's society, in March they paid tribute to female mechanical engineering student Miriam "Micky" Gerla, with a special woman's badge for excellence in engineering.

1944: Glenn L. Martin contributed $2.5 million to build new engineering buildings, and established an endowment fund. Ten years later the Board of Regents renamed the engineering unit the Glenn L. Martin Institute of Technology, which included all the buildings built with Martin's support. The current primary home of Mechanical Engineering continues to be Martin Hall.

1945: The wartime had claimed many young men, and the enrollment dropped so that we only had two faculty, John Younger and Charles Shreeve, and no instructors.

1945: Dr. Younger took leave of absence from the University of Maryland to go to the Wright Field Air Force Base, to initiate a research program for developing high-speed thin wings for jet-propelled aircraft.

1947: Younger accepted a position in Brazil offering an outstanding opportunity financially and professionally. His new job was the complete design and organization of a new technical college in Brazil, starting from scratch.

1949: In the Fall the aeronautical sciences option was separated as a discipline from the Mechanical Engineering department and became the standalone Aerospace department.

1950: The Department moves to the new Glenn L. Martin Engineering building, which was one of four new buildings erected with funds contributed by aviation pioneer Martin.

1956: The Tau Mu Chapter of the Pi Tau Sigma honor society was founded on our campus on for the purpose of honoring outstanding seniors in the field of Mechanical Engineering.

1958: Professor Charles A. Shreeve was appointed as interim Head of the Mechanical Engineering Department following the untimely passing of John E. Younger in December.

1960: Early PhDs: The University began listing advanced degrees with fields in the commencement program in 1960, when there were three recipients from Mechanical Engineering: Ralph Gordon Barclay, Horace Tharp Mann, and Walter Robinson Wise, Jr.

1960: The Board of Regents officially announced Charles A. Shreeve's appointment to Head of the Mechanical Engineering Department.

1964: A Ph.D. in the Department was awarded to Frederick S. Billig, who later received a patent for a supersonic combustion ramjet based on his Ph.D. thesis.

1965: Frederic T. Mavis, Dean of Engineering since 1957, stepped down and joined the Mechanical Department faculty to teach for two years before retiring.

1965: James Dingman (ME 1922), was elected Vice Chairman of the Board of AT&T, the parent company of Bell Laboratories, the nation's largest research organization. He was an important player in the development of the 170-pound Telstar satellite, whose launching as the first private venture in space opened the modern era of telecommunications, expanding telephone service and paving the way for cable television and other industries.

1966: To alleviate the acute shortage of engineers with earned doctors degrees, the campus catalog advertised to attract graduate engineers, but with the caution that "Preference is given to graduate students who are American citizens in view of the limitations of available funding."

1966: John Jackson was the chairman of the Peace Essay Contest for the College Park Lions Club. The purpose of the contest, he said at the time, was "to focus

people's attention on the desirability of searching for ideas and developing a plan toward making world peace a reality."

1970: Charles A. Shreeve stepped down as the Head of Mechanical Engineering, and Dean Robert B. Beckmann appointed John W. Jackson as Acting Head of Mechanical Engineering.

1971: Dean Beckmann appointed James W. Dally, P.E., Ph.D., as Chairman of Mechanical Engineering. John W. Jackson retired two years later.

1972: George Irwin, widely considered the father of Fracture Mechanics, joined the newly established Photomechanics Laboratory as Professor of Mechanical Engineering. He was an essential part of a team that established the concept of crack arrest and a crack arrest toughness. This was an important concept, which had considerable relevance to crack propagation in nuclear reactor heads that would occur in a loss of coolant accident. He became a member of the U.S. National Academy of Engineering in 1977.

1975: James W. Dally stepped down as Chairman to accept the position of Dean at Rhode Island, Kingston and Dean Beckmann appointed Patrick F. Cunniff as the new Chairman of Mechanical Engineering.

1976: Clayton Dupree McKindra became the first African American to be receive a Ph.D. in Mechanical Engineering. His advisor was Davinder Anand, and the degree was granted in December.

1977: The Department had its first female Ph.D. graduate, Nilüfer Egrican, advised by Professor Redfield W. Allen.

1978: Mary Lacey was the only female student in the University of Maryland's undergraduate class of that year who majored in Mechanical Engineering. A member of the Clark School's Board of Visitors and former technical director of the Naval Surface Warfare Center, Indian Head Division, she ultimately became the Deputy Assistant Secretary of the US Navy. Lacey made an effort throughout her career to mentor future female executives.

