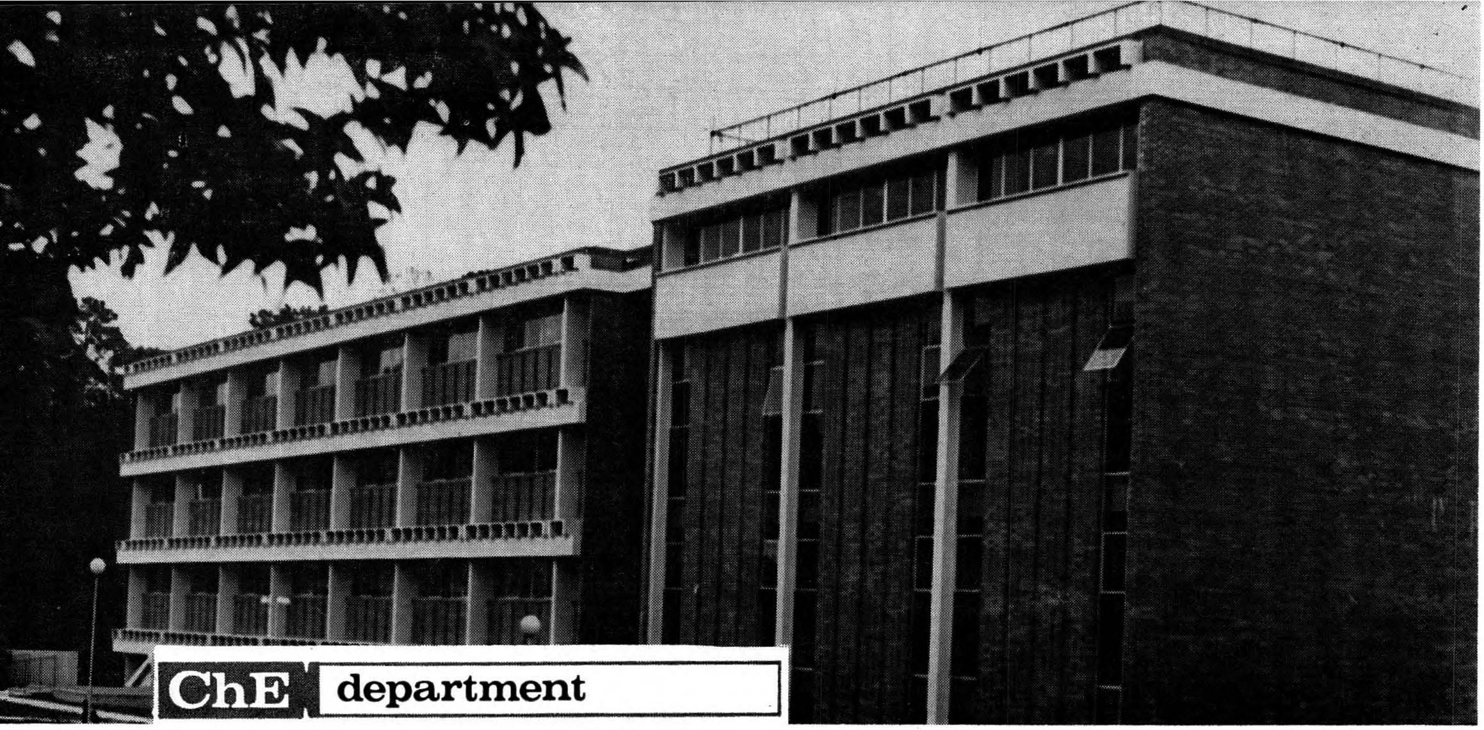

ChE department

THE GATORS GO

. . . a balanced department with multiple objectives is desirable at the University of Florida . . .

RAY FAHIEN

What should be the goals of a department of chemical engineering? National prominence through a strong graduate program or a quality undergraduate program? An orientation toward "engineering science" or an orientation toward engineering practice? A large graduate program or a large undergraduate degree production? A PhD-oriented graduate program or a master's-oriented graduate program? Should it espouse a philosophy of service to the state, a philosophy of service to the engineering profession, or to a "community of scholars"?

When a department has a single objective, the fulfillment of its goal demands a concentrated effort in one direction. For example, a department that is interested in undergraduate degree production can hire faculty who are inspiring teachers and who would also enjoy visiting high schools to aid in recruitment; a department that aspires to national prominence for the quality of its research can hire faculty who have brilliant, creative minds and a personal desire to do research and to publish their results. When the goal of the department is singular, and when the faculty and administration accepts the singularity, the implementation of its goal can be carried out smoothly and without conflict. Departments of great prominence can be developed in this manner.

