A Case Study Documenting the Work of Dr. Clyde Orr in the Academic and Commercial Pursuits of Advancing the Field of Particle Technology

An excerpt from Technology, Southern style : Case Studies of High-Tech Firms in Atlanta, 1836-1984 a Ph.D. Dissertation by Richard Snyder Combes, Georgia Institute of Technology, May-2002
In Memoriam
1921 - 2010

This photograph of Dr. Orr best represents how most will remember him, engaged in what he most enjoyed: designing novel solutions to particle characterization challenges confronted by analysts worldwide.
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CHAPTER V

Case Study: Micromeritics Instrument Corporation

Introduction

Almost eleven years after EES radar researchers incorporated Scientific-Atlanta, two chemical engineering researchers who also worked at EES created the Micromeritics Instrument Corporation (Micromeritics) in 1962. Using an EES research program started in 1948 as a springboard, Dr. Clyde Orr and Mr. Warren Hendrix developed and patented an analyzer to determine surface area, porosity and volume of samples of fine particles, such as those found in Georgia’s extensive kaolin deposits. They parlayed this original instrument technology, which they licensed from Georgia Tech, into a firm that today manufactures and markets an array of scientific instruments related to the “science of fine particles”, with estimated annual revenues of $50 million1 and a worldwide workforce of 240. As with the Scientific-Atlanta case, Micromeritics is an example of entrepreneurs creating a new firm from technology and intellectual capital brought together by a public research institute and supported by federal agencies. Both S-A and Micromeritics have been successful in identifying and exploiting highly specialized extra-regional markets based on the foresight of the firms’ founders, bringing a new high-tech dimension to Atlanta’s industrial development. Both firms also demonstrate that regional natives, in these cases native Southerners, will succeed as entrepreneurs if given the opportunity to develop technical skills in an environment such as Georgia Tech provided after WW II.

The case of the Micromeritics Instrument Corporation is representative of the second generation of technology firms started in Atlanta and illustrates a firm built around specialized intellectual property and knowledge that evolved from R&D supported by federal agencies. Some of the same institutional forces that led to the founding of S-A are evident with the start-up of Micromeritics, particularly the role of Georgia Tech and its Engineering Experiment Station (EES). In addition, the successes of both firms depended on the efforts of entrepreneurs, Glen Robinson for S-A and Warren Hendrix for Micromeritics, who were willing to stake their personal resources and assume a great deal of risk in the start-ups. Micromeritics differs from S-A in that a single product, the adsorption analyzer, was the principal reason for starting the firm. During the twenty-seven years since its incorporation, Micromeritics has captured the major share of the worldwide market for instruments used in fine particle analysis.

The historical path that led to the founding of Micromeritics starts at Georgia Tech, where the 1948 establishment of a doctoral program in chemical engineering, the first Ph.D. at the newly named Georgia Institute of Technology, brought the main players together as a research team.
Georgia Tech’s Role

The radar and electronics research at Georgia Tech’s Engineering Experiment Station (EES) that spawned S-A grew out of war-related R&D programs that flourished in the late 1940s and throughout the 1950s with the Cold War and the buildup of new military technology. In contrast, the research that spawned Micromeritics was more closely tied to industrial applications and, although military agencies provided early funding, non-military federal agencies, such as the National Institutes for Health, also supported it. The founders of both firms came to Georgia Tech to attend newly established graduate programs, programs which attracted Ph.D.-holding faculty members with outstanding research credentials and capable of attracting new federal funding needed to create credible and sustainable research programs. In the case of Micromeritics, the founders were trained by Dr. Joseph DallaValle who joined the faculty in the School of Chemical Engineering, with a joint EES appointment, in 1948 and immediately set about establishing a new research program around a facility he named the Micromeritics Laboratory.

In the post-war expansion of Georgia Tech’s research and graduate degree programs, the School of Chemical Engineering distinguished itself by hiring several talented new faculty and becoming the first academic department at Tech to award a doctoral degree. Some twenty years earlier, the faculty of the School’s precedent, the Chemistry and Chemical Engineering Department, played key roles in starting a formal research program with the creation of the Engineering Experiment Station (EES). Thus, for the present case, it is useful to examine the historical development of the School of Chemical Engineering.

Chemical Engineering at Tech – When Georgia Tech opened in 1888, the school emphasized a program of practical engineering education designed to train a new cadre of industrial managers who would lead Georgia into a “New South” era of industrialization. The first course of study offered led to a degree in mechanical engineering, and other degree programs followed, including civil engineering and electrical engineering in 1896 and textile engineering in 1898.

Georgia Tech first addressed the need for chemical engineers in 1901 by establishing a Bachelor of Science degree in Engineering Chemistry within the Chemistry Department. Dr. William H. Emerson, one of the original Georgia Tech faculty members hired in August 1888, taught chemistry and proposed the new degree program to Tech President Lyman Hall. In 1904 Emerson hired Dr. Gilbert Boggs, who earned a Ph.D. in Chemistry from University of Pennsylvania in 1901, to help teach courses required for the new Engineering Chemistry degree. In 1924 Boggs became the Head of the Chemistry Department with Emerson’s death. The BS in Engineering Chemistry remained the only degree granted by the Department of Chemistry until 1930, when Tech changed the unit’s name to the Chemistry and Chemical Engineering Department and it began offering the Bachelor of Science and Master of Science in Chemical Engineering, dropping the Engineering Chemistry degree. Boggs, who served as Head of the Department until his death in 1941, led the initiative to start a chemical engineering program. In 1930, he hired the first new faculty member for the chemical engineering initiative, Harold Bunger,
to teach new courses, such as “Unit Processes,” beginning in 1930-31.6 The Engineering Chemistry/Chemical Engineering program was a small one; in the period 1901-1933, 216 Bachelor and 7 Masters degrees were granted in Engineering Chemistry or Chemical Engineering (after 1930).7 When the chemical engineering program started in 1930, the Chemistry and Chemical Engineering Department’s faculty consisted of three Professors, one Associate Professor, four Assistant Professors, and seven Instructors (primarily teaching basic chemistry courses to students in other departments).8 From its 1901 inception, the faculty for the engineering chemistry/chemical engineering program consistently included more Ph.D.s than did the rest of the Georgia Tech faculty. For example, three of the Department’s seven faculty held Ph.D.s in 1930, when only 13 members of Tech’s entire 133 faculty held doctorates.9 After 1930, Boggs and Bunger favored adding Ph.D.s to the faculty to teach relatively difficult courses in a field that was attracting some of the brightest students, as well as increasing Georgia Tech’s emphasis on research and involvement of graduate students. For example, Paul Weber, hired in 1928 as an Instructor in the Chemistry Department, took a leave of absence during 1931-34 to earn a Ph.D. in Chemical Engineering from Purdue and rejoined the Department in 1935 as an Assistant Professor of Chemical Engineering. In 1938, Boggs and Bunger hired Dr. Jesse Mason, who held a Ph.D. in Chemical Engineering from Yale, as an Assistant Professor in the chemical engineering program. Weber and Mason would have long careers at Tech as faculty members and administrators.

