1. *Hematology.* Complete blood counts, which are performed routinely in the clinical laboratory, represent the single largest current application of flow cytometry. Several dedicated, single-purpose commercial machines have been developed for this purpose. Reticulocyte and platelet counting are examples of two recent developments that are moving immediately into the clinical consulting laboratory. The efficacy of diagnosis and radiotherapeutic and chemotherapeutic treatment of leukemia is being assessed by flow cytometry.
2. *Immunology.* The clinical significance of circulating monoclonal B-lymphocytes in non-Hodgkin's lymphoma has recently been demonstrated. Accurate monitoring of new patients and those in remission is being performed, and definitive markers useful in determining the results of therapy and the prognosis for relapse have been developed.
3. *Oncology.* Considerable effort has been directed to modifying the basic flow cytometric instrument to allow automation of Pap smear analysis for detecting cervical cancer. The objectives are to reduce costs, increase the information content and statistical reliability of the tests, and increase the number of early detections.
4. *Genetics.* Several genetic abnormalities involve chromosome duplication beyond the normal human complement of 46 chromosomes. Flow cytometry is used not only to detect these gross changes in the number of chromosomes, which typically result in severe mental retardation, but also to detect more subtle polymorphic events that promise the first means of diagnosing several inheritable diseases.

Centrifugal Fast Analyzers The centrifugal fast analyzer is an instrument used for medical diagnostic purposes to perform routine and special blood chemistry tests in hospitals, clinics, and research laboratories. The centrifugal fast analyzer tests multiple samples simultaneously. It is built around a flat rotor with numerous sets of wells arranged radially. Measured quantities of the samples and reagents are introduced into individual wells toward the center of the rotor. Centrifugal force mixes each sample and its reagent and moves them into transparent reaction cells at the periphery of the rotor. During each revolution a time-synchronized measurement is made of light transmittance, color, fluorescence, or other relevant property. The course of the chemical changes in each reaction cell is monitored by an on-line computer, and analytical results are developed simultaneously for all samples on the rotor. The resulting data are stored, interpreted, and provided to the laboratory technician very rapidly. One run of the analyzer performs the same analysis on from 1 to 42 samples.

History R&D of the centrifugal fast analyzer was an outgrowth of National Laboratory expertise in biological sciences and separations science. The original funding for the project was shared by the National Institute of General Medical Sciences and the AEC. The original name of the device, GeMSAEC, is an acronym of these two contributors. The National Aeronautics and Space Administration (NASA) provided support from 1974 to 1976 for a zero-gravity centrifugal fast analyzer. Invention of the centrifugal fast analyzer is attributed to Dr. Norman G. Anderson while he was Director of the Molecular Anatomy Program at ORNL in 1968.

The original GeMSAEC system received the Industrial Research Magazine IR-100 Award as 1 of the 100 most significant new technical products of 1969. A second IR-100 Award was awarded in 1977 for the portable, miniaturized, centrifugal fast analyzer developed at ORNL.

Transfer of the analyzer to industry occurred very rapidly. In late 1968 and early 1969, representatives of Electro-Nucleonics, Inc., Union Carbide Corporation, and the American Instrument Company applied for and were granted royalty-free licenses from AEC to commercially produce a centrifugal fast analyzer. Today, five domestic companies sell centrifugal analyzers. Both industry and DOE researchers have made major contributions to its continued development analyzer; for example, improved sample handling, miniaturization, and microchemistry techniques to save reagent costs and laboratory workspace and permit improved blood analyses in areas such as pediatrics and geriatrics, where only small samples are obtainable.

Benefits Major markets for the centrifugal fast analyzer are hospitals and laboratories with low-to-medium daily test volumes. These include small-to-moderate-sized hospitals, specialty laboratories in large hospitals, and commercial laboratories. Major advantages of the centrifugal fast analyzer are its throughput capacity, flexibility to perform any type of assay, concur rent ability to perform economically single tests and batches of tests, and ability to perform emergency tests. At the time of its introduction, the centrifugal fast analyzer represented a 25 to 50 percent cost savings over the discrete analyzers then available. The centrifugal fast analyzer also represented an 80 percent cost savings over the manual methods that predominated in small-to-medium-sized hospitals. Then, as now, existing continuous-flow analyzers perform a fixed battery of tests (a "profile") for less cost than a centrifugal analyzer, but this economy is only obtainable by a laboratory that has a high enough volume of tests to justify purchasing the larger, more expensive continuous-flow instrument.

The significant benefits arising from the development of centrifugal fast analyzers include:

1. Introduction of true automation to clinical chemistry (as differentiated from mechanization);
2. Improved precision for certain tests, thus eliminating the need to retest;