Chemical & Biological Engineering
The University of Alabama

A Century of Excellence and Quality
A Legacy of Leadership
1910 – 2010

By

Gary C. April
University Research Professor & Head
(Emeritus)

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Dedication

The author would like to dedicate this brief history of the Chemical Engineering Department at The University of Alabama to ***Lynne***, his wife, partner and soul mate of 48 years, to his children, ***Andrew***, ***Brian*** and ***Elizabeth***, who lived most of their lives while he was a professor there, and to his granddaughters, ***Andrea***, ***Abigail, Caroline*** and ***Olivia*** who continue to provide him with encouragement by sharing a vision for the future that is filled with hope and opportunities.

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Preface

Years ago someone suggested that a change in the classical educational model could lead to the creation of unique curricula in fields important to the development of our country. Each step toward the establishment of these special degree programs introduced students to new challenges and careers limited only by their imagination and ambition. Although chemical engineering was not the first discipline to be developed, its positive impact on solving problems of the day in water purification, waste treatment and resource development was essential to Alabama's future.

All over the United States, universities were recognizing the need for professional programs to address the growth and prosperity within their own regions. Little did anyone realize at the time the enormous positive impact that these professional degree programs would have on the growth and prosperity of our Nation. Another great benefit of specialized, professional engineering programs was the emphasis that they placed on practical, hands-on, applications-oriented instruction. Born out of necessity in the early days, engineering programs would show, over time, how practical applications would lead to new ideas and knowledge that would define its own place among the discoveries and contributions thought to reside within a more classical educational model. Abundant examples of engineering's role in invention, innovation and creative thought fill text books and journals around the world. Many more ideas formed from dreams of encouragement and of necessity have been transformed into reality – a reality that now defines the norm in everyday life for many peoples. And those dreams of yesteryear were indeed the seeds of thought that continue to blossom into the reality that will become tomorrow.

Reality, to a chemical engineer, is but one step beyond the dream. Original thought can be found by engineers in any environment when the skills to recognize and nurture its development are mastered. Leadership in bringing ideas to fruition for the purpose of producing a result that benefits mankind is integral to an engineering degree. Luck, as defined so eloquently by Coach Paul W. “Bear” Bryant “ … as being prepared for any opportunity,” is indeed an important element for chemical engineering success.

Today’s engineers are as essential in solving twenty-first century problems as those persons who emerged from the early professional curricula solved problems of their time. In creating these special fields of study long ago, the visionaries of higher education devised models that continue to be replicated around the world. Dedication, to the ideals set forth when these special curricula were created, remains to be the overarching commitment needed to sustain these degree programs and their tradition of a quality, professional education. Excellence in all aspects of its degrees will forever be the hallmark by which Chemical Engineers of The University of Alabama will be recognized.

1

The Beginning of Engineering Education at The University of Alabama [1]

The history of the Chemical & Biological Engineering Department has obvious connections with the history of The University of Alabama and the State of Alabama. While its origin is not unlike those of other institutions of higher education, it is unique and filled with rich stories at the very foundation of our State and its culture.

It took little over 12 years (in April 1831) after the entrance of Alabama into the Union to create the University of Alabama -- an institution of higher learning located in Tuscaloosa, Alabama. Just six years after that event, under the leadership of newly elected president, Dr. Basil Manly, the University embraced his concept that "religion, science and capitalism formed a tripod upholding a view of how the world – and the University of Alabama – ought to proceed." Thus, in 1837 the trustees of the university called to the chair of mathematics and natural history a Massachusetts native named Frederick Augustus Porter Barnard to fill the first academic position in civil (in contrast to military) engineering. It was Barnard's contact with nationally acclaimed Benjamin Silliman and his lectures on chemistry and geology that led to discussions of the "practical uses of chemistry and the introduction and extension of the *Chemical Arts*." This caught the eye of Manly and the board of trustees.

While this was the beginning of engineering education in the State, it would take nearly seventy years to arrive at distinctive differences in curriculum content that would produce specific disciplines within the engineering profession. Railroad fever and the need to connect developing cities and to exploit Alabama's abundant natural resources were prime movers for creating civil engineering. Major revisions in the traditional curriculum included more mathematics earlier in the students' program followed by mensuration and surveying. Botany and paleontology were moved forward to allow the introduction of hydrostatics, electricity and magnetism. Chemistry was also adjusted forward so the additions of physiology, mineralogy, geology, meteorology and astronomy could be added. A course in civil engineering was taught in the last year. Mahan's text "*Elementary Course of Civil Engineering,*" published in 1837, was a primer on building materials and transportation projects. Unfortunately, finances prevented the full implementation of this curriculum and the University relied on Arnoldus V. Brumby, the brother of chemistry professor Richard Brumby and a tutor, to deliver the needed engineering courses. In spite of his best efforts, the curriculum in engineering foundered. University faculty in 1843 recommended that civil engineering be dropped from the curriculum because additional courses were needed to make it a sounder program, but the board insisted that it was a necessary option. The faculty succeeded in having it removed in 1846 while other universities in the nation were finding resources to meet expanding enrollments. In spite of this action, emphasis on an agricultural chemistry course emerged in 1845 to help farmers, one of whom was Manly himself. In addition, the establishment of a state geological survey coincided with the loss of civil engineering in order to address emerging mineral resource developments in the State. This awareness of Alabama's mineral wealth was focused on its abundant coal. Michael Toumey was hired as the State's first geologist. Citing a failure of the university to meet the needs of the state, a review of the classical curriculum resulted in the adoption of the Virginia model. Engineering education would quietly resurrect itself in 1851 in the guise of a statement for the practical application of science needed to reinvigorate railroad development in the state. When the impending war came, the university, converted to a military school in 1860, dedicated itself to support the Confederacy. Barnard would flee the south to become president of Columbia University's women's college, today called Barnard University.

After the civil war, leadership passed to James T. Murfee, the old engineering professor, who drafted a modern curriculum plan – an elective college system -- centered around four colleges. One of these was the College for Civil, Military, Mining and Mechanical Engineers. This college was joined by the Classical College, the Agricultural College and the Commercial College. His plan followed the pathway that universities like Harvard, Yale, Columbia and Cornell were also adopting. Later, the Morrill Act would see the Agricultural College moved to two other locations in the state, a setback for the university at the time. This was also the trend in other southern states (North Carolina, South Carolina and Mississippi) that had operated under land-grant status prior to the Morrill Act. Georgia opted for and received approval to create a mechanical only university, the Georgia School of Technology, while Kentucky, Tennessee, Arkansas, Louisiana and Florida successfully integrated the Morrill Act into their land-grant charters.

William J. Vaughan, an applied mathematics professor, undertook the design of a Civil Engineering (CE) degree. It was a rigorous curriculum that few students followed to completion. However, engineering did receive recognition as a separate department during his tenure. In 1875 Horace Harding expanded the civil engineering curriculum to include mechanics, strength of materials, conic sections, analytical geometry and construction. He also included study of road, railroad, roof, bridge, arch, wall, lock and dam construction. These courses reflected his emphasis on practical application of the sciences. He proclaimed and boosted Alabama's engineering profession by saying that "Alabama presents a promising field to the young engineer." His vision for engineering, mirroring that which other universities in the United States also exhibited, led to the introduction of the first new engineering field outside of the civil designation. Mining engineering appeared in the 1870's. Soon thereafter, mechanical engineering, long practiced in shops and factories, and electrical engineering were added as separate disciplines. This led to a wave of interests in professionalism that produced specific societies for Civil Engineering (ASCE in 1852), Mining Engineering (AIME in 1871), Mechanical Engineering (ASME in 1880) and Electrical Engineering (AIEE in 1884). Unfortunately, these movements in the United States took place out of the sight of most Alabamans except for those who worked directly in the field. In Alabama, the School of Engineering was named in 1881. This was Murfee's modern university concept, implemented at Alabama fifteen years after he had earlier described it.

After this designation, William J. Vaughn reemerged as the first engineering professor. Unlike the prior experience of students avoiding the more rigorous curriculum, this time students flocked to it. It was the large enrollment (154) that allowed the school to hire more faculty members, including Robert A. Hardaway. His son, Benjamin H. Hardaway joined him as a mathematics professor. In 1890, the university hired William B. Phillips as professor of chemistry and metallurgy to help. He stayed just two years and much of his teaching reverted to Eugene Allen Smith. No Mining Engineering professor was hired and only two degrees were awarded in that field. This malaise would persist until after the turn of the century.

In 1903 Edgar Boyd Kay, a civil engineer, undertook modernization of Alabama's engineering school. He began by reorganizing civil and mineral engineering. He also found resources scarce and was responsible for teaching as many as 28 course hours per week. That workload would eventually reach fifty hours per week under his new plan. He was persistent and in 1908-1909 he had assembled, with great effort, students, teachers, equipment and a building to fully implement his modern revisions. Enrollment again climbed to over one hundred, even after he ejected some students who did not meet his higher standards. He, and a visiting colleague, Elmer J. McCoustland, restarted the mechanical and electrical engineering curricula. When McCoustland left, Kay hired Frederick H. Sibley as the first Mechanical Engineering professor and Harold B. Litchman as the new Mining Engineering professor. B. B. Comer Hall was completed in 1910. Edgar B. Kay was given the title of dean of engineering. Specialized departments in the college of engineering began in 1910. Civil Engineering thrived. Mining Engineering continued to have problems. The Mechanical Engineering program developed hastily after its 1908 beginning. The Electrical Engineering program enjoyed greater success after its 1909 beginning. Gustav Wittig was its first professor.

The Department of Chemical Engineering was announced in the Board of Trustees' approved 1910 academic year catalog, but didn't fully organize until 1912. It was formed to train engineers "specialized in Chemistry as applied to the great problems … of sanitation, public water supplies, metallurgical and other manufacturing industries." Nationally, the field of Chemical Engineering, as a specific discipline, can be said to have begun officially in 1908 with creation of its own technical society (AIChE). The first curriculum in the field was offered by MIT in 1888. At Alabama, like most of the early programs in the United States, chemical engineering would have its beginnings in the department of chemistry.

Stewart J. Lloyd, a Canadian born metallurgist, was its first professor. During the early years its focus was almost entirely on metallurgical chemistry. However, World War I caused the program to expand its role into the field of explosives. Major changes in the curriculum would not occur, however, until after this war. The expansion included applications in organic matter, especially wood and petroleum processing. By 1917 the program enrolled seventeen students and by 1920 it enrolled forty students. This made it the second most popular course behind electrical engineering at the time.

During this period there were two factors that contributed to the success or the failure of the individual engineering programs at the university. The first was a dedicated faculty with a commitment and a talent for instruction. The second was whether that faculty had sufficient time to teach and to advise students. Electrical, chemical and civil engineering thrived during this period. Mineral engineering did not. And Mechanical engineering did not become strong until it was able to attract John Gallalee later during the 1910-1920 time frame. Many attribute engineering success at the university to its then president, John W. Abercrombie. The arrival of George H. Denny in 1912, replacing Abercrombie, continued the strong leadership during a time of growth and prosperity. Edgar B. Kay's leadership in the college is also significant in that the programs seemingly sustained themselves after his departure in 1912 by hiring George J. Davis. Davis' similar background and philosophy produced a nearly seamless transition. In spite of this great internal success, in 1919 the university was cited to have serious problems in engineering relative to the successful program at Alabama Polytechnic Institute (Auburn). There was a call for consolidation of the two programs into one located at just one institution to strengthen engineering education in Alabama by reducing duplication that put a strain on resources.