Boggs, Bunger, Weber, and Wyatt Whitley, another faculty member in the Department, all figured prominently in the creation and subsequent administration of the Engineering Experiment Station (EES). From 1931 to 1933, Boggs and Bunger were members of a four-person Engineering Experiment Station Investigation Committee whose work led to the start-up of EES in June 1934.10 In 1940, Bunger became the second EES Director,11 serving until his death in 1941. Dr. Gerald Rosselot succeeded Bunger and Weber became Associate Director of EES, holding the position until 1948 when he was named Director of the School of Chemical Engineering. Finally, Wyatt Whitley, a long-tenured member of the Chemical Engineering faculty, held the position of EES Director from 1962 until his retirement in 1968. In addition to these EES administrators, new Chemical Engineering faculty became some of the most respected researchers at EES during its rapid post-war growth.

In 1941, both Boggs and Bunger died and Tech’s administration divided the Chemistry and Chemical Engineering Department into the School of Chemical Engineering and the School of Chemistry. Jesse Mason, who had risen rapidly in faculty rank since arriving on campus in 1938, was named Director of the School of Chemical Engineering, establishing a takeoff point for the post-war expansion of graduate and research programs that led to the founding of the Micromeritics Instrument Corporation. Mason and Paul Weber, who had joint administrative responsibilities in the new School and EES, started the School’s doctoral program after the war. Extending Boggs’ and Bunger’s earlier initiative to upgrade the School of Chemistry, Mason and Weber recruited new faculty who had exceptional credentials to teach graduate chemical engineering courses and establish doctoral-level research programs, even before the Board of Regents approved a doctoral degree
program in April 1946. In 1947 the School submitted the first departmental proposal for a doctoral program and in 1950 granted the first Ph.D. conferred by Georgia Tech, with the honor going to one of Mason’s students.

The first new Chemical Engineering faculty member hired in March 1946 was Dr. Waldemar Ziegler, an Atlanta native born in 1910 in the suburb of College Park. In 1932, Ziegler earned one of the first Bachelor of Science in Chemical Engineering degrees from Georgia Tech while enrolled in the popular Cooperative Education work-study program. Ziegler then earned a Master of Science in Chemistry from Emory University, also located in Atlanta, and a Ph.D. in Chemical Engineering from Johns Hopkins University in 1938, attending on a fellowship that recognized his academic excellence. After earning his doctorate, he joined the faculty at Johns Hopkins, teaching and continuing his dissertation research in material properties at very low temperatures (-200°F). From 1940-44 Ziegler helped develop a sensitive radiation detector using low temperature superconducting materials, and in August 1944 he was selected to join the research staff of the Manhattan Project at Columbia University. He worked on the gaseous diffusion system for enriching uranium and helped monitor the installation of a large-scale plant at Oak Ridge. After the war, the researchers at Columbia became employees of Carbide Chemicals, the contractor who built the Oak Ridge gaseous diffusion plant. Wanting to return to an academic position, Ziegler placed an advertisement in Chemical & Engineering News in early 1946, proclaiming his availability for an academic appointment. Mason, Weber, and EES Director Gerald Rosselot recruited Ziegler, and he was hired as a Research Professor with a joint appointment in the School of Chemical Engineering and EES. Mason and Weber needed him to teach graduate courses in thermodynamics and advise new graduate students, and EES wanted him to develop a contract with the Office of Naval Research to generate charts of thermodynamic properties. Beginning with his arrival on campus in 1946, Zeigler is mentioned prominently in EES publications for his fundamental research in cryogenics and thermodynamics until 1970. In 1947, he served on the committee that started the Ph.D. in Chemical Engineering and, throughout his career at Tech, Zeigler advised 15-20 students who earned Ph.D.s through his research programs. The project-oriented environment of EES research did not always provide opportunities to involve Ph.D. students, so Zeigler’s sponsored research gravitated towards grants from the National Science Foundation that would yield dissertation research support, but that were not administered through EES.

Waldemar Ziegler rose to the highest faculty rank of Regents Professor and twice chaired faculty selection committees for Georgia Tech presidents. As one of the earliest Tech faculty recruited for his research and academic credentials, he played a key role in the establishment and growth of Tech’s doctoral program. During the period 1951-1966, thirteen of Zeigler’s students earned Ph.D.s in Chemical Engineering, including Dr. Henry McGee, who stayed at Tech as a member of the Chemical Engineering faculty. He also advised fourteen students who earned the M.S. in Chemical Engineering. A long-time member of the prestigious Sigma Xi Society for researchers, Ziegler helped convince the national Sigma Xi administration to charter a Georgia Tech chapter.
Chapter in 1953, helping Georgia Tech realize Van Leer’s goal of transforming a regional undergraduate engineering school into a nationally recognized engineering university.

Dr. Joseph DallaValle Joins the School of Chemical Engineering - Almost two years after Waldemar Zeigler was recruited, Mason, Weber and Rosselot recruited Dr. Joseph DallaValle with a similar joint academic/EES appointment to the faculty. DallaValle was born in New York City in 1906 and earned two degrees from Harvard, a Bachelor of Science degree in 1927 and a Doctor of Science (Sc.D.) in 1930. The research for his doctoral dissertation, titled “Studies in the Design of Exhaust Hoods,” started a distinguished career as an expert in the field of industrial dusts and their control. After two Depression-era years as an engineer with the Public Welfare Division of Cleveland, Ohio, DallaValle worked for the U.S. Public Health Service from 1932 to 1942, conducting studies of dusts generated by industrial processes and their control. While employed with the Public Health Service, he helped develop the earliest industrial hygiene standards for worker dust exposure, a growing health problem in mining and manufacturing. From 1941 to 1948 he was an independent industrial hygiene consultant in the U.S. and South America. During this period, he wrote several books in his field, including The Industrial Environment and Its Control (Pitman Publishing Corp., NY, 1948), and Micromeritics: the Technology of Fine Particles, (Pitman Publishing Corp., NY, 1943). DallaValle joined the faculty in the School of Chemical Engineering in 1948 as an Associate Research Professor and in 1953 became one of the first three Tech faculty who achieved the distinguished rank of Regents Professor. He died after a brief illness in 1958.

