processing, without question, has always come from the weapons program. Weapons designers, be they physicists or engineers, come to us with requests that to them seem exceedingly simple and to us almost impossible, at least at first glance. For example, the physicists wouldn't hestitate to ask us for structural air, that is, something with no density but enormous strength. Faced with sophisticated problems for years and years, we've learned how to tailor-make many special materials.

We have also done some basic research in materials science, and in the past few years we have begun to apply our understanding of materials on an atomic level to materials processing. One example is rapid-solidification-rate technology to make amorphous metals with high strength and good corrosion resistance, Another is ceramics processing; we are attempting to make materials for high-temperature environments, such as composites containing single-crystal ceramic whiskers.

LANDT: Electronics is another field that combines ideas and applications; it's partly software and partly hardware, and it's a crucial part of future technologies. I would like to put before you a statement by Dr. DeLauer, Undersecretary for the Department of Defense. Dr. DeLauer insists that electronics is the most critical of all technologies for the maintenance of peace, and he claims that "Further development of the electronics technology base of the United States is as important to defense today as the atomic bomb in World War II."* I think it's time the Laboratory took its electronics seriously.

BAKER: There are, however, a lot of good electronics firms.

LANDT: We are working on several projects that could make significant contributions in electronics—areas that private industry is not touching. These include high-speed electro-optic switches and thermionic integrated circuits that have important military as well as commerical potential. We are also developing high-power microwaves from lasers. This is research that could not be done without the exceptional computer and experimental facilities at Los Alamos.

SCIENCE: *Since we have mentioned speaking freely, I'd like to ask Steven whether there's anything he can tell us about weapons design work.*

HOWE: Most of what we do is classified, but I can say that we work to get better codes, better computational abilities to describe the processes in the weapon, to put in the things we do know so that the things we have to extrapolate can be better estimated. In the year I have been here we have come up with several interesting pursuits. One is in low-energy nuclear physics: there is a process that we think exists in the weapon but that we don't account for in the codes. This particular development is interesting because we have shared it with Livermore, and we have collaborated with them in getting it into the codes and making estimates. We also do secondary design work on weapons materials, attempting to understand basic processes. Generally we aim to satisfy the military requests and to come up with smaller, more efficient devices. We are continually looking at new

Jeremy Landt on Electronics

Our heavy reliance on the world of electronics has led Los Alamos into several fledgling projects that show great promise for the future. One is the development of the high-speed electro-optic switch, which can be used to probe integrated circuits with pulse widths of 50 picosecond or less. Understanding of semiconductor physics on these short time frames is essential for development of reliable, very high-speed integrated circuits for future weapons systems. The first generation of very high-speed integrated circuits is largely based on extrapolations of existing technology. To go beyond will require new technologies and understanding that industry does not have at present.

Another device under development is the thermionic integrated circuit, which is inherently hardened to radiation and EMP phenomena. Before research on this device began at Los Alamos an attempt to commercialize the technology failed because the basic physics was not understood. We could use this device to instrument nuclear and geothermal systems, as well as in military applications.

The area I find most exciting, however, is the broad area of high-power microwaves. We are working on novel generation mechanisms as well as novel applications. One new generation scheme involves the Helios laser, the "Laboratory's high-power carbon dioxide laser. Large numbers of hot electrons are generated in high-power laser targets. A carbon dioxide laser produces far more hot electrons than do lasers operating at shorter wavelengths. We are presently investigating ways of converting these electrons to high-power microwaves. The power levels achieved to date are very impressive and probably can be emproved much more. At present this research cannot be done anywhere else in the world. Los Alamos has both the computer codes to handle the flow of particles in electronagnetic fields and the experimental facilities to benchmark the codes. ■

"Richard D. DeLauer, "The Force Multiplier, " **IEEE Spectrum,** *October 1982, p. 37.*