In many cases, external factors, such as whether it is a private or public institution, may influence or even fix the goal of the department. In some cases, it is more desirable (and even necessary) for a department to have multiple goals. For example, the composition of a tenured faculty can, by its very nature, demand a diversity of objectives; or the faculty may express an objective opposed to that of the institution or college as a whole (such as in the case of an undergraduate-oriented faculty in a graduate-oriented institution).

While many departments seek more than one of the many objectives listed above, few of them strive for excellence in **all of them.** But one department that, for the last four or five years, has been attempting to do all of these is the Chemical Engineering Department at the University of Florida. We might therefore properly ask the following questions:

What are the reasons for such a multiplicity of objectives?

What kind of results have been achieved?

JUSTIFICATION FOR BALANCE

A balanced department with multiple objectives is desirable at the University of Florida because of the following:

- It is the *only* department of chemical engineering in a state serving over six million people; it therefore feels a broad responsibility to provide a diversified and balanced program.

a department must recognize both academic and industrial professional goals . . . its achievements will never be easily measured by quantitative indices . . . an engineer is not merely a technical robot . . . the goal of the department, and that of the student it educates, must be the betterment of human society.

• Its tenured faculty in 1964 was already of above-average size; it was a diversified, heterogeneous and capable group that was brought together to do sponsored research under the Engineering and Industrial Experiment Station and partly to teach. It consisted of several people with degrees in chemistry (organic, biochemistry, pharmaceutical, inorganic and physical), a pulp and paper technologist, an authority on imbedding flowers in plastics, an expert on asphalt technology and economics, a world-famous fluorine chemist (and philosopher of science and education), and an electrochemist doing over $100,000 a year of research (much of it classified) on thermal batteries and fuel cells. Some of the faculty were interested only in undergraduate teaching, others only in sponsored research, still others in both activities. Its average age was 55 and there was only one assistant professor in the group.

• The new energetic and dynamic dean of the College of Engineering from 1964-68 strongly encouraged the development of the graduate program — both from the standpoint of increased enrollment, and also in terms of quality of research and instruction.

• It began participation in 1965 in an NSF Science Development (or "Center-of-Excellence") Grant that provided funds for bringing in new faculty and graduate students to do fundamental research in chemical engineering.

The diversity of faculty interests and backgrounds plus the strong leadership of the dean made it obligatory for the department to pursue multiple objectives — lest it suffer from internal conflict among its faculty or from an external gap between the objectives of the administration and those of the faculty. Hence the objectives of the department became balanced ones and diversified ones; *both* quality *and* quantity were needed in the graduate *and* undergraduate program; *both* theory *and* practice had to be emphasized; *both* teaching *and* research had to be acknowledged; both masters *and* PhD degrees had to be offered; and *both* service to the State and Nation as well as service to the engineering profession and to the academic community had to be a part of departmental philosophy.

To express these multiple goals in a cohesive philosophy became a first task of the new chairman when he arrived in June 1964. A statement of goals recognized the diversity of the chemical engineering profession through its strong roots in both chemistry and physics. This diversity meant that a chemical engineering department must recognize bifold professional goals: *academic* goals that strive for the advancement of fundamental knowledge and *industrial* (or professional) goals that have to do with the economical design and operation of plants that produce consumer goods (or of substances that go into making consumer products). *"Just as the overall aim of the University is to serve mankind,"* it further stated, *"so also the goal of the department, and that of the student it educates, must be the betterment of human society. For as a professional man, an engineer is not merely a technical robot who responds passively and unquestioningly to conformist pressures or to the commands of others.* Instead he must be aware of, and deeply concerned with the social and political problems of our times. He must have a high sense of values and be capable of making decisions with regard to principles and ideals derived from these, rather than from narrow self-interest or partisan group interest. In keeping with this philosophy, the department should investigate methods of establishing communications between the 'two cultures' of technology and the humanities."