When Mason and Weber recruited DallaValle to the Georgia Tech faculty, he had no previous experience as a university faculty member, offering instead 18 years of practical engineering and industrial research. However, he quickly established himself as an early contributor to both the new Chemical Engineering doctoral program and the fast-growing EES research program. During his ten year career at Tech, he advised more students who earned advanced degrees than any other member of the faculty. During the period 1952-1959, thirteen of DallaValle’s students earned Ph.D. degrees and eighteen earned M.S. degrees. In 1953, six of his students earned Ph.D.s, including Dr. Clyde Orr and Dr. Henderson Ward, both whom joined the faculty in the School of Chemical Engineering.

In order to provide support for his large group of graduate students, DallaValle quickly established a research program within EES that would attract contract funding with which he could pay stipends. Soon after he arrived on the Tech campus, he secured funds from EES and the Georgia Tech Research Institute to construct a “laboratory devoted to fine particle technology” with the objective of “assumption of leadership in the field of particulate studies, by evaluating and coordinating the many techniques used in specifying the properties of fine particles; that is by standardizing experimental procedures.” While he was creating the new Micromeritics Laboratory, DallaValle recruited new graduate students to assist him in setting up a major new research program.
Clyde Orr Joins DallaValle as a Research Assistant - One of the new Ph.D. aspirants joining DallaValle in 1948 was Clyde Orr, Jr., a Tennessee native who earned a Master of Science in Chemical Engineering from the University of Tennessee earlier that year. Orr was born in 1921 in Lewisberg, Tennessee and grew up on his family’s farm there. Working on the farm he learned to operate and repair machinery, an interest that guided him towards an engineering education. He earned a BS of Chemical Engineering from the University of Tennessee in 1942 and during the war he was commissioned as a Naval officer, serving in the Combat Information Center (CIC) aboard a transport. As a CIC officer, Orr was exposed to early use of shipboard radar to track other ships relative to his own. Upon his discharge he went back to the University of Tennessee and earned an Masters degree in Chemical Engineering in 1948, with plans to earn a doctorate in the same field. At the time, Tennessee didn’t have a Ph.D. program for chemical engineers, but Georgia Tech had started one in 1947. On the advice of his University of Tennessee faculty advisor, Orr applied to Tech’s new program and entered it in the summer of 1948, with DallaValle as his advisor.

Orr used the G.I. Bill educational benefits to attend graduate school at both the University of Tennessee and Georgia Tech. Like many students who were returning war veterans, Orr was already married and he and his wife had twin sons less than a year old when he arrived on the Tech campus. In order to support his family, he needed to have additional income, and DallaValle offered him a research assistantship that provided a stipend on which he and his family could live comfortably. The Tech administration provided funds for departmental graduate stipends to attract new students to its infant doctoral programs. Orr recalls that he “didn’t have much trouble at all surviving” as a married Ph.D. student, using the G.I. Bill and the research funding made possible by DallaValle. Orr was one of the earliest participants in the new Georgia Tech Ph.D. programs, arriving at a time when talented new faculty, such as DallaValle and Zeigler, joined the faculty to start ambitious research programs. The success of these programs depended on recruiting and training bright and resourceful graduate students, such as Orr, while simultaneously securing new research funding from previously untapped sources, such as federal agencies and industry.

In 1948, DallaValle and Orr started working together to build a new research facility, which DallaValle named the Micromeritics Laboratory, in the basement of the Swann building, a converted dormitory in the middle of the Tech campus. The term “micromeritics” was one that DallaValle had first used in his 1943 book, Micromeritics: the Technology of Fine Particles, (Pitman Publishing Corp., NY), and it referred to physical measurements of very small (i.e., fine) particles of materials. Orr recalls constructing the apparatus (see Figure 1) used for performing very accurate adsorption measurements on samples of fine particles by using blueprints that DallaValle had obtained from the National Bureau of Standards. The original apparatus was an intricate network of glass tubes and vessels that were operated under a strong vacuum. The use of glass allowed the apparatus to be cleaned after every measurement to avoid cross-contamination of samples. Orr became skilled at glass-blowing while fabricating and continuously repairing the adsorption measurement system during the four
years he worked as a graduate student for DallaValle. He also became adept at operating the apparatus, along with a number of other highly sensitive measuring systems and devices DallaValle assembled in the Micromeritics Laboratory. DallaValle and his students selected dissertation topics that would help them better understand the fundamentals of the measurement techniques that were being used and improved in the Laboratory. For example, Orr conducted fundamental research in heat transfer for his 1952 Ph.D. dissertation, The Transference of Heat Between a Pipe Wall and a Liquid-Solid Suspension Flowing Turbulently Inside the Pipe; the Thermal Conductivity and Viscosity of a Liquid-Solid Suspension. Thus, DallaValle directed a results-oriented research operation that attracted support from government and industrial sponsors, while simultaneously providing students with opportunities for fundamental research. Clyde Orr’s training under DallaValle gave him both empirical and theoretical backgrounds in micromeritics, a combination that would serve him well when he co-founded an instrument company in 1962.

For the period 1948-1952, as a graduate student, Orr had served a research apprenticeship under DallaValle in the Micromeritics Laboratory, conducting fine particle research sponsored by federal agencies such as the Army Signal Corps, the National Institutes for Health, and various industrial sponsors. Orr completed his doctoral dissertation and other requirements for a Ph.D. in Chemical Engineering in 1952, although his degree was not conferred until 1953. Tech immediately hired him as an Assistant Research Professor, with a joint appointment in EES and the School of Chemical Engineering. A review of EES sponsored projects starting with DallaValle’s 1948 arrival shows that Orr began assuming leadership (i.e., was designated the Project Director for research contracts) for research in the Laboratory shortly after earning his Ph.D. In 1983, Orr retired with the rank of Regents Professor in the School of Chemical Engineering, having served as a faculty member full-time for 30 years.