However, an independent study concluded that four areas must be retained at both locations where engineering education is offered – these fundamental areas were civil, mechanical, electrical and chemical engineering. In addition, recommendations were made to add industrial and sanitation engineering at

Alabama. Highway engineering and continued emphasis on agricultural engineering were to be located at Auburn. Little effort was made by either university to reduce programs and, in fact, programs were added at both locations. In 1920 the United States Department of Education vindicated the University of Alabama's argument for sustaining engineering education in direct conflict with the state study. The continued difficulties with funding for higher education would persist even as the twenty first century began. In fact, if anything has occurred, higher education in Alabama has become even more diversified and less concentrated, especially in the professional programs. The upsurge in engineering enrollment during the 1910-1940 period (***the Industrial Development Era***), after World War II from 1940-1970 (***the World War II Era***), and during the 1970-2000 period (***the Space and Computer Era***) established engineering education in Alabama. During the early twenty first century (***the Nano-, Bio- and Electronic Technology Era***) another wave of advancement kept hope alive in all seven of Alabama's engineering programs.

2

The Emergence of the Chemical Engineering Profession

The need for a specific discipline of study for Chemical Engineering, like all the other engineering fields, was born out of necessity to train young people in areas that represented growth and diversity within the context of an expanding state and national identity.

On September 8, 1910, the students of The University of Alabama returned to their lectures for the year's second session. It was time for explosive growth for the University. The College of Engineering had been established the previous year, composed of several departments. In September 1910, they were joined by another: The Department of Chemical Engineering.[2]

The Chemical Engineering program at The University of Alabama was established under the instructions of the Legislature. Water supply and sewage treatment problems confronted the state, and the training available to civil engineers was not considered sufficient to deal with the problem. Thus, the early Chemical Engineering requirements included courses in water treatment. Following World War I, these courses were dropped, as the water supply problems had been largely solved.[2]

Other industrial development in specialized areas occurred rapidly. One need only follow the growth and development of technology to put into perspective the accurate history of engineering from its roots within military and civil cultures, to the systematic reorganization of curricula to meet emerging, new industries and technology.

The statement contained in the 1910-1911 University Catalog stated the purpose for creating this new department. It read as follows:

> *"The aim of the department of chemical engineering is to provide such instruction in the various branches of chemistry as will enable the student who has passed through it to take an effective and intelligent part in the development of the numerous and growing chemical and metallurgical industries, such as the manufacture of cements, sulphuric acid, iron and steel, sugar, starch, etc."*[3]

The statement continues:

> "*To do so he must not only be familiar with the chemical process involved, but may be required to design and oversee the construction of new buildings and to direct the installation and use of machinery. The department has no less in view the requirements of those intending to devote themselves to the study of water supply and its purification and to the related subject of sewage treatment; two problems of growing importance."*[3]

The early department was populated largely by students of chemistry, metallurgy and civil engineering. The initial curriculum consisted of many science courses and a few courses in engineering taught by other departments within the College of Engineering. A course listed "Chemical Engineering" was first required of the entering class of 1912. This course, Electro-Chemistry, was a conglomeration of some of the earlier Electrical Engineering courses with chemistry courses.[2]

The need for a more focused curriculum in chemical engineering came in response to developments in the forest products, coal and minerals industries. Knowledge in the art of problem solving related to these resources followed quickly out of necessity and opportunity. The needs of the petroleum and fertilizer industries further defined the unique elements that would shape chemical engineering. Growing interests in nuclear, space, computerization, electronic, medical, pharmaceutical, bio-technology, nanotechnology and a multitude of new fields now forming continue to show the versatility and the diversity of the chemical engineering degree programs.

In chemical engineering, the trend to maintain contact with science courses, especially chemistry, likely lingered longer than the other engineering fields. All engineering fields relied heavily on physics and mathematics and those areas of science continue to play a role in engineering education today. The more traditional and classical approaches to education have given way to professional schools, like engineering, business, law and medicine. The persistent inclusion of the sciences in chemical engineering has often placed the degree just to the left of center with its engineering cousins in civil, electrical, mechanical, industrial, and aerospace engineering. This separation of the engineering core curriculum occurred gradually from 1900 to 1930, and slightly faster from 1930 until the onset of World War II when the urgency for engineering solutions tailored to specific war effort problems took over the academic processes. At war's end, the chemical engineering program maintained many of the characteristics adopted prior to the war years.

Although the concept of *"Unit Operations"* was introduced in England in Davis' Handbook of Chemical Engineering (1901, 1904), the term would not be coined in the United States until 1915 at MIT by Arthur D. Little.

The idea that all chemical processes can be analyzed by dividing them into distinct operations, such as distillation, extraction, filtration and crystallization, all of which are governed by certain principles, was a key factor in helping chemical engineering form a core curriculum that would lead to an accredited, professional degree.[4]

For well over a half century, this would be the prevailing culture driving chemical engineering education in the world. New technologies exploded onto the scene in post-World War II America. And chemical engineering was used interchangeably with the concept of process engineering to refine these technologies into viable industries. The ability to understand fundamental principles in specialized areas like reactor design, separations, stage-wise operations, material and energy balances, fluid flow, heat transfer, control and process dynamics were successfully linked together to describe the physicochemical nature of chemical operations and to build plants for the production of marketable products. Mastery of the knowledge in each unit operation was paramount in the design of effective, integrated solutions. This tried and true method continues to make the chemical process industry an effective leader in the worldwide production of chemical and other related products.

However, during the last quarter of the twentieth century, there emerged a need to have chemical engineering return to its more fundamental scientific roots. This movement was brought on by technological advancements that required more fundamental understanding of scientific principles and non-steady state analytical methods. This required the profession to return to first principles to provide answers to problems occurring in real time often at the molecular or smaller levels. Large system, steady state, process engineering methods could not provide the complete answers needed for small scale systems that operate dynamically or within a transient mode. This caused shifts in curricula incorporating higher levels of mathematical proficiency, greater dependence on sophisticated computational systems, and more fundamental understanding of the sciences, including biology and microbiology, and dynamic, transient analytical methods.

This period was marked by a surge to rename some departments reflecting their effort to incorporate these ideas into their curriculum. Departmental names such as chemical and “something,” where “something” might be environmental, materials, molecular, biological and biomedical, appeared over night in some cases. These changes not only represented shifts in research, but also additions to the curriculum reflecting the body of knowledge needed to cover these expanding areas of the profession. It became common place to find diverse faculties including not only those trained in chemical engineering, but others with doctorates in allied fields.

If the World War II era was described as the *Unit Operations* era, then current day chemical engineering must be termed the *Interdisciplinary or Interfacial Operations* era. New discovery today almost always occurs at the interface of chemical engineering with other disciplines, including other engineering fields, the sciences, medicine, law and business. Nowhere is this reflected better than in the curricula that describe the twenty-first century BS (ChE) degree. Nowhere has this evolution toward the interfaces and interdisciplinary collaboration with other professional disciplines occurred more effectively than in chemical engineering. It has produced challenge and opportunity for graduates and it has secured the future value of a chemical engineering education and a profession that is adaptable to new ideas and to the needs of society.

3

Chemical Engineering at the University of Alabama – A Century of Excellence and Quality – A Legacy of Leadership[5]

With a clear picture of engineering education, in general, and chemical engineering education, in specific terms as it developed within the academic community, it is time to focus, in some detail, on chemical engineering at the University of Alabama. In many regards, the history of chemical engineering in the United States is an accurate description of the history at the University of Alabama. The profession, since the advent of the national accreditation process (first ECPD and now ABET), requires all accredited programs to meet or exceed specific minimum standards in faculty size and quality, curriculum and program content and in student admission, retention and progress toward a degree. However, to simply classify chemical engineering education by accreditation guidelines would do an injustice to the many different ways that the educational package is formulated, delivered and validated. These latter areas define the uniqueness of an institution as a separate and special program from all others within the chemical engineering field. There are traditions at each institution that evolve over time because faculty members, staff and students are indeed different. Curricula, while generally similar in coverage, reflect the expertise of the faculty members and the specific needs and resources that exist within the state or region in which the institution resides. The culture of the people, the quality of the students entering college, the involvement of alumni and the resources made available to each program at a given university all determine the way programs are configured and operated. Therefore, it is important to reflect on a personal history to measure how true any program is to its mission, to its constituencies and to the profession.

It is with this spirit of pride that calls one to celebrate the past and, in so doing, to engage the University of Alabama chemical engineering family in the task of shaping the future. Let us recognize that our brand of ***Leadership, Excellence*** and ***Quality*** is unique and makes degrees earned at The University of Alabama in Chemical Engineering valuable assets that are worth preserving for future generations.

The words of Ralph Waldo Emerson are appropriate here as the department celebrates its first 100 years and the ***Excellence*** and ***Quality*** for which its graduates are known to possess.

"What lies behind us and what lies before us
are tiny matters compared to what lies within us."

And remembering that the real purpose of the program, started in 1910 and continuing through 2010, must be the development of ***Leaders*** who can have an impact on the future of chemical engineering and our society, his words serve to challenge each student when he writes:

"Do not go where the path may lead,
go instead where there is no path
and leave a trail."

These two eloquent verses, more than any others, capture the essence of what a University of Alabama Chemical Engineer aspires to become. They also define our unique place within this profession. They serve as guiding principles that shape our vision, our mission, our goals, our core values and our philosophy and beliefs.

Vision

The Chemical Engineering Program at the University of Alabama will be the program of choice for those persons who wish to pursue excellence and leadership in professional careers that place value on the human resource and spirit that are essential in shaping the future of our global community.

Mission

- *To provide students with a multidisciplinary undergraduate/graduate education at a high standard of excellence, recognized by industry and the national academic community, enabling them to perform to their maximum potential in a technologically-based and environmentally-sensitive society.*
- *To sustain an international position of leadership in dynamic scientific and technological research that is engaged by students and faculty members and that is focused on global issues that positively impact the State of Alabama.*
- *To contribute to the economic and technical well being of the State and Nation through innovative educational, professional, and informational service.*

Goals

- *A sustained, nationally accredited undergraduate program, internationally recognized research, and a graduate program focused on doctoral level achievements.*
- *Attainment of leadership in innovative educational and research areas that recognize the diversity of Alabama's human and natural resources.*
- *Preparation of all graduates for meaningful, challenging and rewarding careers in scientific and engineering fields, or allied professional fields such as medicine, dentistry, business and law.*
- *Provide outreach activities for those within Alabama and the nation who can benefit from the unique educational and professional opportunities offered by our programs.*

Core Values

- *The pursuit of **excellence** in all activities.*
- *The promotion of **leadership** by students, alumni, faculty and staff.*
- *Recognition of **diversity** and an awareness of the **value of difference**.*
- *A **caring educational environment** that recognizes the strengths and needs of individuals.*
- *Possessing **integrity, commitment and sensitivity** in all personal and professional relationships.*

- *Bringing **balance** in program emphasis among all levels of professional education and research.*

Philosophy and Beliefs

*We believe in the importance of **continuity** to our purpose and mission; in achieving **international recognition**; in treating people with **equity, integrity, dignity, and respect**; in encouraging **pride of accomplishments**; in maintaining a **positive attitude**; in **considering the opinions** of others; and in **communicating effectively**.*

4
The Significance of Who We Are

Who we are, as chemical engineering professionals, can be measured by looking at the many graduates of our program and what they have achieved in their lives. Contributions to the profession, to society and to our educational programs show vividly what "***lies within***" and the "***trails***" that they have blazed over their collective lifetimes. These collective achievements validate the programs in Chemical Engineering at The University of Alabama.