1979: The Department set up a learning center for undergraduate students, staffing the center with retired volunteers.

1979: Professor Clifford Sayre was appointed Acting Chairman, while Department Chair Patrick Cunniff went on sabbatical leave.

1980: Juliani Gatzoulus was the first female faculty member hired in the Department. Gatzoulus, who brought considerable experience as a Marine and mechanical engineer for the U.S. Navy and NOAA, joined the Department as an Assistant Professor.

1980: A. J. Durelli, a true luminary in photoelasticity, joined the Photomechanics Laboratory as a Visiting Professor in the Mechanical Engineering department.

1981: The Department moved temporarily to the Mill Building, to allow for the extensive renovation of the Glenn L. Martin Hall classroom and lab buildings, estimated at the time to cost $7.5 million.

1982: Patrick Cunniff stepped down as Chair, and Dean George Dieter appointed William L. Fourney as Chairman of Mechanical Engineering.

1984: The Department moved back to Glenn L. Martin Hall after the building's $12 million renovation.

1985: In accordance with a plan by President John Toll, a new Mechanical Engineering Department was established at UMBC, chaired by William Fourney.

1986: The Mechanical Engineering Department began offering courses via Instructional Televsision (ITV) to Hagerstown in Western Maryland in Fall.

1986: The Computer Aided Life Cycle Engineering (CALCE) was organized and established in October by Professor Michael Pecht. A grant in 1998 from the Division Of Industrial Innovation & Partnerships at the National Science Foundation (NSF) was to start a planning process to include industry. This center has worked closely with industry in developing computer-aided design procedures for electronic circuit boards and other electronic devices. The center is world renowned for its work in electronics reliability, includes electrical, mechanical, chemical, and reliability engineers and computer scientists. In 1991, the name was changed to the CALCE Electronic Packaging Research Center (EPRC), following major funding from the National Science Foundation and the Maryland Department of Economic and Employment Development's Business Resource Division and participating industries.

1987: Alumnus James A. Clark, B.S. (ME, 1944), M.S. (ME, 1948), was inducted into the Engineering Hall of Fame for his many innovations in optical instruments and manufacture of soft contact lenses. John E. Younger, Professor and Chairman

of Mechanical Engineering (1938-1958), was inducted into the Engineering Hall of Fame for his many innovations in all-metal airplanes.

1988: The Center for Environmental Energy Engineering (CEEE) was established. CEEE's focus has been on determining environmentally friendly solutions for different energy systems. Directed by Professor Reinhard Radermacher of Mechanical Engineering, CEEE was concerned with research on heating, ventilation, and air conditioning systems. CEEE grew out of the Energy Laboratory established by Professor Radermacher in 1983.

1988: A group of ME undergraduate students under the direction of Professors Azarm, Chen and Tsai designed and fabricated the Terrapin 1 Walking Robot for the First Annual Walking Machine Decathlon, a nationwide competition. The robot was required to walk through a one by one square meter hoop and carry a gallon of water. The team was successful in capturing second place in the competition.

1989: Alumnus Ronald E. Bowles B.S. (ME, 1947); M.S. (ME, 1948); Ph.D. (ME, 1957), was inducted into the Engineering Hall of Fame for his many innovations in fluidics and fluid mechanics.

1990: The Department's solar-powered vehicle competition entry, called "The Pride of Maryland", finished third in the GM Sunrayce competition from Orlando to Detroit and went on to compete in the World Solar Challenge in Australia, and in an invitation only rally in Japan.

1991: William Fourney stepped down as Chairman, and Dean George Dieter appointed Davinder K. Anand as Chairman of Mechanical Engineering at College Park and UMBC.

1991: The faculty went on a collegial two-day retreat to the Xerox Center in Virginia to prepare a strategic plan for the Department. The first was to separate the Department of Mechanical Engineering at UMBC into an independent entity. The second was to recommend the decrease from 134 to 124 credits for the BME degree, and the third decision was made to strengthen the faculty.

1992: Construction started on the $1.2 million Manufacturing Technology building on campus. This was funded by the Departments of Mechanical and Electrical Engineering, and the Minta Martin Fund.

1992: The Mechanical Engineering Department at College Park officially cut ties with the UMBC Mechanical Engineering Department, and Akhtar Khan was appointed as Chairman of Mechanical Engineering at UMBC.

