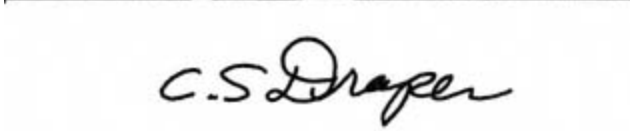

Charles Stark Draper

1901-1987

By Robert A. Duffy

Charles Stark Draper, a complex genius of the twentieth century, was a modern version of the Renaissance man. A teacher, scientist, and engineer by profession, but self-described as a "greasy thumb mechanic," he was born on October 2, 1901. He grew up in the small Missouri town of Windsor where he went through the town's public school system. He entered college when he was fifteen years old at the Rolla campus of the University of Missouri as a liberal arts student. After two years, he transferred to Stanford University from which he graduated in 1922 with a B.A. in psychology.

Among all of the other things at which he excelled, Doc understood human beings and he understood how to challenge them towards a common goal. The psychology curriculum probably did no harm, but instinctively Doc knew how to lead and how to get people to follow to a common goal. He naturally interacted well with people. He liked and was interested in his students and his colleagues. His students and colleagues loved him in return. Above all, he lived for his technology—his life became the technology he nurtured to useful maturity.

He earned a B.S. in electro-chemical engineering at the Massachusetts Institute of Technology (MIT) where he went after Stanford. Despite short defections, he essentially remained

at MIT for the rest of his life, immersed and totally involved in the developments associated with his measurement and control instrumentation. Legend has it that he took more courses at MIT than anyone else has ever taken. There he earned an M.S. in 1928 and a Ph.D. in physics in 1938. Doc's involvement with MIT became convincingly more permanent by the mid-1930s when he became an assistant, then an associate professor in aeronautical engineering. By 1939 he was a full professor.

It was during those early days, however, before advancing as a member of the junior faculty that he tried and failed to become an Air Corps pilot. Perhaps as a consequence of this rejection he enrolled in and quickly passed a civilian course qualifying him to fly. He acquired an airplane and recognized the need to improve the pilot's flight instrumentation. He taught a course in aircraft instruments concurrently. To make his point about instrumentation inadequacies, he took Professor Jay Stratton, later to be president of MIT, up in his airplane and showed him how one used the flight instruments, indicating shortcomings he had perceived. He caused the airplane to perform stalls and spins over Boston's outer harbor. Professor Stratton was duly impressed by the inadequacy of the instrumentation and Draper's ideas about needed improvements. He did not fly again with Draper!

Draper really pursued three major thrusts in his life's work: measurement of physical processes, primarily the instrumentation of dynamic geometry; the systems engineering of those processes in the larger context of new concepts; and, finally, the education of the engineering profession. Following his early experiments with basic instruments, the solution of the dynamic geometry problems associated with gunfire control, both on fixed-wing aircraft mounted guns and with deck-mounted antiaircraft guns, occurred first. The second major thrust was the systems study, analysis, and synthesis that came from using instrumentation to measure quantities that are part of a larger issue. Here his conceptualization and vision were applied to what we later

termed the systems engineering process. The solution was usually implemented by some control means using intelligence from the sensory elements processed through what Draper termed the informetics of some computational element.

In the development of this process, Draper and his people, Bob Seamans leading, developed and demonstrated the first all-attitude adaptive autopilot. Rocket and gunfire control systems and the early inertial navigation and guidance systems followed.

In the age of Apollo, the unheard-of challenge of putting men on the moon and safely returning them to Earth appealed to Doc as a prime application for his technology. The creation of the guidance, navigation, and control elements in the Apollo program was inspired by Draper although many others made fundamental contributions.

Underlying all of that was the third, and perhaps the most important, of all his interests—the education process that he created when he had both the MIT Aeronautical Engineering Department and his Instrumentation Lab under his direct control. "Mens et Manus," minds and hands—the MIT motto—had real meaning in this context. The invention and creation of the elements that went with measuring and controlling complex functions and processes served as a superb environment for learning. His Instrumentation Laboratory, the Aero Department and its distinguished faculty, and the long list of his students led by him into leadership positions are as much his legacy as the magnificent systems capabilities he created. His entrepreneurial spirit and verve, concepts like navigating in a "black box" so that a submerged vehicle can know its position and velocity without external reference, the creation of spacecraft and booster guidance systems, a mathematical language—the so-called Draper notation—optimalization as a control theory, and the conceptualization with Milton Trageser of a Mars mission in the 1950s are all as much a part of this genius as his care and concern for children and the young.

Draper became a public person with the Apollo program.

Although he had been honored by both the Air Force and the Navy for his wartime contributions, it wasn't until the Apollo program began that the nation as a whole knew Charles Stark Draper. Even before President Kennedy made the public announcement that within the decade man would be landed on the moon and brought back safely to Earth, Draper, always with an ear to the ground, had seen that evolving challenge as applying to him and his laboratory. He and his people, using the Mars reconnaissance system design as a background, had been working for several years attempting to get government support. With the formation of the Apollo program as the triggering event, he went to James Webb, who had been appointed administrator of the new National Aeronautics and Space Administration, offering to design, build, and fly the Apollo guidance, control, and navigation system. Webb and Hugh Dryden (of National Advisory Committee for Aeronautics heritage) believed Draper's statements to the effect that navigation to the vicinity of the moon without external aid was feasible. The Instrumentation Laboratory received the first contract award made by NASA for the moon program.

The design of the guidance, navigation, and control equipment was not an extraordinary task for the Instrumentation Laboratory. Thus, the challenge for the Instrumentation Laboratory was not to prove a concept or even a technology but rather to adapt the system to the extraordinary distances and the demanding reliability requirements of the manned moon mission. In actuality the version of Draper's system implemented by Dave Hoag and his team used both a star tracker and accepted radio position and velocity updates from NASA's long base-line earth-based tracking stations—a sort of belt-and-suspenders solution that worked.

Draper died on July 25, 1987. Draper Laboratory along with the MIT community honored him in a memorial service during the fall academic session of 1987 when his long-term friends and colleagues had returned to the campus. MIT has two endowed chairs in his name (for junior faculty

members) in the Aeronautics and Astronautics Department. The Draper Laboratory awards graduate fellowships at MIT and supports military officers studying for graduate degrees at MIT, all in Draper's name.

Dr. Draper was elected to the National Academy of Sciences and the National Academy of Engineering, and as a foreign associate member to the French Academy of Sciences. He was president of the von Kármán Foundation, The International Academy of Astronautics, and The National Inventors Council. He had many academic honorary degrees and citations.

The board of directors of the Draper Laboratory authorized an annual award in Draper's name to be administered by the National Academy of Engineering. The award honors the engineer who has contributed most to engineering in the opinion of the NAE-appointed selection committee. The award approximates the Nobel award in value, is permanently endowed, and is expected to be given every two years.

Dr. Draper is survived by his wife, the former Ivy Hurd Willard, and four children, James, Martha Draper Ditmeyer, John, and Michael. The Drapers lived for many years in Newton, Massachusetts, where Mrs. Draper now resides, remembered fondly for her strong support of Draper through many long years of extended separations, interminable Saturday sessions in her home, and memorable parties and picnics for Doc's students and colleagues.