The Alumni

To define the uniqueness of the Chemical Engineering degree programs at the University of Alabama, one need only look at the students and the alumni that make up its history.

Charles Arthur Abele of Ensley enrolled at the university in 1909. He was a member of Theta Psi Omega. He played class football from 1909-1913 (serving as captain in 1911-1912), and class basketball from 1910-1913 (serving as captain in 1910-1911). Further, he participated in "scrub football" (today known as the practice squad) from 1909-1913 (serving as captain in 1910-1911). In addition to his sports interests, he was a member of the orchestra from 1910-1911, served on the Corolla Board from 1910-1911 and 1912-1914, and was Editor-in-Chief for the 1914 Corolla. As Editor-in-Chief, he made several changes to the Corolla format which it made rather more readable. He was a Fellow in Chemistry from 1910-1913, and served as Corresponding Secretary of the Engineering Club. His friends gave him the nickname "Monk." The 1914 Corolla offers the following about him, in the caption next to his picture:

> *"Here, good reader, you see the party solely responsible for all the innuendo, slander, and libel in this volume. His host of enemies acquired by his dictatorship in the Mess hall (apt name) will be swelled a hundred-fold as his victims turn these pages. We could sock him brutally about Alter*

Annex, his Starko, and his rising hours, but if we did this little sketch wouldn't appear."[2]

During Abele's tenure as Editor-in-Chief, the Corolla was dedicated to George J. Davis, Dean of the College of Engineering.

In 1911, there were 68 students enrolled in the College of Engineering. When the freshmen of this class graduated in 1914, six degrees were awarded college-wide. One of those was a professional degree in Chemical Engineering, awarded to Charles Arthur Abele. The next time a chemical engineering degree would be awarded was 1916. Abele returned to The University of Alabama to earn his BS degree, one of four degrees awarded in the College in 1916. He was the only graduate to be required to complete a thesis for his Bachelor of Science degree (as the thesis requirement was dropped for the 1915 graduating class). In the University of Alabama catalog, Emmett Norman Barnes of Ozark is also listed as receiving his degree in 1916. Since that date, there has been at least one BS degree awarded in Chemical Engineering every year. [2]

There exists in the 1923-1924 catalog a curious entry. Within the sophomore class of Chemical Engineering students, the name Sarah Elizabeth Satterfield appears. This appearance marks, for the first time, the enrollment of a female student in the program. Satterfield does not appear as a freshman or sophomore in the Corolla, and also does not appear in the Crimson White from the time period. She appears, for this one year, as a Chemical Engineering student, and is not mentioned again. Also, no mention of her as a freshman at the university appears in the previous year's catalog. Who was she, from where did she come, and what became of her? That she was not mentioned in an earlier catalog could indicate that she transferred to The University of Alabama from another college or university. She may have studied engineering at that institution, or may have chosen to transfer to the University of Alabama for the express purpose of becoming a Chemical Engineering student.[2]

The 1910 and 1920 Alabama census records provide some background on who she was and where she lived. In the 1910 census, Sarah Elizabeth (5) is listed as the daughter of Moses L. and Elizabeth Satterfield, both from Georgia, now residents of Birmingham in Jefferson County. She had an older brother, Harry (17), and a younger sister, Annie (3). In the 1920 census record, Elizabeth, the widowed mother, is listed as the head of household along with daughters Sarah Elizabeth (17) and Annie (15). [6]

What became of her after her enrollment in 1923 is a question which requires some speculation. Perhaps she transferred out of the university, or chose to drop out of college. In the latter case, it could have been as a result of marriage, as most newly married female college students in the 1920's did not continue to attend college. There is information that Sarah Elizabeth married Perrin R. Oliver, but the marriage date has not been found.

It could also have been a result of her mother's health or death requiring her to return home to take care of her younger sister and the family household. There is also the possibility that Satterfield was made uncomfortable by the male-dominated engineering field and chose to leave to pursue something in a less stressful environment.[2]

She was not an alumna of the Chemical Engineering Department, but certainly she was someone who dared to be different by joining a male-dominated field at a time when women were strongly discouraged from doing so. She is a part of our history, but more importantly, she is a part of our academic family and represents the spirit that is Chemical Engineering at The University of Alabama. It would be two decades after Satterfield enrolled in Chemical Engineering before the department would graduate its first female student. Alice Hargis received a BS degree in 1944.[2] Since the 1980's, female students have comprised approximately 40% of the students enrolled in the department.

From 1916 to 1930 the department awarded an average of 4 BS degrees per year. By contrast, from 1980 to 2005, an average of 33 BS degrees per year was reported.

The first MS degree in Chemical Engineering was awarded in 1924 to Kenneth G. Harris. Since then, 270 MS degrees have been awarded. From 1974 to 2005, at least one MS degree has been awarded each year, with an average of 5 MS graduates per year for that period.

In 1948, The University of Alabama Board of Trustees authorized the awarding of PhD degrees. The first to be awarded was a Chemistry PhD degree in 1952. The first time PhD degrees were awarded in the College of Engineering was in 1964. Both 1964 PhD recipients were from Chemical Engineering. Since then, 75 Chemical Engineering PhD degrees have been awarded, a number which accounts for 17% of the total number awarded by the College of Engineering. The most Chemical Engineering PhD degrees earned in one year was 4 in 2002.[2]

The steady growth of the program is shown in Table 1 where cumulative degrees awarded (BS, MS and PhD) are shown for each decade. Since 1910 and through the summer graduation of 2009, the program has graduated 2,000 students of which 400 were female and 1,600 were male. Among these students, are 1,800 BS, 270 MS and 75 PhD degrees, including some graduates who earned more than one academic degree in the department.

Table 1. A Decade-by-Decade Snapshot of Degrees Awarded (Cumulative) by the Chemical Engineering Department at the University of Alabama

Decade	BS			MS			PhD		
	Total	Female	Minority	Total	Female	Minority	Total	Female	Minority
1910-1919	5			5*					
1920-1929	100			10					
1930-1939	200	1		20					
1940-1949	300	3		35					
1950-1959	500	5		52	1		2		
1960-1969	600	19	1	70	2		10	1	
1970-1979	800	96	18	125	6	1	22	1	
1980-1989	1100	211	38	175	12	3	32	2	
1990-1999	1400	324	55	225	17	4	50	3	
2000-2009	1800	400	75	270	20	6	75	6	

* The first degrees in this category were referred to as “professional” degrees

Table 2 identifies alumni who are the ***first*** few graduates in each degree program.

Table 2. A List of the Alumni/Alumna who Hold the Distinction of being the First Few Graduates in each Chemical Engineering Degree Program

Degrees	Name	Year
BS (Chemical Engineering)	Charles Arthur Abele	1914
BS (Male)	Charles Arthur Abele	1916
	Emmett Norman Barnes	1916
	Steadham Acker	1918
	James Lee Cawthon	1918
	Donald Hobson Thornbury	1919
BS (Female)	Alice Nedora Hargis	1944
	Susanna Virtue Tomlinson	1955
	Patricia Lee Moore	1957
BS (Minority)	Douglas Ray Robinson	1977
	Richard Louis Canty	1978
	Rodney Bernard Ellis	1979
	Michael Bernard Kitt	1981
	Milton Arthur Davis	1981
MS (Male)	Kenneth Gilespie Harris	1923
	Walter Shaffer Ernst	1924
	William Jackson Porter	1924
MS (Female)	Vassiliki Sinis Lygeros	1966
	Dianne Massey	1971
	Razia Bharoocha Forte	1980
MS (Minority)	Claude Eubanks	1983
	David Raine	1994
	April Cole	1998
PhD (Male)	Robert C. Head*	1964
	John Stark*	1964
	G. Merrill Jones, Jr.	1965
PhD (Female)	Vassiliki Sinis Lygeros	1967

* These two PhD degrees were the first granted by the College of Engineering

The graduates of our program represent all 67 counties within Alabama, 32 of the 50 states and 35 foreign countries. The top locations in each of these categories are listed in Table 3. Alabama residents account for 86% of all degrees awarded by the department.

Table 3. Top Locations, by City, County, States and Foreign Countries for Students Earning Degrees in Chemical Engineering*

Alabama Cities	Alabama Counties	Other States	Foreign Countries
Tuscaloosa (205)	Tuscaloosa (253)	Florida (49)	India (36)
Birmingham (135)	Jefferson (222)	Mississippi (37)	Taiwan (29)
Mobile (74)	Mobile (93)	New York (33)	Saudi Arabia (25)
Huntsville (48)	Morgan (60)	Tennessee (31)	China (19)
Florence (47)	Madison (59)	New Jersey (22)	Malaysia (18)
Montgomery (43)	Lauderdale (58)	Illinois (17)	
Decatur (39)	Montgomery (43)	Georgia (17)	
Gadsden (27)	Etowah (35)	Connecticut (15)	
Dothan (18)	Walker (32)	Louisiana (15)	
Hartselle (16)	Colbert (29)	Pennsylvania (15)	
Anniston (15)	Calhoun (28)	Texas (10)	
Bessemer (14)	Baldwin (21)		
Fayette (12)	Houston (20)		
Cullman (12)	Marshall (20)		
Demopolis (11)			

* A Detailed List of all locations, by category, is available in the ChE Department

The active alumni of our program, through their collective achievements and contributions, are entrusted with the responsibility for setting the high standards that become the *reputation* for which all UA/ChE graduates aspire. To recognize those who have, by action and deed, set forth the ideals against which all future alumni shall be measured, the department, the college and the State of Alabama established, during the sesquicentennial of engineering education in 1987, three distinctive awards, Departmental (Chemical Engineering) Fellows, College of Engineering Fellows and State of Alabama Engineering Hall of Fame Honorees (this latter award being administered by a State Board with representatives from all seven engineering universities, engineering professional organizations and businesses and past honorees).

To be selected a Chemical Engineering Fellow, a person must demonstrate that (s) he has achieved significant status through contributions to the profession, to society or to the department. Nominations are accepted annually and are valid for three consecutive years. Selection is made by a committee of departmental faculty, annually. Table 4 is a listing of the Chemical Engineering Fellows that have been recognized for this distinct honor since 1987, the inaugural year.

