Engineering offers men and women an unparalleled opportunity to experience the satisfaction of improving our quality of life. As a result, engineering has had many positive aspects on our world—longer and healthier lives, global communications, ease of transit etc. Stephen Hawking recently noted that, improvements in science and technology also have the effect of threatening our society—nuclear war, genetically engineered viruses, global warming. He stated, “We are not going to stop making progress or reverse it, so we have to recognize the dangers and control them.” What role do engineers have in this recognition and control capacity? What do you see as the moral and ethical challenges and what would you do to balance them?

By Joy Lees

To Space and Back

In the words of Socrates, “Man must rise above the Earth—to the top of the atmosphere and beyond—for only thus will he fully understand the world in which he lives.” Generations of physicists and engineers wondered at the earth’s moon and the stars in the vastness above, speculating on the significance of these incredible structures. Innovations like the telescope aided in endeavors to study the moon and stars, but the feat of physically reaching such a transcendental destination as the moon seemed out of mankind’s capabilities. However, with difficulty comes the opportunity both to inspire passion and to acquire knowledge. Therefore, despite the difficulties and limitations involved, United States engineers in the 1960’s, members of the National Aeronautics and Space Administration (NASA), took their opportunity to undertake this fantastic venture of reaching the moon. NASA eventually accomplished what I believe to be the greatest engineering victory of mankind’s history—landing on the earth’s moon on July 20, 1969. But the mere success of the mission was hardly its only reason to be deemed great. Often, the most significant successes are accompanied by a number of failures. NASA’s endeavor to reach the moon was no exception. Its first crewed flight into outer space never left the ground due to a fire sweeping through the inside and killing the three astronauts—Virgil Grissom, Edward White, and Roger Chaffee. Apollo 6, the last unmanned test of the rocket, Saturn V, failed to accomplish its goal of a 100 mile circular orbit after two of its engines shut down shortly after take-off. Numerous other accidents occurred, both fatal and non-fatal. But NASA recognized each failure as an opportunity for learning and improvement. With the same concept in mind, Thomas Edison is well known for his famous words, “I have not failed. I've just found 10,000 ways that won't work.” NASA’s mission to reach the moon is considered to be great because of its persistence to succeed despite
extreme disappointment and intense criticism. The mission is also considered extraordinary because of the extreme situations experienced and the fatalities of many of the men involved. Each astronaut that died had a contagious passion for reaching the moon, and their deaths, while tragic, served to further inspire the engineers to finish the mission.

Besides overcoming failures, NASA engineers had to make the most with the technology available at that time. Advances in telemetry, radar, and digital computers became a necessity to accomplish the goal of reaching the moon. More specifically, it was necessary for vital signs to be detected for each of the astronauts through telemetry.\textsuperscript{5} Radar was to be used with the lunar lander, the spacecraft intended for a direct landing on the moon.\textsuperscript{6} The radar was needed to show altitude and velocity in relation to the ground. Digital computers became necessary to obtain high accuracy, one of the disadvantages to analog computers. The command module (CM) included the computer mainly used for large-scale navigation—that is between the earth and its moon. The lunar module (LM) contained several computers used for navigation during landing, ascents, and rendezvous.\textsuperscript{6, 7} Much of the technology developed during the 1960's cannot compare with the technology that is seen today. However, the venture to reach the moon was not inhibited by this fact, and the passion that drove the mission forward eventually led to success, justifying the statement that reaching the moon is mankind's greatest engineering accomplishment.

Additionally, landing on the moon resulted in many advantages. It provided a strong sense of nationalism for the United States, and while there were definite scientific benefits to reaching the moon (collecting 850 pounds of rock and soil), even more resulted from the efforts of the entire operation. In other words, in the process of advancing technology to meet the needs of the mission, a multitude of scientific experiments were conducted and many new innovations were created along the way. For example, one of the numerous innovations was the invention of multispectral terrain photography. It was used while orbiting the earth and detected objects and structures unseen by only visible light using a combination of infrared and ultraviolet light. Also, America's first space station, Skylab, used hardware from NASA's Apollo missions. Here many scientific experiments were conducted, and a solar observatory was created, reaping many scientific benefits. Therefore, the venture to reach the moon resulted not only in a greater knowledge of outer space, but also of earth.\textsuperscript{8, 9, 10}

However, landing on the moon holds still more significance since it is a symbol of mankind's utter determination. Neil Armstrong said the following: "I think we're going to the moon because it's in the nature of the human being to face challenges. It's by the nature of his deep inner soul... we're required to
do these things just as salmon swim upstream." Landing on the moon not only provided mankind with a sense of self-worth, but also it sparked passion, determination, and immense curiosity. This feat paved the way for a new generations of engineers to continue testing mankind’s limitations in the search for knowledge and for the purpose of solving many of life’s difficulties. Already, a new mission is set in place to reach Mars by the year 2020. Here NASA plans to study the environment to determine if the conditions are at all habitable for humans. This new venture holds a promise of hope and passion much like that of reaching the moon in 1969. But there is one significant reason why the latter is outstanding: landing on the moon was the first great step that opened the doors to a multitude of new ideas.

Overall, I consider the mission to land on the moon to be the greatest engineering achievement of all time. It overcame great failure, it worked despite its technological disadvantages, it resulted in great scientific achievements, and it remains a symbol of mankind’s extreme determination. In the words of Neil Armstrong, “One small step for man, one giant leap for mankind.”
References: