Technological Spinoffs

NASA creates new economic leaps

by Dr. John Schoonover

> Each new technology derived from science has a permanence that continues to benefit society indefinitely into the future. Thus capital represented by discovery outlives all other forms. Consequently, the investment in basic research should be written off over an indefinitely long time against the permanent gains acquired by society.
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> —Dr. Lloyd Berkner, former chairman of the Space Board of the National Academy of Sciences.

Every dollar spent by NASA during the Apollo program brought $14 back into the U.S. economy—in the form of new technologies, factories, jobs, and related benefits. That conclusion from a 1976 Chase Econometrics study, confirming Dr. Berkner's observation, punctures the notion that projects like the Space Shuttle are merely a shot in the arm for national prestige, or perhaps for national defense. Rather, new technologies are a payoff that rapidly enters the U.S. economy from the NASA programs.

Advances in the computer and electronics industries are the best-known spinoffs frm the American space program. They resulted from the stringent requirements of the control and communication systems needed for satellites and spaccraft. These, and now the achievements of the Shuttle, are transmitted to industry by the regional branches of NASA's Office of Technology Utilization. The concept of transforming new discoveries into commercial products and processes was built into NASA at its start.

The Space Shuttle itself has delivered a large payload of new materials, devices, and processes. They were developed while creating a craft that combines the capabilities of a space capsule and an airplane.

• The protective tiles, which kept the vehicle from burning up during reentry, are the most talked about new material developed for the Shuttle. The tile material for the reusable Shuttle is such a good insulator that, while its surface reached a temperature of 2,800 degrees, the aluminum orbiter shell beneath it was kept below 350 degrees. This was achieved with a layer of tiles from one-half to three inches thick. The extremely light materal was initially developed by Lockheed in the 1950s.

One likely application for tile material is in energy production technology, where energy loss through heat escape is a major problem.

• To build the engine's combustion chamber, which must sustain repeated reactions, and where the ignited mixture of liquid hydrogen and liquid oxygen reaches a temperature of about 6,000 degrees and pressure of more than 200 atmospheres, Rocketdyne Division of Rockwell International had to develop both a new alloy and a new manufacturing technique. The new alloy, commercially called Narloy, combined the heat-conducting properties of copper with incresed strength and machinability.

Special ducts had to be constructed for the passage of the extremely cold liquid hydrogen into the combustion chamber-resulting in a new manufacturing process, employing the new allow.

• Out of this engine-building experience, Rockwell has launched a number of applications in the energy field. One is a down-hole steam generator for the oil industry. This device extends production from otherwise spent wells by forcing very hot, high-pressure steam into the well. Rocket technology is helping with the problem of transporting the hot steam, and with space-saving insulation.

Rockwell is also developing a high-performance pump for moving coal slurries. The pump will be able to withstand the highly abrasive coal mixture, yet require servicing only once a year. Current pumps are serviced monthly.

• Computerized electronic control of aircraft is a Shuttle innovation that came of age before the Shuttle itself. In 1972, when the project was just getting under way, the Shuttle was the only vehicle designed with "fly-by-wire" digital electronic control of its maneuvering and stability. In standard aircraft, the pilot controls the ailerons, flaps, and rudder by cables connected to his steering mechanism. The far greater precision required during shuttle re-entry led to the introduction of computer-steering for the control system.

Fly-by-wire is now coming into widespread use, and is expected to increase the already high safety standards of commercial aircraft.

• A comparison with the system for the Saturn V rockets used to launch the Apollo spacecraft shows the leap in computer technology represented by the Shuttle. Columbia's computers are forty times faster, with five times more memory and eight times as many instructions in their programs. They weigh only two-thirds as much as Saturn V's, and occupy only one-third the volume.

Shuttle scientists have developed significant new computer languages for the project. One, called GOAL, gives commands in something very close to everyday language. The program automatically scans a multitude of operating parameters bringing potential problems to the pilot's attention.