Table 4. Chemical Engineering Fellows (1987 – 2009)

Name (Degree/Year)	Name (Degree/Year)	Name (Degree/Year)
Anders, J., Jr. (BS62)	Arnold, D. (BS71)	Ashton, E. (Friend)
Bagdasarian, A. (BS43)	Bailey, B. (BS74)	Barrett, K. (BS71)
Baxendale, D. (BS66)	Bentley, W. (BS59)	Beyer, J. (BS52)
Biggs, S. (BS68)	Black, J. (Faculty)	Blackwell, A. (BS52)
Boggan, J. (BS60)	Bonzagni, C. (BS69)	Boykin, R. (BS55)
Burnum, J. (BS46)	Bush, S. (BS70)	Campbell, L. (BS56)
Cannon, R. (BS41)	Carlisle, L. (BS57)	Chilton, T. (Adj. Faculty)
Choudhury, I. (BS77)	Cobb, F. (BS39)	Condon, F. (BS63)
Connaughton, J. (BS50)	Coons, K. (Faculty)	Cooper, M. (BS83)
Courington, D. (BS74)	Cousins, A. (BS86)	Covington, J. (BS72)
Crook, G. (Friend)	Croxton, E. (BS52)	Curry, B. (BS41)
Dailey, C. (BS52)	Dasher, J. (BS36)	Davis, M. (BS81)
DeMiller, W. (BS48)	Deshpande, P. (BS67)	Dillard, D. (BS63)
Dixon, J. (Friend)	Downs, J. (BS75, MS77, PhD82)	Edwards, J. (BS56)
Eichhorn, E. (BS54)	Englebert, E. (BS68, MS70)	Farabee, R. (BS22)
Faulkner, B. (BS61)	Faulkner, H.A. (BS88)	Faulkner, L. (BS64)
Ferguson, B., Jr. (BS56)	Ford, J. (BS57)	Fuller, M. (BS82)
Fuller, R. (BS31)	Gause, L., Jr. (BS52)	Gooch, J. (PhD71)
Goode, R. (BS50)	Greene, J. (BS41)	Guin, J. (BS65)
Hansen, S. (BS75, MS77, PhD81)	Hargett, D. (BS71)	Harris, C. (BS40)
Harris, K. (BS22, MS23)	Hart, D. (MS70, PhD75)	Haynie, D. (BS72)

Hays, J. (BS31)	Head, R. (BS64)	Hedrick, B. (BS73)
Herbert, T. (BS79)	Hill, D. (MS71, PhD74)	Hill, W. (BS85, MS87)
Hilleke, J. (BS71)	Holliman, H. (BS63, MS66)	Hostler, K. (BS77)
Houston, H. (BS31)	Hull, D., Jr. (BS64)	Ingram, B. (BS64)
James, J. (BS57)	Johnson, G. (BS71, MS72)	Johnson, J., Jr. (BS59)
Johnston, B. (BS74)	Jones, M. BS61, MS63, PhD65)	Jones, G, III (BS84)
Jones, W. (BS64)	Kendall, F., Jr. (BS62)	Kennedy, L. (BS82)
Konstanzer, D. (BS66)	Krause, H. (BS36)	Lahoti, R. (BS87, MS89)
Lamana, S. (BS37)	Lammers, P. (BS85)	Lammon, D. (BS42)
Lankenau, H. (BS38)	Letson, B. (BS54, MS59, PhD69)	Lee, D. (BS52)
Lewis, J., Jr. (BS42)	Lewis, M. (BS70)	Lewis, R. (BS56)
Liu, H-A (MS75)	Livingston, J. (BS56)	Lukens, A. (BS43)
MacKay, R. (BS79)	Mahan, J. (BS62)	Mair, J. (BS51)
Marlen, J. (BS65)	May, B. (BS51)	McCollum, J. (BS40)
McCondichie, D. (BS40)	McKinley, J. (BS40)	McKinnon, J. (BS42)
Messelt, C. (BS71, MS75)	Mitchell, R. (BS56)	Mixson, J. (BS36)
Nolen, J. (BS38)	Oden, E. (BS33)	Owen, H. (BS43)
Ortega-Zamora, J. (BS68, PhD73)	Pappas, P. (BS84)	Parker, H. (BS59)
Pate, S. (BS83)	Peters, M. (BS72)	Pirkle, J. (BS96)
Prater, P. (BS40)	Rampacek, C. (BS65, MS67)	Robertson, S. (BS71)
Sadler, L. ( )	Samdahl, D. (BS48)	Sanders, J. (BS60)
Schrodt, V. (Faculty)	Scott, C. (BS29)	Sedlin, L. (BS55)
Shumaker, T. (Friend)	Sievertsen, G. (BS37)	Simmons, A. (BS33)
Sobell, L. (BS48)	Summers, A. (PhD93)	Still, A.J. (Faculty)
Stark, J. (BS47, MS62, PhD 64)	Swann, R. (BS54)	Sweat, R. (BS50)
Tatum, E. (BS73)	Taylor, T. (BS56)	Teas, B. (BS41)
Tidwell, T (BS74)	Tomlinson, S. (BS55)	Vaughan, J. (BS71)
Vaughan, W. (Friend)	Vogler, W. (BS50)	Wallace, A. (BS57)
Wallace, K. (BS81)	Waltman, S. (BS86)	Webster, J. (BS60)
White, B. (BS68)	Winter, J. (BS77, MS84, PhD88)	Wright, H. (BS84)

Source: Chemical and Biological Departmental Archives, The University of Alabama, 2009.

Currently, there are 153 Chemical Engineering Fellows representing 7.5% of the alumni corps. Generally, no more than 10% of the alumni can be selected at any given time. When those achievements and contributions of individual departmental alumni become significant with respect to those alumni from other departments, a person may be nominated for consideration as a College of

Engineering Fellow. This recognition is much more selective and represents, in addition to outstanding contributions in the professional field or to society in general, a high level of involvement in college programs. Nominations may be made at any time with selection of a few (5-8) for recognition annually during the spring semester. Table 5 is a listing of all chemical engineering alumni who have received this distinctive honor since its inception in 1987. The total number of chemical engineers honored as College Fellows is 48 or 2.5%. Normally, no more than 3% of the alumni may be recognized for this distinguished award.

Table 5. College of Engineering Fellows and State of Alabama Engineering Hall of Fame Honorees (1987 – 2009)

College of Engineering Fellows		AEHOF Honorees
Name (Degree/Year)	**Name (Degree/Year)**	**Name (Degree/Year)**
Biggs, S. (BS68)	Black, J. (Faculty)	Baxendale, D. (BS66)
Burnum, J. (BS46)	Cannon, R. (BS41)	Chilton, T. (Adj. Faculty)
Cobb, F. (BS39)	Coons, K. (Faculty)	Hart, D. (MS70, PhD75)
Cooper, M. (BS83)	Courington, D. (BS74)	Holliman, H. (BS63, MS66)
Covington, J. (BS72)	Deshpande, P. (BS67)	Hostler, K. (BS77)
Dillard, D. (BS63)	Englebert, E. (BS68, MS70)	Marlen, J. (BS65)
Farabee, R. (BS22)	Faulkner, L. (BS64)	McKinley, J. (BS40)
Gooch, J. (PhD71)	Harris, K. (BS22, MS23)	Rampacek, C. (BS65, MS67)
Hill, D. (MS71, PhD74)	Ingram, B. (BS64)	
Johnson, J. (BS59)	Jones, M. (BS61, MS63, PhD64)	
Jones, W. (BS64)	Lewis, J. (BS42)	
Lewis, R. (BS56)	Liu, H-A (MS75)	
McCollum, J. (BS40)	McKinnon, J. (BS42)	
Messelt, C. (BS71, MS75)	Mixson, J. (BS36)	
Nolen, J. (BS36)	Prater, P. (BS40)	
Sanders, J. (BS60)	Scott, C. (BS29)	
Sedlin, L. (BS55)	Shumaker, T. (Friend)	
Simmons, A. (BS33)	Summers, A. (PhD93)	
Tatum, E. (BS73)	Tomlinson, S. (BS55)	
Wallace, K. (BS81)	Waltman, S. (BS86)	

Source: Chemical and Biological Departmental Archives, The University of Alabama, 2009.

Also shown in Table 5 are those chemical engineering Departmental and College Fellows who have been selected for the highest recognition within the state, induction into the State of Alabama Engineering Hall of Fame (AEHoF). This annual event recognizes outstanding contributions to the profession, to society and to engineering education by those who have been affiliated with the state or one of its engineering institutions. Since the first ceremony in 1989, 8 of the 120 AEHoF honorees have been University of Alabama Chemical Engineering graduates, representing 0.4% of the alumni corps. Normally, not more than 1% of the graduates from any department at any institution are considered for this honor.

The Students

The life blood of any academic program is its students. They represent, more than any other entity of the department, the ***quality*** that can be attained when the faculty develop challenging, accredited curricula that represent the fundamental and cutting edge knowledge that is needed to advance the state-of-the-field. It is this attribute that determines how high the educational standards may be set, and how deep and complete the concepts that define our degree programs can be covered. The university and college might set general requirements for admission to study and for assignment of scholarships; however, it is the nature of the degree programs that ultimately attracts students to the department. The diversity and flexibility of the profession also play an important role in catching the interest and enthusiasm of these bright students.

The fact that chemical engineering leads freshmen enrollment in the college with respect to ACT scores (28.2 average in 2009) and retained students with an average GPA of 3.32 in 2009 cannot be disputed. The presence of these outstanding students is sufficient enough to demand that the faculty and staff members remain current and at the top of their field in all aspects of the academic programs.

Enrollment trends in chemical engineering generally follow the national trends. Occasionally, due to the nature of the program’s location in the southeastern region and within a state that has abundant natural resources, the enrollment has shown some anomalies in comparison with the national trends. The State’s dependence on chemical engineering degree holders to address technical problems associated with the development of its resources account for many of these anomalies. Generally, the nature of chemical engineering education in Alabama can be described by four distinctive eras. These are labeled as: the ***Industrial Era*** (1910-1940), the ***World War II Era*** (1940-1970), ***the Space and Computer Era*** (1970-2000) and ***the Nano-, Bio- and Electronic Technology Era*** (2000-present). Table 6 gives estimated values for enrollment trends for these four eras. Since the early 1980's, the student population has been approximately 60% male and 40% female with 15% of the total representing African American students.

Table 6. Estimated Enrollment in Chemical Engineering during Its 100 Year History (1910 – 2010)

Era	Period	Enrollment		
		Maximum	Average	Minimum
Industrial Development	1910-1940	50	30	10*
World War II	1940-1970	120	60	20
Space & Computer	1970-2000	250	180	120
Nano-, Bio-, Electronic Technology	2000-present	310	230	195

***After the first ten years with enrollments less than 10.**

The ***Industrial Development Era*** (1910-1940) covers the period from the classical model of higher education to the idea that specific engineering fields were needed to fully develop the nation's infrastructure for expansion and growth. The establishment of separate engineering disciplines focused interests in those specific areas for which the individual states' resources were targeted for development. In Alabama, the need for potable water and sewage treatment, followed closely by the emergence of the coal, coke and steel industry, and the continuing need for technology improvements in farming and forestry, defined the University of Alabama's chemical engineering program. Later during this period, the regional discovery and development of petroleum and petrochemicals expanded course coverage to include these new areas. This was the picture in Alabama, a state that is not first in any of the major sources of energy (coal, oil, gas), but rather a state that is unique in that all major forms of energy are found in abundance.