At the beginning of his career as a faculty member, Orr emulated the research relationship he had had with DallaValle, hiring several graduate students to continue and expand fine particle research in the Micromeritics Laboratory. The students Orr hired as Graduate Research Assistants would receive stipends for working half-time on sponsored research administered by EES, while simultaneously completing coursework and thesis requirements. Orr, as DallaValle before him, acted as the overall Director of research, delegating research responsibilities to his graduate students who were using the research experience to earn advanced degrees. This team approach to research was made possible by the institutional support of EES, where grants and contracts that Orr attracted were administered and investments in research facilities, such as the Micromeritics Laboratory, could be made. Thus, Orr extended the EES model that combined contract research with graduate studies to train a new generation of Ph.D. students. In the ten-year period from his joining the Tech faculty to the 1962 founding of the Micromeritics Instrument Corporation, Orr advised, mentored, and employed a group whose size was impressive for a graduate program that had existed for just a few years. Table 5-1 gives a list of
students whom Orr advised and who assisted in EES research while earning graduate degrees in Chemical Engineering (ChE).
Table 5-1 Graduate Students Advised and Employed as Research Assistants by Dr. Clyde Orr

<table>
<thead>
<tr>
<th>Graduate Student</th>
<th>Degree Earned</th>
<th>Year</th>
<th>Approximate Dates Employed by Orr</th>
</tr>
</thead>
<tbody>
<tr>
<td>William Corbett</td>
<td>Ph.D. in ChE</td>
<td>1964</td>
<td>1955-1964</td>
</tr>
<tr>
<td>John Henry Burson</td>
<td>Ph.D. in ChE</td>
<td>1965</td>
<td>1956-1965</td>
</tr>
<tr>
<td>Edward Keng</td>
<td>M.S. in ChE</td>
<td>1964</td>
<td>1960-1974</td>
</tr>
<tr>
<td>Andrew McAlister</td>
<td>Ph.D. in ChE</td>
<td>1965</td>
<td>1958-1965</td>
</tr>
<tr>
<td>Alberto Hidalgo</td>
<td>Ph.D. in ChE</td>
<td>1967</td>
<td>1960-1967</td>
</tr>
<tr>
<td>Thomas Stonecypher (advised by H.V. Grubb)</td>
<td>Ph.D. in ChE</td>
<td>1961</td>
<td>1955-1961</td>
</tr>
</tbody>
</table>

When Clyde Orr and Glen Robinson began graduate studies and associated research at Tech in 1948, they represented Southerners who were early beneficiaries of Georgia Tech’s post-war expansion of graduate programs. Before 1947, young men (Tech didn’t admit women on a full-time basis until 1952, through Van Leer’s initiative) who had the ability to pursue doctoral studies in the technical fields taught at Tech had to leave the region to do so. For example, in the 1930s, talented Georgia residents Jim Boyd, Waldemar Ziegler and Paul Weber had to go north to attend Yale, Johns Hopkins, and Purdue, respectively, to earn their Ph.Ds. It would have been easy for these influential faculty to have never returned to Georgia, knowing that a career in their native region didn’t hold much promise. However, they chose to return because they saw opportunities developing to have a substantial impact on the transformation of Atlanta from the status of a technological backwater. Once doctoral programs were started at Tech in engineering and physics, bright southern natives who were also latent entrepreneurs had the opportunity to fully develop their intellectual talents and start firms in the location they preferred. The high-tech sector in Atlanta was established because a local group of talented individuals working at Georgia Tech possessed specialized expertise and education that allowed them to compete with similar, technically sophisticated enclaves in other regions. This group started as visionary administrators and faculty, most with Ph.Ds earned outside the South, who expanded Georgia Tech’s offerings to include research of a caliber that matched other programs around the U.S. Particularly significant for the cases presented here were the creation of the Engineering Experiment Station as a dynamic research organization supported primarily by federal agencies, and the evolution of the Ph.D. program in chemical engineering.
DallaValle, who died after a short illness in 1958, left a legacy at Tech that was embodied in the Micromeritics Laboratory he had designed and built in 1948-49. DallaValle’s extensive experience in fine particle studies and his engineering skills with analytical instruments needed to attract sponsored research were unique capabilities he had brought to Georgia Tech, together with his ability to mentor and pass on his theoretical and practical knowledge to bright graduate students. The first generation of analytical instrumentation at Tech was borrowed from the National Bureau of Standards, whose design DallaValle and Orr replicated when they designed and built the Laboratory. DallaValle’s vision of a research program in fine particles proved successful, and he and his students built a capability that attracted sponsors who funded research in a little-known, but fast-developing field of chemical engineering. Orr’s decision to stay at Tech and continue the research DallaValle started created a continuum in the research process, attracting Warren Hendrix and other students to the field of micromeritics. However, unlike DallaValle, Orr also introduced a new element of entrepreneurial engineering to the second generation research team in the Micromeritics Laboratory. Although he came to Tech after some success as an independent consultant, DallaValle never expressed much interest in commercializing the technology he used in his research.33 In contrast, Clyde Orr had visions of starting a business from the time he started as a research assistant at Tech.

Clyde Orr as an Entrepreneur - Since arriving at Tech as a graduate student, Orr had been interested in patenting an invention in order to gain financially from it, and this was “…one reason I stayed at Tech.”34 As with other research organizations, in 1948 EES required all employees (including student employees) to sign an “Employee Patent Agreement” which assigned patent rights for any EES invention to the Georgia Tech Research Institute (GTRI), a not-for-profit corporation that was the exclusive contract agent for EES grants and contracts. In conjunction with this Agreement, GTRI established a Patent Policy that allowed the inventor of record to receive between 15 and 33-1/3% of the “net proceeds” of their invention.35 Orr found very attractive the opportunity to engage in research and invent, with the potential to benefit financially from his inventions, and he made one attempt to commercialize an invention before he and Warren Hendrix used the patented Orr Analyzer to start the Micromeritics Instrument Corporation.

Using EES research he and others conducted in 1952-5536, Orr developed an instrument that could separate airborne particles from an air stream using a thermal gradient maintained between two flow surfaces. Joseph DallaValle had first suggested using the principles employed in developing the new instrument.37 Orr, while conducting early research on airborne pollutants, developed a portable air sampling instrument that allowed him to take samples of dirty air in-situ and accurately collect the entrained particulates or microorganisms for later characterization. He worked with fellow EES staffer Roy Martin to develop and refine an instrument that he and Martin called the Thermal Precipitator (see Figure 5-1), and they obtained a patent for the instrument through the Georgia Tech Research Institute, hoping that the GTRI policy on patents would generate income from instrument sales. In order to commercialize the Thermal Precipitator, Martin agreed to form a new company, the
Roy A. Martin Company, and manufacture the units in his home workshop under the trademark name, “Thermopositor.” GTRI President Harry Baker worked with Orr and Martin to “advertise” the new instrument by publishing articles about it in several scholarly journals, assuming their market would be university researchers who needed to sample dirty air streams, similar to their own needs. However, the inventors got little response from this advertising approach and Orr and Martin subsequently abandoned the commercialization effort after selling only a few instruments.

