within extremely shallow depths. The average thickness of the human skin is only about one milimeter, or about 1/32 of an inch. Second, they had to devise a means of distinguishing the subtle acoustic differences between normal tissue and recently burned tissue, wherein the more telling characteristics of dead tissue are not yet set. Also, they had to find a way to overcome a nearly blinding reflection of the original sound wave, the so-called main bang echo, as it bounced off tissues in the body other than those of interest.

Using samples of tissue burned in varying degrees, and comparing the results of microscopic analysis to ultrasound data, they investigated a number of different approaches to overcoming these difficulties. Ultimately, they determined that certain ultra-high sound frequencies could yield the resolution required within the shallow depth. They devised a means for subtracting out the main bang echo. And they employed a clever mathematical technique, called Fourier transforms, to process the returned signals and distinguish between the healthy and burned tissue.

These early successes demonstrated the feasibility of burn depth measurement by means of ultrasound, and paved the way for subsequent technology development. The results were published in numerous technical journals, including *Medical Physics*, *Journal of Trauma*, and the *Journal of the Acoustics Society of America*.

Their research and the resulting device won an IR-100 Award from *Research & Development* magazine and was granted a U.S. patent. NASA sponsored subsequent development and testing of the prototype unit. It is being built under a licensing agreement with Advanced Technology Laboratories of Seattle, Washington. Its clinical trials are scheduled to take place on burn patients at the hospital and medical school of Virginia Commonwealth University.

If successful, this machine could revolutionize burn diagnostics in the hospital emergency room. When needed, early removal of burned tissue, often recommended reluctantly in borderline cases, can reduce mortality, promote earlier wound closure, and reduce deformaties. Armed with knowledge of where the precise interface occurs between burned and healthy tissue, the physician can make well informed judgements about patient prognosis and prescribe the correct treatment. Aided by such a machine, the burn patient of the future could look forward to less physical trauma, a shorter hospital stay, and a more rapid return to normal life.

Legionnaires' Disease

In August of 1976, a mysterious and frightening disease was visited upon the American Legion convention at the Bellevue-Stratford Hotel in Philadelphia. One by one, conventioneers became fatally ill with flu- and pneumonia-like symptoms for which there was no known cure. The hotel was closed; but before it was over, 29 people had died.

Months later, the cause of what came to be known as Legionnaires' disease was isolated from autopsied tissues by microbiologists at the Center for Disease Control in Atlanta. It was found to be a form of bacteria, classified and named *Legionella pneumophila*. *Legionella* have since been found to be present in minute amounts in almost all fresh waters.

Normally, this form of bacteria is relatively harmless. Under certain conditions, however, it can become deadly. Tragically, the disease struck twice more in the warm weather months of 1977 at hospitals in Burlington, Vermont, and Los Angeles; and more people died.

Today, there is a cure for Legionnaires' disease. If properly diagnosed, it may be treated with a readily available antibiotic called erythromycin. Yet, for years following these incidents, crucial aspects of the disease remained a mystery.

Why did the disease seem to strike so selectively in hotels and hospitals, and seemingly most often in the warm weather months? How could relatively harmless bacteria, found in almost all fresh waters, become so infectious and dangerous? Since *Legionella* normally exist in low concentrations, what caused them to proliferate? Most importantly, how could the tragic events of the past be prevented in the future?

Results from Seed Money research, funded in three separate projects in 1976, 1983, and 1984, as well as from follow-on research funded by others, played a key role in answering some of these questions. Owing, in part, to this work and to that of other scientists working on the problem, a fairly clear picture of the disease and its underlying causal factors has since emerged.

Under normal circumstances, the bacteria are not dangerous to man, even if swallowed. This is particularly true if they remain in their usual state of low concentration. They do become dangerous, however, if they begin to proliferate wildly and if they happen to gain entry into the lungs.

A common route of entry into the lungs was found to be from inhalation of airborne mist. Such mists can arise from shower heads, building air conditioning systems in large hotels and hospitals, and cooling towers associated with certain types of large industrial plants and electric power generating stations.

Concerning proliferation, Seed Money researchers, working on a problem unrelated to *Legionella* at the time, discovered a means by which the bacteria might multiply themselves more than a millionfold. Their study in 1976 focused on the effects of heated waters on the growth of two varieties of one-celled organisms, called amoebae, namely *Naegleria* and *Acanthamoebae*. These organisms attack bacteria and consume them as