Each state in the union during this period had its own unique first chapter. In Louisiana, LSU chemical engineering emerged in 1908-1909 driven by the need to assist the state's sugar industry. Until recent times, that department was inseparable from the Audubon Sugar Factory, a pilot scale processing facility that served as the practical chemical engineering laboratory for the degree programs. Very quickly, as the Gulf Coast area blossomed into this country's chief source of petroleum refining, the LSU program shifted its interest and its focus. There are likely dozens of other similar stories throughout the United States.

The early Chemical Engineering curriculum was a curious creature. For the first years (1910-1912), the curriculum bore a striking resemblance to the chemistry curriculum. This was dropped in favor of a more interdisciplinary approach during which integration of courses from different areas occurred. This approach featured courses from other engineering disciplines, metallurgy, and chemistry. Chemistry formed the bulk of the curriculum, with the engineering courses taking a secondary role.[2]

Beginning in 1912, all Chemical Engineering students were required to take a broad range of courses, from physics to chemistry to drawing to mathematics to electrical engineering to geology to economics. Minor changes were made to the curriculum throughout this period; however, the course titles in the curriculum of 1940 would have been familiar to the students of 1915. From time to time, courses designed to integrate engineering into other courses (for example, English) were offered in the form of "Technical English" or "English for Engineers." Despite the repetition of this instructional experiment numerous times, the courses never caught on, and were removed after being deemed failures.[2]

As the years went by, the number of engineering courses required for the degree in Chemical Engineering began to increase, while the number of required chemistry courses decreased (culminating with the removal of Physical Chemistry as a required course in 1998). Although Chemical Engineering courses were offered for periods of a few years at a time, for the most part courses from other engineering disciplines, or general engineering courses, formed the bulk of the engineering component.

The initial chemical operations laboratory was offered in 1934 in Smith Hall. This is the origin of the now famous Unit Operations Summer Laboratory Experience that so many alumni believe to be the capstone course, the course that separates Alabama's program from its peer institutions, in the chemical engineering curriculum.

However, it was only after World War II that courses designated as *"Chemical Engineering"* became a large portion of the curriculum.[2]

The ***World War II Era*** (1940-1970) emerges out of necessity and also out of a time in the nation when the great depression negatively impacted on all growth and development in the country.

College enrollment decreased substantially during this period as well. During World War II, the university switched from semesters to quarters, in order to provide the maximum possible amount of instruction in the limited time that some students were in Tuscaloosa. This was due in part to the establishment of a nearby military flight school. The actual coursework of this period was largely similar to the pre-war coursework; however, many classes were split to allow for the shorter length of the quarters.[2]

While many believe government programs like the Works Progress Administration (WPA) and Civilian Conservation Corps (CCC) saved the nation during President Roosevelt's administration, entry by the United States into World War II mobilized the imagination and the human resources long idled by the depression. New technologies, some untested and unchallenged, were often described with phrases like *seat-of-the-pants engineering*, *back-of-the envelope designs* and many other phrases that entered the vocabulary for the first time. Developments in engineering and science blossomed causing changes in academic curricula. The critical need for materials, food, fuels and other essential products to support the war effort required a commitment to the development of efficient systems and processes.

Many of the discoveries produced during the war years would not be fully used until long after the treaties of peace and cooperation were signed.

In 1950, the university returned to semesters. In this period, the number of required engineering classes continued to increase. Additionally, the number of chemical engineering courses required for the BS degree increased. The majority of the other engineering courses required were part of the college-wide freshman curriculum. The "Subjects for Engineers" experiments returned a few times in this period, but with the same results as the pre-World War II forays into the idea. Also, during much of this period, economics courses were required, or became recommended electives.[2]

The growth of technology in these post-war years was like nothing seen before in the history of engineering education. During this period, the size of the Chemical Engineering Department in terms of both students and faculty members continued to increase. This led to even more emphasis on courses specifically for Chemical Engineering. Once again, the college-wide freshman curriculum was discontinued. While at first each department maintained a suggested freshman curriculum, as time went on these became more individualized by departments. Once again, a few courses were designated, mostly in mathematics, as "Calculus for Engineers." Following historical trends, these courses were again dropped.[2]

In chemical engineering, this was the time for the expansion of knowledge using the notion of "***Unit Operations,***" that had been introduced in 1901 in Davis' Handbook of Chemical Engineering, and that was later adopted and forged into a defining concept by Little of MIT during 1915, and that expanded into a professional curriculum by increasing numbers of chemical engineering departments through the 1930's. These "black boxes of knowledge," when suitably linked together, would produce results that would ultimately thrust the United States into the forefront of the chemical and petrochemical process industry during and after the war years. So revolutionary was this educational concept that chemical engineering curricula throughout the world would not substantially deviate from this protocol for over 75 years, well into the twenty-first century. Unit operations as a staple in the chemical engineering curriculum continues to be a valuable source of knowledge in the application of engineering solutions to a wide variety of complex problems. Industries like electronics, electrical power generation, and food and pharmaceuticals, are now finding great utility in this once dominant concept that drove the chemical process industry and chemical engineering education for well over a half century.

The ***Space and Computer Era*** (1970-2000) is marked by the need for better and more sophisticated understanding of engineering principles and their scientific origins. The ability to collect, analyze and handle large volumes of time variant and spatial data required higher levels of knowledge than those possible at the baccalaureate level. Up to the time of man's interest in space exploration, sound BS level materials and the occasional need for "advanced studies" at the MS level were all that were needed to solve most chemical engineering problems or to design most chemical engineering systems. The ability to use advanced mathematical formulae to approximate solutions to complex differential and partial differential equations, often involving a large number of simultaneous operations, could not have been done in the pre-space and computer era.

While the early stage of this era did not produce major changes in the unit operations protocols, the ability to optimize a set of equations used to describe transient rather than steady-state operating modes, introduced new applications in optimization, in process simulation, and in process dynamics and control that would eventually revolutionize the modern chemical engineering curricula and the resulting chemical process industries. Transport phenomena, while an interesting subject adopted by a few programs in the undergraduate program during the third quarter of the century, found greater acceptance during the last quarter as programs began to require more sophisticated methods to analyze systems based on first principles. While some engineering programs like electrical engineering and aerospace engineering covered transient methods of analysis in their undergraduate programs during the latter stages of this era, chemical engineering used such analyses primarily in graduate or advanced courses.

One great outcome for Alabama engineering during this era was the development of the PhD degree in engineering. Until man began thinking about orbiting the earth and walking on the moon, many engineering academic programs seemed content that the BS and MS degree programs could meet the needs of the industrial sector. In 1964, the University of Alabama, College of Engineering awarded its first PhD degree. In fact two chemical engineering students were the first to receive the PhD, Robert C. Head and John Stark. After a brief time at The University of Alabama, John Stark would become a chemical engineering professor at the University of South Alabama serving in that capacity until his recent retirement.

The PhD programs opened up the University and College to the nationally competitive world of funded research. While many MS degree programs could be supported by modest industrial contracts and grants awarded for specific tasks, the PhD degree required substantial support that fostered the development of new ideas or new uses for innovative technological discovery. This one requirement would change forever the way the college recruited faculty members, the emphasis that would be placed on research and PhD productivity and, more importantly, the way the college would be viewed by the rest of the university community. Perhaps more than any other time in its history, chemical engineering emerged from this period with equally important respect for its engineering cousins, on one hand, and its scientific cousins on the other. The real impact of the emergence of the PhD degree in chemical engineering at Alabama would not be felt until the waning years of the twentieth century. The migration from unit operations to the interdisciplinary age would require modifications in the curriculum and in course content unparalleled in its history.

The ***Nano-, Bio-, Electronic Technology Era*** (2000 -), or perhaps more accurately, the ***Interdisciplinary and Interfacial Era***, came swiftly at the start of the twenty-first century. It is still developing with ongoing changes emerging in faculty composition, infrastructure needs for research, curricula changes and research support requirements for successful nationally funded, fundamental research programs that drive PhD degree education.

In 2004, the Department of Chemical Engineering became the Department of Chemical and Biological Engineering. This name change was the result of a discussion centered on the idea that biochemical engineering departments were being looked upon as a way to fill the need for specialized education in the biochemical field. Many chemical engineering programs, across the nation, felt that chemical engineering could provide the fundamental instructional needs that this new field required through adjustments in the curriculum. With the addition of biology to the science core, the department began a new period of instruction. These course additions marked the most striking curriculum change since the removal of Physical Chemistry in 1998. It was considered by many to be the greatest single change affecting the nature of chemical engineering education since the department was created in 1910. While it is too early to determine the full impact of this change at Alabama and at other institutions in the United States, increases in enrollment, increases in the quality of freshmen students and a more diverse interest in careers ranging from traditional chemical engineering fields to biological, medical and pharmaceutical fields have already been recorded. This is perhaps the broadest "interdisciplinary" change that has been noted for the entire university system.[2]

While many students in the previous eras of the department searched for advanced, professional study in business, law, science and related fields, students today are looking for challenges in medicine, food and pharmaceuticals and biological research. These shifts in interest are addressed in the curricula and in the undergraduate and graduate research areas that give the department's students inside tracks to careers of choice. While that has always remained the chief goal of the department's educational programs, the diversity of student interests, the complexity of new research and the broader interest of departmental faculty members make achievement of this goal more challenging for all concerned.

In 2009, four in ten baccalaureate chemical engineering graduates in the United States accept entry level employment in industry, three in ten enter graduate school, two in ten are seeking employment and one in ten find employment in government, in service or remain undecided. These numbers are in stark contrast to the decades of the 1960's, 1970's and 1980's when the vast majority of BS chemical engineering students accepted entry level jobs in the chemical process industries. The most dramatic increases have occurred in the area of graduate study (or post-baccalaureate professional study), primarily at the PhD level. It is possible that within the first quarter of the twenty-first century, the number of students seeking entry level positions will be equaled or exceeded by the number of *students using the baccalaureate degree as a basis for further, more advanced study to meet the challenges in high tech industries.*[7]

The department is poised to maintain its *Leadership* role within the college, but it will take innovative and creative solutions to sustain its *Excellence* and *Quality* in all of its degree programs. In 2009, the department enrolled its largest class of freshmen (130) since its creation in 1910. The quality of this group of students is the highest (average ACT score of 28.2) it has been in the history of the department. Currently, there are more students in chemical engineering on presidential and other scholarships, enrolled in the Honors College and in other honors programs on campus, and recipients of prestigious awards such as the USA Today All American, Goldwater and Hollings designations than those in any other engineering field. The BS degree program is indeed one of the best, if not the best, programs in this university. It is clearly competitive with any program at any other university in the United States. A clear understanding of the departmental vision is needed to insure that this asset is protected and the goals of the individual students can be met or exceeded.

With the relocation of the Chemical Engineering faculty members into the new Science and Engineering II (Shelby Hall II) complex, the ability to conduct world class research is helpful in attracting new faculty candidates to the four open positions that now exist within the department. The rapid hiring of qualified faculty members with research competence and a strong interest in academic instruction at the undergraduate and graduate levels are paramount to the department's future success and status within the college.

Never before has the department faced such a diverse and complex set of expectations. Creative and innovative programs of education for the university's best students at the BS degree level and equally creative and innovative programs of research to grow the PhD program are essential to the future success of the department. Any plan that strengthens one without equally strengthening the other will result in turmoil and chaos to a program that can ill afford such distractions. How this challenge is met will determine the department's fate – one that is a beginning point for the next century or one that is a point of contention that will distract it from meeting its vision, mission and goals. The requirements to sustain

Quality in chemical engineering programs are clearly delineated. The resources to address those requirements are less clearly defined.