When the patented Thermpositor failed to achieve significant sales, Orr sought other opportunities to commercialize patented inventions resulting from his research. In 1958, he and Warren Hendrix, a member of Orr’s research team in the Micromeritics Laboratory, began designing a new gas adsorption analyzer that would improve on the system they were using at the time in the Lab. This effort eventually led to a patented instrument, dubbed the Orr Analyzer, that became the basis for starting the Micromeritics Instrument Corporation. That Clyde Orr persisted in seeking a technology to first patent and then commercialize demonstrates the level of his entrepreneurial motivation, a drive he passed on to several of the graduate students working with him during the 1950s and 60s.
For example, William Corbett worked with Orr as a graduate student for nine years and then worked until 1967 as an EES researcher before leaving to form his own firm. Corbett, the son of a Gadsden, Alabama brickmason, enrolled in Georgia Tech as an undergraduate student in 1951. After earning a Bachelors degree in Chemical Engineering in 1955, Corbett began working with Dr. Orr in the Micromeritics Laboratory while simultaneously pursuing graduate studies. With Orr as his advisor, he earned a Ph.D. in Chemical Engineering in 1964 and went to work full-time at EES in a newly established High Temperature Materials Group. There Corbett helped his Group develop aerospace applications for an advanced ceramic product, Rebonded Fused Silica (RFS). In 1967, Corbett left EES and, backed by a group of investors connected with his father-in-law, started a firm in Atlanta that manufactured RFS products. Bill and his wife Charlotte were majority owners and operated the firm, ThermoMaterials Corporation, successfully in the Atlanta area until 1986, when they sold it to a division of Ford Motor Company. In 1983, Corbett and his wife started a new injection-molded ceramics firm, Technical Ceramics Lab, which they sold in 1989 to Alcan, under an agreement that called for them to continue managing the firm for five years. However, Alcan sold the operation to Carpenter Steel and there were problems with the new owners. As a result, Corbett and his wife left the operation and Atlanta in 1993, when they bought the product line of a major chemical company located in Michigan and formed a new firm, SilBond Corporation. In 1999, they sold SilBond, with plans to retire.39

Bill Corbett had designs on starting his own business from the time he earned his undergraduate degree in 1955.40 His work at EES and pursuit of a graduate degree under Clyde Orr helped fuel that ambition, as he witnessed Orr’s efforts to commercialize the Thermal Precipitator and the Orr Analyzer. Like his mentor, Corbett carefully planned to identify a product upon which he could build a new business,41 and then took his knowledge of Rebonded Fused Silica gained at EES and started ThermoMaterials Corporation. While he had Orr’s support and encouragement in his new enterprise, the EES administration “saw him as a crook” for starting his new business in 1967.42 Corbett suggests that the two things that hindered high-tech startup firms in Atlanta during the late 1960s were a negative attitude at Georgia Tech about spinning off new ventures, and a less-than-supportive financial community. He characterized Atlanta banks at the time as not understanding new technology-related products, and therefore not willing to lend funds to firms built around such products. However, like Glen Robinson, Corbett has seen a significant change in both Georgia Tech’s and Atlanta banks’ attitudes toward high-tech firms. In fact, his son has recently started his own advanced ceramics firm within Georgia Tech’s incubator for high-tech startups, the Advanced Technology Development Center.43

Orr’s influence on his students was evident in his initial group of graduate students that worked with him in the 1950s and 1960s, when several of them, including Bill Corbett, Warren Hendrix and Thomas Stonecypher, eventually started new technology-based firms. That this enclave of entrepreneurs existed, in spite of Georgia Tech’s efforts to discourage spin-off enterprises, suggests that Orr was an extraordinary teacher and mentor. After the 1962 founding of the Micromeritics Instrument Corporation, Orr increasingly directed his scientific
inventiveness and creativity to research and product development for his company. He remained on the faculty full-time for another twenty years after starting the new firm, rising to the rank of Regents Professor in 1966. He increasingly devoted his academic time to teaching, rather than to sponsored research, because it became more difficult to obtain grants and contracts. One of the courses he taught in the early 1980s, not long before he retired from Georgia Tech, was “Entrepreneurship for Engineers.” In 1999, he remains very active as Chief Executive Officer of the Micromeritics Corporation, while the co-inventor of the Orr Analyzer, Warren Hendrix, is President of the firm.

Warren Hendrix Trains Under Clyde Orr - One of the first graduate students Orr hired was Warren Hendrix, who joined the EES research staff in 1955. Today Orr and Hendrix are CEO and President, respectively, of the Micromeritics Instrument Corporation, and they remain majority owners of the firm they founded in 1962. Hendrix, a native of Union County, in northwest Georgia, moved to Gwinnett County, just outside of Atlanta, as a teenager in 1945. He attended North Georgia College in Dahlonega, located just south of his native Union County. Hendrix earned a Bachelor of Physics from the College in 1950 and, through participation in the school’s Recruit Officer Training Program, also secured an Army commission as a Second Lieutenant in the Signal Corps. North Georgia College has a long tradition as a military college that trains students as Army officers and Hendrix’s was the first commission granted by the school in the Signal Corps. After additional training, he was stationed in Korea and operated a communications system there during the Korean Conflict. He completed his military service in late 1954 and returned to Georgia to pursue graduate studies in physics. For two semesters, Hendrix attended Emory University’s campus at Oxford, Georgia, about forty miles east of Atlanta. In late 1955, he transferred to Georgia Tech and Clyde Orr hired him for the research staff of EES to assist in the ongoing research of the Micromeritics Laboratory. As was the case with Orr, Hendrix found earning a salary while being able to take graduate courses an attractive proposition. He joined a group of graduate students who were working with Orr in the Laboratory during the latter 1950s, including Thomas Stonecypher, Bill Corbett, John Henry Burson, and Andrew McAlister (see Table 5-1). Orr assigned Hendrix responsibility for operating the adsorption analyzer and other instruments that comprised the heart of the Lab’s analytical capability.