1992: A successful proposal was made to the college to revise the curriculum of the mechanical engineering department such that 124 credit hours would be required for graduation.

1993: The first patent the Department had ever sold was from the CEEE laboratory. For a method to increase the efficiency of refrigerant systems. The patent was sold to Samsung for $500,000.

1993: Mechanical Engineering Professor George R. Irwin was inducted into the Engineering Hall of Fame for his pioneering efforts in creating the discipline of fracture mechanics and for his guidance of the technical community in helping to make it a useful design tool.

1993: The Department was featured in *The Washington Post* in recognition of Lancelot, a student-built robot that took first honors at the Japanese Robot Grand Prix in Tokyo. The team, under advisor Greg Walsh of Mechanical Engineering, outperformed 100 other teams for the victory.

1994: Edward Magrab received an important grant for $2.4 million from NSF/ARPA to institutionalize manufacturing education across much of the undergraduate curriculum.

1994: Professor James Sirkis established the university's Smart Materials and Structures Research Center (SMSRC). At that time, it was one of the largest of university-based efforts of its kind in the country.

1994: DeWALT (and parent company Stanley Black and Decker) began supporting the Department with donated materials, funds and time as a corporate partner for the newly created ENME 371: Product Engineering and Manufacturing undergraduate course.

1994: The university's hybrid electric vehicle, designed to run at an efficient 70 miles-per-gallon and also to reduce emissions, won over every other vehicle entry in all of the 10 categories at the Society of Automotive Engineers (SAE) Hybrid Electric Vehicle Challenge in Southfield, Michigan.

1995: Formal opening ceremonies of the Manufacturing building occurred with the presence of President William E. Kirwan and Dean George E. Dieter.

1995: The Department acquired a state of the art stereolithography machine in the Advanced Design and Manufacturing Laboratory. The machine, acquired from 3D Systems Inc. in Valencia, California, was for research on rapid prototyping. The acquisition was reported in the Washington Post in a profile on the ADML Lab.

1996: Professor James Sirkis and his student Harmeet Singh won the Physical Science Invention of the Year for their "Fiber-Optic Three Strain Sensor".

1996: Under the leadership of Patrick Cunniff and Jim Dally, a team from Mechanical Engineering received the prestigious $50,000 Boeing Outstanding Educator Award.

1997: Started in Fall at Frostburg State University in Frostburg, Maryland, developed jointly by the University of Maryland, College Park (UMCP), and Frostburg State University (FSU).

1997: Mechanical Engineering Associate Professor Linda Schmidt, the Clark School's director of student research, created the Research Internships in Science and Engineering (RISE) program following a grant by the National Science Foundation's Program for Gender Equity (PGE).

1998: A student exchange program between the Department of Mechanical Engineering and the University of Applied Sciences in Mannheim, Germany began in the Fall.

1998: The Center for Energetic Concepts Development (CECD), now known as the Center for Engineering Concepts Development, was established as a partnership with the Naval Surface Warfare Center at Indian Head. Directed by Professor Davinder K. Anand, CECD is now a platform for experimenting with new ideas in engineering education, future technologies, research, and the impact of engineering on society.

1998: Professor C. D. Mote Jr. was appointed as Professor of Mechanical Engineering and President of the University of Maryland College Park. In our Department, the refrain was "Vote for Mote" when the full professors voted for his tenure.

1999: James Sirkis left the Department to go into industry, and Amr Baz was appointed Director of the SMSRC Laboratory. Professor Baz also established the virtual reality CAVE laboratory in the off-campus Meyers Building.

2000: The Department held its First Annual Research Review Day at the University of Maryland's Inn and Conference Center. Over 100 attendees from industry, government, and academia were presented with an overview of the research being conducted in the Department through talks, poster presentations and videos. Attendees were welcomed by University President and Professor of Mechanical Engineering C. Daniel Mote, Jr. and Dean of the Graduate School William W. Destler.

2000: In the *FutureTruck* competition at the General Motors Desert Proving Ground in Mesa, Ariz., Mechanical Engineering students led by Professor David Holloway took a stock Chevy Suburban and successfully converted it to a hybrid by combining an electric motor with an ethanol-fueled smaller engine. The design netted the students top honors overall and in the off-road category.

2001: Professor Linda Schmidt received a three year, $400,000 grant from NSF to support the Building Engineering Student Team Effectiveness and Management Systems (BESTEAMS) program.