The Faculty and Staff

The faculty and staff members in chemical engineering provide the energy and the talent that are needed to develop programs that challenge students, that create state-of-the-art courses, that lead the profession in innovation and creativity, and that engage students and faculty members in internationally recognized research that compliments the educational mission of the departmental programs. By meeting the commitment to the department the faculty members insure the ***integrity*** for which the degree programs are known.

Stewart J. Lloyd served as the department's only faculty member from 1910 to 1926. His degrees were in chemistry and metallurgy. When other faculty members were recruited, he remained as the head until 1944 often serving, concurrently, in other administrative capacities in the university. The first chemical engineering degree holder was Ray Farabee, a 1923 graduate, who was hired as a faculty member in 1926. Following the departure of another professor, Henry Coles, in 1940, Farabee was the department's most senior faculty member. He remained at the University of Alabama until the end of World War II. After working in industry, he would later join the Department of Metallurgical Engineering as an adjunct faculty member.[2]

In 1935 the first faculty member to earn a PhD degree in the field of Chemical Engineering, Kenneth W. Coons, was hired as an instructor. He would later become the department head in 1946. Upon his retirement, James Black served as head from 1964-1967. E. K. Landis stepped in when Black suffered a heart attack. Black continued to serve as a faculty member until 1984.

The first name change for the department occurred in 1933 when it became the Chemical and Metallurgical Engineering Department. This was done to reflect the importance of the two emerging industries in Alabama and to parallel the development of the Chemistry, Ceramics and Metallurgy program in the College of

Arts and Sciences. The department returned to the Chemical Engineering designation in 1946 when Kenneth Coons was named its head. The department would again come together with Metallurgical Engineering in 1970 in an effort by the college to focus on the commonality of courses and faculty member interests, and to test the theory of "economy of size" a7s it might apply to academic units. The Department of Chemical and Metallurgical Engineering had a number of department heads beginning with E. K. Landis (ChE) in 1969-70, John P. Hansen (MtE) in 1970-74, William J. Hatcher (ChE) in 1974-80 and Marvin McKinley (ChE) from 1980-86.

Although there was one administrative head, the faculty members of the two degree programs really operated autonomously. Individual department status was reinstated in 1986 under McKinley followed by Hatcher in 1988-94. McKinley would again be named department head in 1994. Gary April served as department head from 1995-2007. He had also served for a time (1982-1989) as Assistant Dean for Research and Graduate studies in the College of Engineering. Currently, Heath Turner is the interim head of Chemical and Biological Engineering (2010-), succeeding Viola Acoff, a Metallurgical Engineering faculty member, who served for a brief time as the department's interim head (2008-2009) and head of both Chemical and Biological Engineering and Metallurgical Engineering (2009-2010).

Table 7. Faculty Members in Chemical Engineering during Its 100 Year History (1910 – 2010)

Name	Years of Service	Name	Years of Service
S. J. Lloyd	1910-1939	**G. C. April**	**1969-2008**
J. P. Montgomery	1926-1938	***T. H. Chilton***	***1970-1971***
R. L. Farabee*	**1926-1945**	**W. J. Hatcher, Jr.**	**1971-1996**
A.M. Kennedy	1928-29, 1938	J. P. Hansen	1971-1974
T. N. McVay	1928-1935	**D. W. Arnold**	**1978-**
J. E. Seabright	1928	**L. Y. Sadler**	**1980-2003**
G. D. Palmer	1928-1935	**C. R. Thompson**	**1980-1982**
J. Barksdale	1929	**I. A. Jefcoat**	**1982-2000**
J. L. Kassner	1929-1938	**A. M. Lane**	**1988-**

H. D. Harrison	1931-1933	**V. N. Schrodt**	**1990-2002**
K. W. Coons+	**1935-1968**	*R. A. Griffin*	*1992-2005*
M. F. H. Jones	1938	E. S. Carlson	1998-
H. L. Coles	1939	P. E. Clark	1998-
R. B. Oliver	1939-1941, 1947	P. W. Johnson	1998-2002
L. H. Thomas	1941-1942	*R. Reddy*	*1999-2003*
A. J. Still	**1947-1975**	**C. S. Brazel**	**1999-**
A. B. Flower	1947-1948	**B. S. Epling**	**2000-2001**
D. C. Reams	**1949-1955**	**T. M. Klein**	**2000-**
J. H. Gary	**1955-1960**	**D. T. Johnson**	**2000-2006**
E. K. Landis	**1958-1989**	**S. M. C. Ritchie**	**2002-**
E. W. Grohse	**1960-1966**	*M. L. Weaver*	*2002-*
J. H. Black	**1963-1984**	**C. H. Turner**	**2003-**
E. R. F. Winter	1963-1964	*A. Gupta*	*2006*-
J. Stark	**1965-1966**	H. Bao	2008-
M. D. McKinley	**1966-1995**	V. Acoff	2008-2010
W. C. Clements	**1967-1995**	**J. Bara**	**2010-**
A. R. Taylor, Jr.	1968-1969	**R. Hartman**	**2010-**

***** Received a chemical engineering degree at the University of Alabama

+ First hired to have earned a PhD in the chemical engineering field

BOLD Faculty with a Chemical Engineering degree *Itallic* Adjunct faculty member

Some quick facts that were determined about the faculty members in searching the archives over the past one hundred years may be of interest here.[2]

- *Stewart Lloyd, the first head of the chemical engineering department, earned his baccalaureate and master's degrees from Canadian universities, and his PhD from the University of Chicago. He served many of his years at the University of Alabama as the Dean of the School of Chemistry and Metallurgy. In several early years (1910-1926), he also served as the sole professor of Chemical Engineering. Lloyd Hall is named for him and was the home of the Chemistry Department until their recent move to Shelby Hall.*

- *From 1926-1930, new faculty members were hired every year. From 1930-1938, only two new faculty members were hired, and the size of the faculty actually decreased over the next twelve years, most likely due to the effects of the Great Depression and World War II on college enrollment.*

- *Other intensive periods of hiring new faculty were 1965-1970 and 1998-2004, during which times 5 and 7 were hired, respectively.*

- *Also, in 1998, the department added three Petroleum Engineering faculty members from the eliminated Mineral Engineering Department.*

- *Gary C. April is the longest serving member of the Chemical Engineering faculty, with nearly 39 years of service. He retired in December 2007.*

- *Nine Chemical Engineering faculty members spent over a quarter of a century at the University: Stewart Lloyd, Kenneth Coons, A. John Still, E. K. Landis, Marvin McKinley, William Clements, William Hatcher, Gary April and David Arnold.*

- *Tonya Klein was the first female faculty member hired in 2000. Hao Bao, hired in 2008, was the second.*

- *Thirty-three universities account for the degrees earned by faculty members hired over the years to direct the programs of Chemical Engineering at the University of Alabama. These universities include: Alabama, Florida, Johns Hopkins, Virginia, Purdue, Louisiana State, Colombia, Delaware, North Carolina State, Chicago, Auburn, Illinois, Indiana, Michigan, Ohio State, Cooper Union, Carnegie Mellon, Pittsburgh, Montpellier (France), Vanderbilt, Lehigh, Cornell, Clemson, Massachusetts, Pennsylvania State, Utah State, Wisconsin, Utah, Wyoming, Oklahoma State, New Mexico Institute, Kentucky and Stanford.*[2]

Were it not for the integrity and the commitment of dedicated individual faculty members, there is speculation that the college of engineering would not have survived. Difficulties of size made it challenging for the college to be responsive to its expected charge. Too few resources, scant numbers of allies in positions to find resources needed to implement programs of study and an ill defined focus for what engineering education could contribute to the academic community all had devastating impacts on the smooth transition from engineering education as an idea to engineering education as a reality. There is evidence that this was a typical feature of many engineering programs in the early twentieth century.

What is perhaps unique to Alabama's college and engineering departments is the reoccurrence of problems with funding, in defining the role and scope of the academic programs, in identifying its educational mission and in understanding what it was uniquely qualified to do. It is reasonably clear that there never seemed to be enough resources to adequately hire a corps of dedicated, engineering faculty members. Early programs in engineering were taught by scientists in allied fields as the best possible outcome, and by persons in non-allied fields under times of great stress. Faculty teaching loads of 28 to 50 hours during some periods seemed intolerable, but necessary. Of course, research and outreach were not adopted yet as part of the tripartite rallying call of the university. But inadequate course coverage for emerging programs designated to carry the burden for the state's myriad resource development needs was obviously clear. This remained an issue for quite some time. In fact, some might even say that this continues to be a chief concern now when faculty positions in the 80-100 range have been in place since the early1970's, even after the emergence of greater research opportunities and interests in the PhD programs. Data at several peer institutions in the southeast show that this has not been the trend at other state universities.

Rather, they have long addressed the dual responsibility for excellence in the baccalaureate degree program and for research or advanced education (at the PhD level) by finding ways to maintain faculty size above the critical number. The numbers in chemical engineering needed to have balance in teaching and research is 12-16 faculty positions. There is an equally sound body of evidence that supports the claim that fewer than 6-10 faculty members in a department leads to an instructional environment at the BS or BS/MS level. Conversely, faculty numbers greater than 20-24 provide a capability to produce higher than normal levels of funded, competitive research and strong PhD level graduate programs.

How some programs found the resources that were needed to evolve and grow over time would be an interesting exercise in identifying the role of university, college and individual faculty members within a department. Clearly, everyone in the academy has responsibility to provide the infrastructure needed for successfully meeting instructional and research objectives and for satisfying the expectations for which the program is held accountable.

Until the creation of the PhD programs in the college in 1960, the primary emphasis for engineering faculty members was teaching at the BS and MS levels. Most research was supported by industry or by governmental projects by way of RFP's; bodies of work or directed studies complimentary of a governmental program where in-house expertise within the agency was unavailable. A large number of faculty members also engaged in consulting. Some funds were generated to support graduate students who would then use the work for their thesis requirements.

The advent of the PhD programs initiated searches for faculty members with some research interest and with the expectation that they would seek external, nationally competitive funding among the few agencies offering research opportunities. Competition for national funding was difficult due to the small number of available agencies supporting research. While funding sources increased over time, competition remained high due to shifts in funding toward more center-focused initiatives and away from individual research programs. Of course, there are also many more programs and faculty members seeking funds under current academic models, especially in science and engineering.

In decades past, it was common for successful faculty members to have a suite of projects funded by the federal government, the state government, private industrial (applied) research and personal consulting. Typical workloads were 2-3 courses per semester with a ten-hour per week (quarter time) commitment to funded research. If one was successful with funded research, the teaching load could be reduced to 1-2 courses per semester with a twenty-hour per week (half time) commitment to funded research. It was not unusual to assign another quarter time commitment to publication or research development, departmental outreach or departmental and university committee activities.