Somewhat later the first annual report for the "Center of Excellence" Grant stated that "the goal of the chemical engineering department in the Science Development Program is to strive towards an excellence that is better expressed in terms of the significance of its contributions to scientific progress than by the volume of its activity. *Its achievements therefore will never be easily measured by quantitative indices—by numbers of students or faculty added, by the dollars worth of equipment purchased, by the number of papers in various journals, or by the number of degrees granted. We believe that the kind of excellence for which we strive cannot readily be programmed, budgeted or allocated on a yearly or semiannual basis. Nor can it be fully accomplished in a time space of one year or three years or even five years.*

"But seeds can be planted. Morale can be improved. Research ideas can be generated. New approaches to engineering education can be tried. A creative intellectual atmosphere can be developed. Bright, highly motivated people, both young and old, can be added to a faculty. A new life, energy, and enthusiasm can be breathed into a faculty with unfulfilled goals and unrealized potential.

GRADUATE ENROLLMENT TRIPLES

With the addition of a new chairman and three other faculty members, the chemical engineering department began its period of development in 1964-65 — one year prior to the award of the "Center of Excellence" grant. Although this development was greatly accelerated by the award of the grant, it was partially retarded by inadequate space and facilities. Until November, 1967, the department had been housed entirely in a crowded World War II airplane hangar which was shared with the Aerospace Engineering Department. Essentially no additional space was available for graduate students and research equipment, and faculty offices were not conducive to the recruitment of prominent senior faculty members. But in less than three years the department could point to the following accomplishments:

- **Revision of graduate and undergraduate curricula.**
- **Graduate enrollment nearly tripled increasing to 66.**
- **Undergraduate degree production increased 50%.**
- **Seven outstanding young faculty members with excellent backgrounds were added, decreasing the average age of the faculty from 55 to 44.**
- **Sponsored research support increased over 50%.**
- **Faculty research productivity in terms of papers submitted and published increased several fold. Two books were published and two others were started.**

Although the above quantitative increases may be startling, even more impressive were the indications of improvements in the *quality* of its graduate student body, its faculty, and its graduate program. In 1964, over half the 23 graduate students were foreign students, and roughly half were University of Florida graduates. The average Graduate Record Examination scores of that group was 550 or slightly above average. However of the group of 28 students admitted in Fall, 1967, all but two were graduates of American institutions other than the University of Florida. The first group of 22 who accepted appointments had an average Graduate Record Examination (Verbal-Quantitative Average) score of 654 — at least one standard deviation higher than in 1964. (Such a score meant that the *average* student was in the top 6-7% of the senior students throughout the nation who took the examination.)

Initially, the award of the "Center of Excellence" grant made possible a shift in the research emphasis of many of the older faculty members to more fundamental areas of research and away from the highly applied sponsored research projects previously emphasized under the Engineering and Industrial Experiment Station. As a result of this heightened interest, new proposals for fundamental research were written and nine new projects were accepted for support by various agencies such as the NSF, NIH, AEC, NASA and DOD. Thus stimulated, the face value of sponsored research nearly doubled and the annual rate increased by over 50%.

The increase in outside research support made available state funds for the addition of new faculty beyond the two positions allocated in the grant. (In addition to positions generated through research, one state supported position was obtained from the University.) The new faculty added were not only graduates of leading institutions; they were also generally among the top students to complete PhD work at their institution over a period of years. (Four of them had won NSF Fellowships in national competition.) Table 1 gives their backgrounds.

TABLE 1. FACULTY ADDITIONS SINCE 1964*

Name and Ph.D. School	Area	Other Background
A. W. Westerberg London	Computer-Aided Design	Control Data Cp. Princeton U. U. of Minnesota
L. E. Johns, Jr. Carnegie Tech	Polymer Dynamics Cont. Mech.	Dow Chemical
J. P. O'Connell Cal. Berkeley	Thermodynamics Transport Properties	Mass. Inst. Tech. Pomona Coll. Union Oil Co.
X. B. Reed, Jr. Minnesota	Bioengineering Appl. Math	U.C.L.A. Texas A & M
A. D. Randolph Iowa State (Now at U. Arizona)	Crystallization-Particulate Systems	Amer. Potash Spencer Chem. Co. Colorado U.
D. W. Kirmse Iowa State	Turbulence	Union Carbide Oklahoma State
K. E. Gubbins London	Transport Properties	Florida U. (Post Doc)
R. W. Fahien Purdue	Transport Processes in Reactors	Ethyl Corp. Iowa State U. Missouri (Rolla) Washington Univ.

*Ronald Gordon (Ph.D. expected from Princeton University) will join faculty in September 1969.