2001: Within weeks of the 9/11 crisis the Office of Naval Intelligence reached out to the Department's Center for Energetics Concepts Development (CECD) to simulate major accidents that would impact harbor safety.

2001: Professor Michael G. Pecht was named as the first George E. Dieter Professor of Mechanical Engineering, the first chaired professor in the Department. This endowed professorial chair was established in the year 2000 to honor George E. Dieter's outstanding leadership as Dean of the A. James Clark School of Engineering from 1977-1994.

2002: Dean Nariman Farvardin appointed Avram Bar-Cohen as Chairman of Mechanical Engineering in January to succeed Davinder K. Anand.

2003: The Human Powered Submarine student team lead by Marjorie Erickson won first place for speed and second place overall at the Seventh International Submarine races, held in June at the Naval Surface Warfare Center, Carderock Division, in Bethesda, MD.

2003-2004: The Reliability Program in the Department of Materials Engineering became a part of the Department of Mechanical Engineering. Professor Ali Mosleh was designated as the Director of the newly formed Center for Risk and Reliability (CRR), which includes research activities in safety, risk, reliability and security research. Alumnus Jeong H. Kim (Ph.D., Reliability Engineering, 1991) was elected into the Innovation Hall of Fame and the U.S. National Academy of Engineering. In 2014, the Reliability Engineering Program celebrated the 25th Anniversary of this educational program.

2007: In the Solar Decathlon competition, sponsored by the Department of Energy, the LEAFHouse, an 800-square-foot solar-powered home, took 2nd place overall and won the People's Choice Award. The team consisted of five mechanical engineering students.

2008: The Terps Racing team won the Formula SAE West competition held at California Speedway in Fontana, California. During the four-day event, the team placed first overall out of 83 teams from all over the world.

2010: Avram Bar-Cohen took leave to go to DARPA, and Dean Darryl Pines appointed Balakumar Balachandran as acting and then Chairman of Mechanical Engineering effective May 2011.

2010: The campus received approval from the Maryland Higher Education Commission for offering of B.S. (Mechanical Engineering) at the Southern Maryland Higher Education Center.

2010: Professor Ali Mosleh was elected to the U.S. National Academy of Engineering for contributions to the development of Bayesian methods and computational tools in probabilistic risk assessment and reliability engineering.

2011: Dr. Elisabeth Smela became the first female faculty member promoted to the rank of full Professor in Mechanical Engineering.

2012: The Department extended its reach into Southern Maryland in November when the University System of Maryland committed nearly $450,000 in base funding support. This created a partnership between the A. James Clark School of Engineering, the College of Southern Maryland, the Southern Maryland Higher Education Center (SMHEC) and the Naval Air Warfare Center Aircraft Division (NAWCAD).

2012: Our student team won first place at the U.S. Department of Energy's inaugural Max Tech and Beyond Design Competition. This competition was for the design of ultra-low energy use appliances and equipment. The team won again in September 2013 for their design of an efficient heat pump clothes dryer.

2013: Professor of Mechanical Engineering, Clayton D. Mote Jr., former President of the University of Maryland, was named the 11th President of the U.S. National Academy of Engineering.

2015: A very special new course was added in collaboration with the School of Public Policy in Spring, namely the technical elective Engineering for Social Change.

2015: A team of Mechanical Engineering students took top honors at the DARPA Field-Reversible Thermal Connector (RevCon) Challenge sponsored by the Office of Naval Research (ONR).

2015: J. Edmon Perkins became the first Native American to receive a Ph.D. in Mechanical Engineering. The advisor was Professor Balakumar Balachandran.

2016: With the support of Carrier, UTC, a Center of Excellence on Building Systems was established at the University of Maryland under the leadership of Mechanical Engineering. Areas of interest include model-based design and cooling technologies.

2017: The Department of Mechanical Engineering's undergraduate and graduate programs are ranked amongst the top twenty of all doctoral degree offering mechanical engineering programs in the U.S and amongst top ten of these programs in public institutions.

2017: A large contingent of our students were members of the University of Maryland Hyperloop team, UMDLoop. They won the Performance and Operations Award and placed in the top five for overall pod design at the first ever SpaceX Hyperloop Pod Competition held in Hawthorne, Calif.

2017: Mechanical Engineering alumnus Mike Cook (ME, 2008) was a member of the Daytona 500-winning team of Stewart-Haas Racing (SHR) in February. He was deeply involved with Terps Racing during his time at the University of Maryland.