Hendrix took several graduate physics courses at Tech, but never earned a graduate degree. Unlike Orr’s other students, he chose to work full-time at EES research and his sole assignment was with the Micromeritics Laboratory. He became very familiar with the analytical systems that DallaValle, Orr and others had assembled, particularly the operation and maintenance of the NBS-designed adsorption analyzer. The analyzer is shown in Figure 5-2, a copy of a photo included in a 1949 EES report on the construction of the Micromeritics Laboratory. He developed a thorough knowledge of the principles of measurement using gas adsorption techniques, as well as the more practical aspects of maintaining required vacuum levels in the extensive glassware, careful cleaning to avoid cross-contamination of samples, and repairing the fragile, hand-blown
glass elements of the apparatus. Hendrix worked closely with Orr in operating the Micromeritics Laboratory, although Orr had other responsibilities, including teaching, developing new grants and contracts, advising students, etc. Hendrix, as the only full-time staff in the Laboratory, became the most knowledgeable member of Orr’s team in the practical aspects of the fine particle analytical services offered by EES.47 After several years of operating the glassware adsorption analyzer, Hendrix and Orr became convinced there had to be a better way to accomplish their measurements.

**The Creation of the Micromeritics Instrument Company**

Starting in 1955, Hendrix worked with Orr to conduct measurements in Tech’s Micromeritics Laboratory using an unwieldy apparatus that was difficult and costly to keep in good working order. By 1958, they had started brain-storming about what would be needed to construct a more rugged, compact analytical instrument that had the same capabilities as the NBS-designed glass apparatus. Hendrix suggests that he and Orr approached the re-design issue as a problem-solving exercise, an approach the two have used successfully for their more than 40 years of business collaboration.48 They believed the measurement technology in which they had become expert would eventually have widespread applications in the laboratories of industries such as those that sponsored research at Tech. Orr, who along with another EES research engineer had designed and built the Thermal Precipitator, already had some experience in transforming an experimental laboratory apparatus into a rugged and portable instrument that could be manufactured with existing materials and technologies.
Orr did the theoretical design of the new adsorption analyzer, but a major design challenge was to replace fragile glass components with ones made of welded stainless steel. The adsorption analyzer (see Figure 5-3) consisted of multiple vessels, columns, tubing, valves and fittings, most of which operated under a vacuum. The stainless steel components required different materials and construction techniques than had been previously used at the Micromeritics Laboratory. In addition, the metal surfaces required cleaning equal to the extent the glass surfaces of the existing analyzer could be cleaned, in order to avoid cross-contamination when analyzing different samples. Orr, who was proficient in glass-blowing, also had experience in welding and brazing from his farm machinery repair background, and he used these skills to produce glass and metal parts for the new analyzer. Hendrix tackled the problem of maintaining vacuum within the instrument and making it easy to clean. He attended an EES course on vacuum systems and then brought that knowledge to the design process. 49 Working together on the design and construction tasks, Orr and Hendrix developed a prototype adsorption analyzer that they installed in the Micromeritics Laboratory. They used the existing apparatus to calibrate and validate their
new analyzer and, within a few months in 1959, they had the new model matching the performance of the NBS-design unit. Figure 3 shows the prototype of the new instrument, dubbed the Orr Analyzer.

The new Orr Analyzer was created to make micromeritics analysis more convenient, more robust, and more compact, thus saving time and money for the types of measurements needed for contract work. However, the new unit also embodied more than ten years of empirical knowledge gained in the Micromeritics Laboratory, where Joseph DallaValle had trained a generation of chemical engineers in the theory, design and operation of esoteric measurement technology. Its invention reflected the creative approach Orr and Hendrix took to doing their job better, in hopes that their invention would present new opportunities for professional growth. Orr had recently given up on his effort to commercialize the Thermal Precipitator, and was looking for a new opportunity to patent and commercialize an instrument. Although, as has been noted earlier in this case study and that of Scientific-Atlanta, Georgia Tech was not supportive of EES researchers leaving to start new firms, the Georgia Tech Research Institute (GTRI) did encourage Orr, Hendrix and other EES researchers to invent and patent technologies in hopes of creating a source of income from new intellectual properties.

GTRI - Georgia Tech’s Corporate Partner - After the 1934 establishment of the Engineering Experiment Station, Professor Harry Vaughan, EES Director during 1934-1940, came to believe EES needed an private sector agent that was independent of the state government, one that could capitalize on the results of EES research. Vaughan and the other faculty involved in the conceptual design of EES (Gilbert Boggs, Harold Bunger, Montgomery Knight), as well as administrators at Tech and the University System of Georgia, saw the Engineering Experiment Station as a stimulus to Georgia’s economic development. Vaughan opined that “institutional research” offers unique conditions, such as academic
freedom, that encourage creativity and can produce “results of the highest social value.” To capitalize on these research results, Vaughan lobbied for a private sector partner to the EES that would have more flexibility in owning and commercializing new technologies arising from EES research.

In 1937, the Industrial Development Council (IDC) was created as a non-profit corporation existing solely to serve the needs of the fledgling EES. Its mission included “seeking grants from private (i.e. non-government) sources,” financing applications for patents, and administering “the net proceeds derived from such patent rights… in the further promotion of research…” The IDC founders were prominent Georgia Tech alumni and regional business leaders, Preston S. Arkwright, Fuller E. Callaway, Jr., and Monie A. Ferst,. The first Chairman of IDC’s Board of Directors was Preston Arkwright, then President of the Georgia Power Company, while EES Director Vaughan was Secretary of the Board. The policies adopted for IDC operation were jointly developed by the Board of Directors and University System Board of Regents and stipulated the following:

• The IDC Patent Policy dealt only with “research conducted under the direction or supervision of the State Engineering Experiment Station.” This reflects the understanding at the time that EES was the sole campus organization conducting research.

• The IDC agreements placed all EES “research workers….under contract with the IDC.”

• EES inventors would receive 15 to 33-1/3% of the net proceeds of patents arising from their inventions, which were assigned to the IDC. In calculating net proceeds, IDC “costs for obtaining patents must first be fully reimbursed.”

• If, after invention disclosure by the EES inventor, IDC failed to pursue patent rights after 90 days, the inventor could pursue a patent application on their own.