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THE GATORS GO

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"CENTER-OF-EXCELLENCE" GRANT

In August 1965, the University of Florida was awarded a 4.2 million dollar Science Development Grant by the National Science Foundation. The Chemical Engineering Department was among the seven participating departments in the University. The proposal submitted by the University was entitled "Radiation, Kinetics, and the Microstructure of Matter." The proposal stated that the first objective of the College of Engineering was "to improve the scientific base of education and research through increased emphasis on the engineering implications of the microstructure of matter." It pointed especially to the developing technology of microelectronics as "only one aspect of the very general field of microengineering which aims to place a strong emphasis upon the microscopic statistical view of nature and to relate this to human needs."

In keeping with this philosophy, the department defined and delineated the meaning of the phrase "microstructure of matter" from the standpoint of modern fundamental research in chemical engineering in terms of the following connotations:

1. MOLECULAR. This approach involves the use of a knowledge of statistical mechanics, molecular structure, and molecular and kinetic theory (a) to predict rates of chemical reaction either on catalyst surfaces or in homogeneous systems, (b) to predict adsorption rates, (c) to predict thermodynamic properties and phase equilibria, or (d) to predict transport properties such as diffusivity, thermal conductivity, or viscosity.

2. PARTICULATE. This approach analyzes particulate systems in terms of their statistical properties and the particle-continuum interaction. Such systems are found in industrial crystallizers and also include aerosols, mists, dispersions, and suspensions.

3. STATISTICAL. This approach is used to describe turbulent transport processes for energy, mass, and momentum in terms of elements in which fluctuations of velocity and other properties occur.

4. CONTINUUM. The microscopic view of matter can be thought of in terms of processes that occur at a point in a continuum. The conservation laws for energy, mass, and momentum can be expressed in terms of the differential equations of change.

Knowledge of matter from these microscopic points of view of course can be used in a given engineering system to predict macroscopic quantities such as the total energy or mass transport or the total friction or drag in a system. This information can be incorporated with modern design and optimization techniques in the design of an engineering system or a complete plant.

NEW BUILDING FOR DEPARTMENT

In the fall of 1967 the department was able to move into a modern air-conditioned educational building containing 51,000 sq. ft. of research and teaching facilities made possible by a State bond issue and funds from the NSF grant. We now have undergraduate teaching space for modern laboratories in process measurements, transport properties, instrumental process analysis, unit operations, process transients and control theory, chemical reaction kinetics, and individual special projects. Graduate research space is available in process dynamics and computer control, transport phenomena and properties, *in vivo* transport studies, fluid dynamics and rheology.

COMPUTER CONTROLLED LABORATORY

Modern computer facilities will permit one to control any of several pieces of process equipment in the unit operations laboratory. At present, a distillation column is being tied to a remote IBM 1070 process control terminal which connects to the IBM 360/65 campus computer via telephone lines. We have designed and are building a special interface between the process equipment and the terminal which serves two major functions. First of all it is a patch panel permitting any one of several processes to be "patched" into the terminal using special jacks and plugs. Its second function results from the fact that one can simulate most of the computer actions to the process and all of the process responses to the computer at the interface itself. One can thus almost completely "debug" the computer software without the process and to some extent "debug" the process hookup without the computer.

The remote computer terminal with interface can tie to 40 analog inputs (low and high level), 30 digital inputs, 24 digital outputs, 10 pulse motor outputs (which can operate in parallel), a digital display, and a rotary switch input station. The terminal's transmission rate is 66 characters per second to and from the computer which will permit about 4 random accesses per second or about 20 analog to 60 digital sequential accesses per second.

The software is written in Fortran and is quite modular permitting most of the essential portions to be used in all processes. The department also has two remote consoles for the IBM 360, a 60-amplifier Ease computer, and a WANG Calculator.

OTHER ACCOMPLISHMENTS

During the past three years, three different members of the faculty have won undergraduate teaching awards; Professor Tyner, Professor Gubbins, and Professor O'Connell. This year the Sigma Xi research award went to a chemical engineering graduate student and the Phi Kappa Phi award for the outstanding student in the University went to a chemical engineering junior. Last year the faculty published 20 papers, had 14 others accepted, and submitted 14. Two books were published, two accepted and two submitted.

CONCLUSION

If the goal of the department is an excellence that is not measured by quantitative indices, the above achievements are not in themselves sufficient indication that excellence has been attained. But they may indicate that the seeds of excellence have indeed been planted and have germinated. If these are now nurtured by additional support, the progress of the department toward excellence can continue — not only in its research program, not only in its instructional program, not only in the achievement of each of its multiple objectives, but also in the fulfillment of its ultimate aim: the betterment of human society.

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OPTIMIZATION: R. R. Hughes

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