Over the next two decades, the college would adopt a unified model for faculty member workloads in an effort to standardize time commitments across departments. This was driven by the need to move from an across-the-board raise structure, based primarily on seniority, to a merit-based raise structure following a management-by-objectives model. During one decade of this plan, externally funded research rose in the college from $500K and 6 active faculty members to $5MM and over 30 active faculty members. Merit raises for faculty members during this period often varied from 0-33% when the state authorized 8-14% increases and from 0-10% when the state authorized 3-6% raises. Faculty morale rose among those who embraced the plan and used the college programs to enhance research to improve external funding. Those embedded in the old model of instruction and personal consulting, RFP and/or industrial funding fought for the plan's termination.

Standardized workload requirements were dropped in the late 1980's and a modified merit-raise plan was adopted that defined acceptable workloads. Research funding continued to rise from $5MM to over $16MM with the help of massive center and block funding for research supporting a group of researchers in special areas rather than individual faculty member projects. These programs provided the needed resources to advance the PhD degree programs and chemical engineering was an active player during these transition periods. Emphasis on the underhraduate educational program shifted still further toward research and advanced degree programs.

This transition continued into the last decade of the century. The department was successful during this period in changing the graduate enrollment from one with a PhD/MS degree ratio of 1-to-4 to one that was 4-to-1. This dramatic shift was due to a rearrangement of resources resulting from increased indirect costs and gift funds needed to address the Alabama Commission on Higher Education's mandate that programs meet minimum numbers for advance degrees (MS, about 4-5 per year and PhD, about 2-3 per year). The program introduced an active non-thesis

MS program for students admitted to the PhD degree program. This eliminated the thesis MS degree program for everyone except those who could not qualify to study at the PhD level.

5
The Importance of Who We Might Become

"There is nothing that will determine the quality of our future as a nation or the lives of our children than the kind of education we provide them."

President Barack H. Obama
An address on United States educational accountability, November 4, 2009

The history of the first 100 years of chemical engineering education at The University of Alabama serves to establish an identity and a tradition for those who graduated in one of the departmental degree programs. The accomplishments of the past, and the rhetoric of today, while inspiring, can do nothing to insure that the characteristics of *Leadership, Excellence* and *Quality* remain as the goals to which each graduate ascribes when they enter the program. Each class must define for themselves how they will uphold these standards and advance them for those who follow. Change in such a dynamic program is inevitable. And it is change that keeps the degrees vital in achieving what the profession and society require.

However, an understanding of its history is important to the process of planning its future.

"*The farther backward you can look, the farther forward you can see.*"

Sir Winston Churchill
Prime Minister of the United Kingdom

Therefore, the importance of what chemical engineering at the University of Alabama might become and about what society and the profession might need from this highly productive academic program starts with reflection about what it has been. It is a question not unlike others being asked of universities, colleges of engineering and engineering departments, globally.

One way to begin understanding what might lie ahead is to consider some of the data that are used to describe this period as “exponential times.” Borrowing from the generally accepted and often viewed commentaries of ***YouTube***, one finds statements that help define this electronic information revolution and the consequences of its emergence.[8]

- *China has a population that is over 4 times larger (1.3 billion) than that of the United States (304 million). In the United States, 1 new baby is born every second. In China this number is 4 and in India this number is 6. (In India, the population increases annually by the number of people living on the whole continent of Australia.)*
- *Twenty five percent of India’s population with the highest IQ is a larger number than the entire U. S. population. (India has more honor kids than the U. S. has kids.)*
- *The top 10 in-demand jobs in 2010 did not exist in 2004.*
- *We are currently preparing students for jobs that don’t yet exist … using technologies that have not yet been invented … in order to solve problems we don’t even know are problems yet.*
- *One in four persons has been in their current jobs less than 1 year, while one in two persons have been there less than 5 years.*
- *There are over 200 million registered users of MySpace. If MySpace were a country it would be the 5th largest in the world (between Indonesia and Brazil).*
- *We currently Google 31 billion electronic searches each month compared to 2.7 billion in 2006. The number of text messages sent each day exceeds the population of the planet.*
- *Technical information doubles every two years. Students starting a four year program of study in a technical field will see half the information out dated before they graduate.*
- *The number of internet devices existing in:*

1984	*1,000*
1992	*10,000*
2008	*1,000,000,000*

- *The time for high profile products to reach a target market of 50 million people was:*

Radio:	*38 years*	*i Pod:*	*3 years*
Television:	*13 years*	*Face Book:*	*2 years*
Internet:	*4 years*		

- *One week of New York Times information would equal the total information exchanged during the 18th century. There will be 4 x 10^{19} pieces of unique information exchanged this year equaling the total that was exchanged during the last 5000 years.*
- *NTT Japan can push information through a single fiber optic strand at 14 trillion bits per second. This would allow 2660 CD's or 210 million phone calls to be transferred each second. This rate is increasing by 3 times every 6 months.*
- *In 2013, a super computer will exceed the computational capability of the human brain. In 2049, a $1000 computer will have the capability to exceed the computational capacity of the entire human race.*

Clearly, the times are changing. Whether one believes the above claims are credible or not, the skills and methods that will be needed to become and to stay informed are going to be dramatically different than what they are today. This will impact the way we view the world, the way we seek and process knowledge and information, and, the way we live.

In light of these startling claims one is advised to turn to the leaders of the academy and the profession, to the benefactors and supporters of the department, to the beneficiaries who earn the degrees and to the citizens, both public and private, in order to gain insight about the way forward for the graduates of this program. To remain viable, a department will need to meet each challenge with new skills, a literacy of technology and an innovative spirit that will form the cutting edge in their field.

Although knowledge may be exposed using different, highly sophisticated and rapidly expanding media, the fundamentals that define the profession and the organization of thought needed to identify and solve problems will remain the same. Communicating these solutions will have to remain effective in form and content.

To forecast how that might be done at The University of Alabama, it is appropriate to look to President Robert E. Witt for guidance in defining the department's role within the academy as its second century of ***Leadership, Excellence*** and ***Quality*** begins.

"The following key issues and questions emerge as I reflect on the future of Chemical Engineering at The University of Alabama.

Teaching. *What our chemical engineering graduates will need to know will be a function of the evolution of the discipline of chemical engineering (new knowledge) plus the needs of employer industries. A close working relationship with industry will help ensure that our graduates are both knowledgeable and employable.*

Cross-Disciplinary. *By its nature, chemical engineering research crosses discipline boundaries with chemistry, biology, and other related fields. Our department should forge and maintain strong working relationships with academic disciplines.*

Competitive Advantage. *How can the department best give* ***'Alabama Graduates'*** *a competitive advantage over the graduates of other programs?*

Facilities. *Within a few years, The University of Alabama will have a four-building, 900,000 square foot engineering and science complex. How can chemical engineering best build on that asset?*

Faculty Environment. *What can the department do to be* ***'a university of choice'*** *for new faculty?"*[9]

To find that these challenging statements by President Witt project a view of those expectations held by the profession, one need only consider those who are the leaders and champions of the profession. The intersection of these visionary academic statements with those coming from university chemical engineering leaders, from those representing the profession (the AIChE) and from those within the industries that rely on the technical competency and personal skills of the department's graduates form a basis upon which future direction can be identified.

"*It is obvious to most engineering educators that we should be looking to a future in which chemical engineering plays an important role in solving many of the problems facing this planet. We are moving away from roots in the petrochemical industry and heading in new, exciting and unexplored directions, many of which relate directly to global challenges. These challenges excite those who wish to make a difference in the quality of life of our planet. They also identify the sources to which chemical engineering researchers might turn to find funding for discoveries at the cutting edge of science and technology. But we must be clear and committed to the notion that the fundamental role of the university remains education. Frontiers of research are exciting and seductive sources of prestige and funding in today's universities. Successful future programs in chemical engineering will use these opportunities to enhance fundamental knowledge in the field rather than to distract student from those core principles that define the field.*

The more successful departments will be those which learn how to keep the educational program anchored in engineering practice while pursuing the more exciting frontiers of research."[10]

"*The general personal characteristics which have always been the 'hallmark' of success for chemical engineering will remain the same:*

- *Intellectual/Organizational Skills*
- *Motivation/Drive/Commitment*
- *Integrity/Morals/Character*
- *Leadership/Communication Skills*

These characteristics must continue to permeate chemical engineering curricula and research regardless of the course content or structure that might evolve from emerging, highly specialized, and interdisciplinary requirements or specialized technologies. It is inevitable that the tools required to perform assignments in *chemical engineering will advance at much faster paces than at any time in the last four decades, and the knowledge base to effectively work at the interface with science and technology will expand in scope and content. It is just as inevitable that the fundamental requirements defining and solving complex problems, communicating results in a clear, concise and complete format and producing effective results that are socially, environmentally and globally constrained, will continue to identify chemical engineering as a valuable professional field."*[11]

"*Chemical engineers apply fundamental knowledge in the sciences and other fields to obtain solutions to problems covering a wide range of categories, such as, consistent product characterization, value generation and issues of profitability, new products, greater production rates, higher specificity of chemical applications, reduced operating costs and myriad other categories. What makes chemical engineering a remarkable field is the breadth of the knowledge domain, which is developed in the context of few specific core competencies. From the foundations provided by mathematics, chemistry, physics and biology, knowledge bases are developed using conservation of mass and energy, transport phenomena, thermodynamics, reaction kinetics and separations that extend the core competencies to an ever-expanding list of problem categories. Some might say that chemical engineers provide "just-in-time" solutions to the widest variety of problems.*

The curriculum and courses that impart this concept are uniquely chemical engineering. Chemical engineers will always need to know that we use natural resources that are often abundant, but none-the-less limited. Simple energy and mass balances tell them that. The speed and the extent to which processes occur will always be constrained by the fundamental principles needed to define the system of importance at the time within the context of the application being considered. Socioeconomic, environmental and geopolitical constraints add interest and challenge to the problems, but ultimately the objectives of the chemical engineer will be to enhance the quality of life, to provide analyses and therapies that diminish or eliminate diseases, to satisfy energy demands and to spread wealth and well-being throughout poorer communities throughout the world. Chemical engineers will not shoulder these burdens alone. But the chemical engineering share of the burdens will contribute substantially to effective solutions *and will provide sufficiently challenging problems for future generations of students and the faculties who are committed to this profession.”*[12]

These views by three noted chemical engineering professionals, and many others who contributed collectively to the discussion, are captured eloquently by another chemical engineering educator who has been a recognized leader and an educational innovator for several decades. His list of appropriate and perceived necessary qualities, that future chemical engineering graduates will need to possess to find jobs in more economically competitive future markets, is pertinent here. His list effectively combines the thoughts expressed above in statements that relate fundamental knowledge, core values and external forces introduced by a global information revolution with seemingly undefined limits. The chemical engineers of the future will have to be:

- *creative researchers, developers and entrepreneurs who can help their companies stay ahead of the technology development curve (in any field);*
- *designers capable of creating products that are attractive as well as functional;*
- *holistic, multidisciplinary thinkers who can recognize complex patterns and opportunities in the global economy and formulate strategies to capitalize on them;*
- *people with strong interpersonal skills that equip them to establish and maintain good relationships with current and potential customers and commercial partners;*
- *people with the language skills and cultural awareness needed to build bridges between companies and workers in developing nations (where many manufacturing facilities and jobs are migrating) and developed nations (where many customers and consumers will continue to be located);*
- *self-directed learners, who can keep acquiring the new knowledge and skills they need to stay abreast of rapidly changing technological and economic conditions.*[13]

These all-inclusive attributes are daunting in their scope within the context of today's chemical engineering baccalaureate program. Are there programs in chemical engineering that now address all of these attributes? The answer is clearly "no." Future chemical engineering departmental faculty members will need to address these items within academic communities that are under growing pressure to keep college education affordable for everyone.