By 1946, the rapid growth of EES research contracts and the 1944 arrival of Tech President Blake Van Leer dictated that a new private sector partner be created to take the place of the IDC, which had become somewhat inactive. Tech administrators also needed a new corporation that could accept and administer private funds donated to build research facilities, such as the 1946 acquisition of a AC Network Calculator that called for Tech to manage a $125,000 donation from local businesses to procure and operate the Calculator. Tech alumnus Fuller Callaway, Jr., a prominent Georgia textile executive and one of the IDC founders, led the effort to supersede the IDC with a new not-for-profit corporation, the Georgia Tech Research Institute (GTRI). Formally incorporated in February 1946, the GTRI Board of Trustees was larger than the IDC Board and included four Tech faculty members, four industry executives, and four Tech alumni. GTRI entered into a new agreement with the Board of Regents that recognized GTRI as the exclusive agent for administering all grants and contracts at Tech, recognizing sponsored research was being conducted in some of the academic departments, as well as in EES. Otherwise, the IDC Patent Policy remained essentially unchanged under the new
Fuller Callaway, Jr. became the first Chairman of the GTRI Board, agreeing to hold the position only if a full-time President was hired to serve as business manager. Callaway recommended Harry A. Baker, Jr., a 1934 Chemical Engineering graduate from Tech, and GTRI hired Baker as its first President in January 1946. In the spring of that year, Baker visited research foundations at a number of U.S. universities and concluded that the Ohio State Research Foundation offered the best model for GTRI to follow. As a result, GTRI remains very closely integrated with Georgia Tech, using its facilities and personnel whenever possible. Baker remained President of GTRI for seventeen years, a period during which Tech’s annual sponsored research increased from $237,000 to $4,500,000.

Baker and the GTRI Board expected that Tech research would yield patents that would produce income stream for reinvestment in research facilities. Working under the GTRI Patent Policy, Baker and his staff encouraged and facilitated patent applications from Tech researchers. It was with Baker’s encouragement and GTRI’s financial support that Orr and Hendrix were able to patent the Orr Analyzer. Under the terms of the Employee Patent Agreement that Orr and Hendrix had signed when they arrived at Tech in 1948 and 1955, respectively, GTRI owned the patent rights. Baker helped Orr and Hendrix with the patent filing on May 10, 1963 and on July 16, 1966 U.S. Patent No. 3262319, “Method and Apparatus for Obtaining Data for Determining Surface Area and Pore Volume,” was assigned to GTRI. Shortly thereafter, GTRI granted an exclusive license for the Orr Analyzer to the Micromeritics Instrument Corporation, and the firm paid a percentage of instrument sales to GTRI until 1983, when the patent expired. Under the terms of the licensing agreement, Orr and Hendrix received a portion of the license fees, as the Georgia Tech inventors of the technology.

**Establishing the Micromeritics Instrument Corporation**

By 1961, the prototype Orr Analyzer had been used and improved in Tech’s Micromeritics Laboratory for two years. Orr and Hendrix relate that a representative of a Philadelphia-based instrument company, NUMINCO, visited their lab in hopes of selling instruments. NUMINCO (an acronym for Nuclear Materials Instrument Company) was formed to sell/distribute instruments for analyzing nuclear materials that were manufactured by a French company. The researchers showed the NUMINCO salesman the Orr Analyzer and demonstrated its capabilities, and he told them the analyzer was superior to others then on the market and encouraged them to consider manufacturing the instrument and letting NUMINCO sell it for them. Orr’s unsuccessful sales experience with his Thermal Precipitator had made him and Hendrix sensitive to the importance of market access and an established sales network, and NUMINCO’s offer to sell the Orr Analyzer provided both. Orr and Hendrix seized the opportunity and incorporated the Micromeritics Instrument Corporation on June 18, 1962 to manufacture and sell the Orr Analyzer, signing an exclusive sales agreement with NUMINCO.
When Orr and Hendrix made their decision to start a company, they were both employed full-time by Georgia Tech. Warren Hendrix decided to resign his position at Tech and devote full-time to the new firm, a decision that was critical to the success of the venture. Hendrix was building a new home in Lawrenceville, Georgia at the time and he converted the basement to a workshop where he and other employees built the Orr Analyzers until “his wife threw us out” in the late 1960s, when the company had 4-5 employees. At that time, the firm bought land in Norcross from Glen Robinson, then President and CEO of Scientific-Atlanta, and built their corporate offices and manufacturing facility. In the ensuing years, the facility has been expanded several times and it remains the only manufacturing plant for Micromeritics, although they now have worldwide sales and service networks.

Orr remained on the faculty at Tech’s School of Chemical Engineering and in the firm’s early years he helped on weekends with the manufacture of instruments by doing brazing for the numerous metal fittings. He also worked with Harry Baker to secure a patent and licensing agreement for the Orr Analyzer and served as head of the firm’s research department, continuing to develop new instruments or improve existing ones, a position he still fills.

When the firm was started, NUMINCO and the principals projected they would sell six analyzers in the first year. However, actual sales amounted to twenty-eight units that first year. About five years after its start-up, Micromeritics experienced a crisis involving NUMINCO as their sales representative. Unknown to Micromeritics, NUMINCO was losing money on the sales of their French instrument line and they were “subsidizing” their losses with the healthy sales of Micromeritics instruments. When Micromeritics discovered this situation, they took legal action against NUMINCO, eventually recovering the withheld revenues but forcing NUMINCO into bankruptcy, in the process. As a result, the firm decided it needed to create its own sales force, a task it completed in the late 1960s and early 1970s.

At about the same time, in an initiative to expand international sales, Micromeritics approached the Coulter Corporation to represent them in Europe and Asia. This resulted in Coulter buying a share in the firm from Orr and Hendrix. The Coulter Corporation was similar in many respects to Micromeritics; established in 1958 by brothers Wallace and Joe Coulter to manufacture the Coulter Counter, a lab instrument used for blood samples, it grew to an international firm that Hewlett-Packard recently purchased for $800 million. As a well-established instrument manufacturer and minority owner of Micromeritics, Coulter proved to be much more successful partner than NUMINCO. International sales for Micromeritics grew at a healthy rate under the agreement with Coulter, and today two-thirds of the firm’s sales are international. In the late 1970s, Georgia’s Governor George Busbee established an award recognizing firms doing export business; the first award went to Scientific-Atlanta and the second award went to Micromeritics. By the mid-1980s, Micromeritics decided to build their own network of international distributors for their products instead of selling through Coulter’s network.
In the years that Micromeritics has done business in Norcross, it has been continuously innovative. The most prominent evidence of this are the many new instruments the company developed since the original Orr Analyzer; today the firm sells fifteen analytical instruments, many which are considered lab standards. The Orr Analyzer has evolved through a number of generations and the most advanced current version, the ASAP 2405, is fully automated and can handle multiple samples. Other examples of the firm’s innovation include integration of computer hardware and software into the instruments; CAD/CAM and MRP systems for manufacturing process control; and certification for the ISO 9000 international quality standards. In addition to instrument sales, the firm also offers customized training in use of their products; laboratory services, such as those once performed at Tech’s Micromeritics Laboratory; and worldwide service for their customers, all of which are managed through their Norcross facility.

**Conclusion**

In referring to Georgia Tech’s role in the start-up of Micromeritics Instrument Corp., Clyde Orr doesn’t “know where else a firm like ours would have started.”