Innovative and creative ways to maintain core values and principles, while making students proficient and confident in continuing their education through directed professional, advanced and industry-based, post baccalaureate programs must be defined, refined and more vigorously implemented.

Will a 120 hour bachelor of engineering degree, covering most of the core principles, allow students to branch into several pathways that compliment their interests in medicine, in scientific research, in international employment, in business and law?

One might see a specialization in engineering practice to go beyond 120 credit hours (eight 15 credit hour semesters) including more detailed coverage of design, economics and practical, hands-on, experiential learning that is now provided in 128-132 hour (eight 16-17 credit hour semesters with one summer term) degree program. This proposed baccalaureate engineering degree is similar in construction, if not in content, to the curriculum that existed during the early years of chemical engineering education at the University.

Could those students with interest in medicine, law and business acquire sufficient coverage in a bachelor of engineering program (120 credit hours) to successfully compete for openings in medical schools of their choice?

This format is far more conducive to those students seeking a professional career in an allied field like medicine, law and business than one requiring highly directed study in engineering practice.

Is this 120 hour curriculum a viable pathway for undergraduate students who are seeking challenging research careers?

The future of chemical engineering will be defined by those who can successfully provide an education that will allow students to keep open the many challenging opportunities that will exist within this innovative, creative and diverse professional field. And this will have to be done in an academic environment that is increasingly constrained by costs, by global pressures, by the need for broader knowledge bases, by unconventional career pathways, by exponential growth in the electronic information field and by a growing diversity of interests, including externally competitive and nationally recognized research among faculty members.

All of the above viewpoints, representing those from the academy and those from other segments of our profession, have a common set of concerns and challenges. How they are used to help the department define a program important to its state and regional mission is the task that lies ahead. An inspection of the chemical engineering programs at the University of Alabama shows that many creative elements addressing these challenges have already been started. From honors college and honors elective courses in chemical engineering, to dual credit status for some advanced undergraduate/introductory graduate courses, to coop- and study abroad-for-credit listings, the department has recognized the urgency of impending changes that will define chemical engineering in the twenty-first century.

The effective changes in the curriculum and in the departmental name to reflect growing interests in non-traditional chemical engineering fields, such as biotechnology and nanotechnology, are other recent changes introduced. But the work is far from completed. In fact, the department will need to remain ever vigilant to stay ahead of the trends that will be used to redefine or redesign what a twenty-first century college of engineering, and a corresponding chemical engineering degree program, will be. The uniqueness and value of chemical engineering as one of the four major degree programs in the early twentieth century has not diminished as the department begins its second century. Core values and principles remain the critical elements in a successful chemical engineering curriculum.

While the ultimate outcome from the program is the education of technically competent, socially aware and globally focused graduates, there is flexibility and diversity in the approach that each institution defines as unique to its mission. This was evident in 1910, it was evident in 1950 after World War II and it remains evident today on the anniversary of its first one hundred years.

Remain confident that in addressing these inherently necessary changes throughout its history, that this department will indeed meet the challenge to do it again for as many times and as often as it is required to do so. It is simply what chemical engineering does – changes itself to better address needs through confidence in processes and reliance on those core values that distinguish its degrees and its graduates from all others.

All of the new challenges cited throughout this chapter by leaders in the academy and the profession are no less exciting than those listed throughout its storied history. As the world changed from a society needing resource and industrial development, to one that chose to leave the surly bonds of earth to seek a better understanding of what we might become, to the globalization of knowledge and information, chemical engineering adapted to each new challenge. Equally daunting were those tasks that tested the profession's capacity to improve the human resource, to enhance the quality of life and to expand the understanding of complex technologies that are now beginning to define the future of the planet.

Be assured that while the systems, problems and tasks may well be different from those of the past, the processes and approaches that define solutions remain the purview of the professional engineering discipline. And take great comfort in the knowledge that from the President of the University of Alabama, to the captains of the chemical engineering profession, this University of Alabama Chemical Engineering Department and its programs, faculty members, student and alumni stand with pride in accepting its responsibility to begin its second century with a renewed focus on *Leadership, Excellence* and *Quality*.

6

The Legacy Continues

Now that we have looked into the past to find out the character and the temperament that has defined University of Alabama chemical engineering, it is time to focus clearly ahead toward the future and the next century. It will certainly be as exciting as the first, filled with many more opportunities and challenges like those within the past. The basic skills and qualities that will forever define the profession will continue to be at the core of the degree programs. The issues and the problems will all be different, caused by the times in which the program will exist and resulting from the needs that twenty-first century Alabama, the United States and the planet Earth will face.

Alabama will look no further than to those pioneers who forged the core values of chemical engineering at the University of Alabama during its first one hundred years. Attention to detail, an ability to define and solve complex problems at the interface of many disciplines and with a steel-like focus tempered by integrity, the graduates of this program will meet these challenges and take advantage of these opportunities like none other before them. A ***trail*** has been clearly marked and the spirit of achievement has been precisely located ***within each person*** who enrolls to study within this challenging field.

The Legacy of Chemical Engineering lives at The University of Alabama!

It lives because of the students, alumni, faculty and staff who have committed themselves to the task of keeping the program alive and at the cutting edge of the profession. From its unique and highly heralded ***summer unit operations laboratory experience,*** to the myriad support programs created by its graduates through generous and thoughtful gifts of time, effort and monetary awards, to its honor programs, to its diversity in student makeup, this program shall always have a place near the center of what is defined as The University of Alabama. This is a call to make this ***Legacy*** still stronger by adding your name and your support to the many funds and programs that serve to keep it alive and well. To all of those who have contributed to sustain this department over the years, this brief history is dedicated.

Discretionary and General Support Funds

- *The Chemical Engineering Discretionary Endowment Fund*
- *The Chemical Engineering Discretionary Annual Gift Fund*
- *The Chemical Engineering Endowed Laboratory Fund*
- *The Clarence W. & Martha T. Scott ChE Endowed Support Fund*
- *The Reichhold-Shumaker Endowed Assistant Professorship Fund*
- *The Hua-An Liu-Halliburton Endowed Discretionary Fund*
- *Laura Spence Davis Endowed Support Fund*

Endowed Scholarship Funds

- *Charles Rampacek*
- *Gary C. April (ChBE Advisory Board)*
- *I. Atly Jefcoat*
- *Leon Y. Sadler*
- *Martha & Clarence Oden*
- *John W. & Miriam B. Lewis*
- *Edward L. & Betty B. Englebert*
- *Dennis & Virginia Baxendale*
- *J. G. G. Frost-Vulcan Materials*
- *David R. & Carol D. Hart*
- *James Hay & Mary Lou Black*
- *A. John & Miriam K. Still*
- *Linda T. & John W. Covington*
- *Harold B. Robinson*
- *Bomar Ingram*
- *James & Carolyn McCollum*
- *Jeffrey Brett Hilleke*
- *Mark E. & Dixie Cooper*

Special Gifts

- *Stan Pate Helping Hand Fund*
- *Peter G. Prater*
- *Albert Simmons Excellence Fund*
- *S. Steve & Janet H. Biggs*
- *John Phillip Gooch*
- *Joseph & LaVonne Sanders*
- *Ralph M. & Clara P. Lewis*
- *John Stumpe Estate Fund*
- *Rick & Barrett Brock MacKay*
- *John K. McKinley Creativity Fund*
- *Carol & James Jones*
- *Harry Hill Holliman*

In addition, the department would like to acknowledge those industries that helped support the chemical engineering programs with matching gift programs or through special educational programs throughout its 100 year history.

3M	Albemarle	Ameron International
BP	Boise Cascade	Celanese Chemical
Amoco	Chevron Texaco	Crown Zellerbach
Standard Oil	Dow Chemical	E. I. DuPont deNemours
Ethyl	Union Carbide	Eastman Chemical
ExxonMobil	GE Plastics	Georgia Pacific
Halliburton	Hercules Chemical	International Paper
Kimberly-Clark	Monsanto Chemical	Olin Corporation
PPG Industries	Procter & Gamble	Reichhold Chemical
RockTenn	Rohm & Haas	Scott Paper
Gulf States Paper	Shell	Solutia
Southern Company	Union Camp	U. S. Pipe & Foundry
Southern Nuclear	U. S. Steel	Vulcan Material
Alabama Power	Westvaco	Weyerhaeuser

These contributions to a program of study that shaped the lives and the careers of so many graduates, and, in turn, affected the lives of so many others who were touched by these graduates as family members, neighbors, colleagues and fellow citizens, speak to the value and to the importance of this academic program at Alabama – ***the Crimson Tide of the Chemical Engineering*** profession.

Help keep this ***Legacy*** alive during the next 100 years!

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11. Personal Communication with Jack R. Hopper, Dean, College of Engineering, Lamar University, Beaumont, Texas, 2009.

12. Personal Communication with Ronald W. Rousseau, Director of the School of Chemical Engineering, The Georgia Institute of Technology, Atlanta, Georgia, 2009.

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The author would like to thank those who graciously responded to his requests for statements regarding chemical engineering education and practice. Their comments and remarks were used to form the consensus views that are represented throughout this book. Many statements expressing similar thoughts and concepts were paraphrased to capture the spirit and the force of the opinions expressed regarding the future of this dynamic profession.

Were you able to find the hidden message in the *Preface*? If not, you may wish to revisit those pages and try again!

About the Author

Gary C. April was born and raised in Metairie (a suburb of New Orleans), Louisiana and was educated in parochial schools, St. Francis Xavier (grades 1 through 8) and De La Salle High School. He enrolled in the first class at Louisiana State University in New Orleans (now the University of New Orleans) where he spent two years in the general sciences program. He transferred to Louisiana State University, Baton Rouge, and completed the BS (ChE) degree in 1962. He married Lynne Slocovich, also a student in LSUNO's first enrolled class, in June 1962 and they moved to Orange, Texas where he was employed as a research engineer for E. I. DuPont deNemours Company, Inc. His first son Andrew was born in 1965.

In 1966, he returned to LSU to pursue graduate study in chemical engineering. He earned the MS (ChE) degree in 1968 and the Ph.D. degree in 1969. His second son, Brian, was born in 1966. Upon graduation in 1969, he took a position as an Assistant Professor in Chemical Engineering at The University of Alabama. His daughter was born in 1970. He rose through the ranks and became a full professor in 1976. In 1980 he was named a University Research Professor by the Board of Trustees.

From 1983 to 1989 he served the College of Engineering as its Assistant Dean for Research and Graduate Studies. He later served as interim head of chemical engineering in 1995 and was named its permanent head in 1996, a position he held until retirement in 2007. Upon retirement, he was named Professor Emeritus by the Board of Trustees. A scholarship in his honor was established by the Chemical Engineering Advisory Board members. He continues to reside in Northport, Alabama with his wife, Lynne, and they both enjoy the enthusiasm for life that their four granddaughters, Andrea (13), Abigail (9), Caroline (9) and Olivia (1 mo) share with them on a regular basis. He continues to be active in teaching and consulting in the chemical engineering field.