The chronology leading to the 1949 establishment of Tech’s Micromeritics Laboratory consists of several influential events:

- The 1901 establishment of the BS in Engineering Chemistry,
- The 1932 creation of the Chemical Engineering program,
- The 1934 creation of the Engineering Experiment Station in which Gilbert Boggs and Harold Bunger played major roles,
- The 1941 creation of the School of Chemical Engineering in which Jesse Mason and Paul Weber played major roles,
- The 1947 creation of Tech’s first PhD program in the School of Chemical Engineering, in response to President Van Leer’s plan to improve graduate education,
- The 1948 recruitment of Joseph DallaValle to a research faculty position with Chemical Engineering and EES.

DallaValle brought to Tech a unique scientific expertise in the field of micromeritics, as well as the ability to mentor graduate students in his research area. One of those students, Clyde Orr, proved to be an exceptional researcher and a motivated entrepreneur who trained another generation of research-trained entrepreneurs, including his business partner Warren Hendrix. Having learned first-hand of the markets for the analytical instruments they would later manufacture, Orr and Hendrix developed their first commercial instrument, the Orr Analyzer, while employed by Georgia Tech.

Warren Hendrix assumed much of the initial risk for the new enterprise by quitting his job and setting up a manufacturing operation in his basement. Despite some hard lessons, such as their experience with NUMINCO,
Orr and Hendrix have prospered as one of the longest-lived technology firms in Atlanta through continuous innovation and attention to customer needs. In addition, as with Glen Robinson’s management of Scientific-Atlanta through its first twenty-five years, Hendrix has used a team-oriented management style that has created a loyal and productive workforce.

References

3 Hall was president 1896-1905 and made extensive changes to Georgia Tech’s curriculum.
6 Interview with W. Ziegler on 7/12/83, conducted by R. McMath and G. Geibelhaus, tapes in Georgia Tech Archives
7 Georgia Tech Catalog, April 1931.
8 Ibid.
9 Georgia Tech Catalog, April 1930.
10 Other members of the Committee were Professor Montgomery Knight, formerly a Research Scientist with the National Advisory Committee for Aeronautics who joined the Tech faculty in 1931 as the first Director of the new Aerospace School, and Harry Vaughan, an Associate Professor of Ceramic Engineering. (Memo dated 10/23/33 from Vaughan to Committee, Georgia Tech Archives.)
11 Bunger succeeded Harry Vaughan, a Ceramic Engineering Professor who chaired the EES Investigation Committee. Vaughan served as EES Director from 1934 to 1940, when he left for a position with the Tennessee Valley Authority.
13 Ziegler interview on 7/12/83; Cumulative List of Master’s Theses and Doctoral Dissertations Accepted in Partial Fulfillment of the Requirements for Degrees Granted by the Georgia Institute of Technology, 1925-1968, Price Gilbert Library, Georgia Institute of Technology, 1968.
14 The Cooperative program provided a job in the student’s field on alternating school quarters, and took an undergraduate student one year longer to complete his degree. Starting in 1927, Ziegler had a student job with a small rubber company, and later worked every other quarter with Law Co., an Atlanta consulting firm, in their Chemistry Division.
15 Ziegler interview on 7/12/83.
16 The last EES technical report that Ziegler authored was in 1970, according to the catalog for the Georgia Tech Library, which is a repository for EES reports.
17 Ziegler interview on 7/12/83.
20 Paul Weber papers, Georgia Tech Archives.
22 Information from Mike DallaValle, Dr. DallaValle’s son, in May 1999.
26 Interviews with Dr. Clyde Orr, Chief Executive Officer of Micromeritics Instrument Corp., conducted on 1/13/99 and 6/24/99 by the author.
27 Tech placed an announcement of expanded graduate studies in chemical engineering and other disciplines in Chemical and Engineering News, Volume 24, No. 1, January 10, 1946, page 107. This announcement advertised the availability of stipends for qualified graduate students, “ranging up to $1,800 per academic year.”
28 Interview with Orr on 1/13/99.
29 Interview with Orr on 1/13/99.
30 Interview with Orr on 1/13/99.
31 At the time, Georgia Tech only conferred degrees once a year and Orr completed his degree requirements too late in 1952 to earn the degree that year, so it was delayed until the spring of 1953.
32 A and B Projects of the Engineering Experiment Station, 1934-1965……
33 Interview with Orr on 1/13/99.
34 Interview with Orr on 1/13/99.
35 The net proceeds referred to any income accruing after GTRI was reimbursed for their cost in pursuing the patent.
37 Ibid., “Acknowledgements.”
38 Ibid.
40 Interview with Corbett on 3/14/99.
41 Corbett came to believe that he could make more money by using his scientific expertise to manufacture and market high-tech products, than as a consultant, because he was always limited by the number of hours he had to spend as a consultant. (Interview with Corbett on 3/14/99)
42 Interview with Corbett on 3/14/99.
43 Interview with Corbett on 3/14/99.
44 Interview with Orr on 1/13/99.
45 Interview with Mr. Warren Hendrix, President of Micromeritics Instrument Corp., conducted on 6/30/99 by the author.
46 Joseph DallaValle, Final report for EES Project 59J, “Development of a Micromeritics Laboratory,” 1949, Figure 1. Georgia Tech Archives.
47 Interview with Hendrix on 6/30/99.
48 Interview with Hendrix on 6/30/99.
49 Interview with Orr on 1/13/99.

50 Letter dated May 13, 1938 from Harry Vaughan to W.H. Glenn, Southeastern Compress & Warehouse Company. Glenn was a newly elected Director of the Industrial Development Council. (Georgia Tech Archives, Subject)

51 Letter dated August 21, 1937 from L.R. Siebert, Secretary of the Board of Regents of the University System of Georgia to Tech’s President Marion Brittain, transmitting an approved agreement between the IDC and the Board of Regents that created the IDC. Georgia Tech Archives, Folder 86-01-08, “Board of Regents 1936-1937.”

52 Patent Policy of the Industrial Development Council, Georgia Tech Archives Subject File, “Industrial Development Council.”

53 Ibid.

54 Ibid.

55 Ibid.


57 Article (unattributed) dated September 10, 1947 summarizing GTRI accomplishments during its first 1-1/2 years. Georgia Tech Archives, Subject File “GTRC (Formerly GTRI).”


59 Interview with Orr on 1/13/99.

60 Interview with Hendrix on 6/30/99.

61 Interviews with Orr on 1/13/99 and Hendrix on 6/30/99.

62 Interview with Orr on 1/13/99.