Professor Cornelis Benjamin Biezeno (1888 –1975)

Cornelis Benjamin Biezeno was born in Delft on March 2, 1888, in the city where he was to spend all his active years. From his father, who was headmaster of a primary school, he inherited, and he demonstrated this at an early age, a natural disposition for and a great interest in both mathematics and music. In later years he was fond of reminiscing of his early life with his father, recalling his indebtedness to the stimulation he received from their many walks in the surroundings of Delft, talking about their common interests. It was a source of great satisfaction to both of them that the father was able to witness for so many years his son's work and the recognition which it has won both at home and abroad.

Biezeno graduated from secondary school when he was barely 16 years of age, and in September 1904 he enrolled in the Polytechnic Institute in Delft that was transformed into the present University of Technology a year later. The choice of this university was largely due to financial considerations, in view of the modest means at the disposal of a headmaster that would hardly have allowed for the considerable living expenses involved in a university education in another city. Mathematics was still Biezeno's primary interest, and he took the difficult examinations required for a teacher's certificate in mathematics nearly simultaneously with his preliminary

examination in mechanical engineering. His further study progressed also smoothly, and he obtained his degree as a mechanical engineer, with distinction, on June 15, 1909. During his years of study he also found ample time to develop his musical talents and he became an excellent piano player. Music has always provided him with the necessary distraction and it enabled him later to make his home a musical centre for students and university staff.

Upon graduation Biezeno was appointed to an assistantship, first in mechanical engineering and a few years later in the mathematics department. At that time these full-time jobs were not rewarded as well as in more recent years, and when Biezeno wanted to marry he had to supplement his income by teaching in evening classes at a Technical School in nearby Rotterdam. In spite of this heavy work-load he still found time to win a prize offered by the Mathematical Society in Amsterdam which operates under the slogan "Een onvermoeide arbeid komt alles te boven", freely translated as "indefatigable work will conquer anything". The prize was awarded for Biezeno's essay on the motion of a straight line when four of its points are constrained to remain in four prescribed planes.

Upon the unexpectedly early retirement of Professor van Iterson from the chair of applied mechanics in the Department of Mechanical Engineering Biezeno was entrusted with the teaching of applied mechanics in 1913, until the time when this vacancy should be filled. He acquitted himself of this task so well that he himself was appointed on this chair on 1 September 1914, at an unusually early age. His glowing oration on taking this office stressed the significance of mathematics as an auxiliary science for applied mechanics, an uncommon and not altogether welcome point of view in engineering circ1es at that time.

The young professor entered upon his new and responsible duties with great enthusiasm. From the start he carried his audience away with his sparkling lectures, which many generations of students remember with gratitude. His influence on all students and engineers who had the privilege of attending his lectures can hardly be overrated. The widespread feelings of indebtedness and gratitude were manifested at his farewell lecture in 1958, attended by many hundreds of former students most of whom had to follow this event by closed-circuit television, because no lecture room of the required size was available.

Biezeno's teaching left its impress on all research in mechanical engineering, naval architecture and aeronautical engineering in the Netherlands, more so than he realized himself, and also far more than the relatively small group of students in his own subject, applied mechanics, would suggest. No more than 8 engineers obtained their doctor's degree under his guidance. This small number is largely due to the circumstance that the writing of a doctoral thesis was uncommon in the University of Technology in the years prior to World War 2, but it also reflects the high standard Biezeno maintained in sponsoring a thesis. Equally important as his own teaching was his influence on the curriculum. He played an essential role in the appointment of J. M. Burgers as the first professor of fluid mechanics and in the inclusion of this discipline in the curriculum for mechanical engineering.

He served the department on numerous committees, and also in more official positions as secretary and chairman. On a wider scale he served the University, first as its Rector Magnificus in the academic year 1937-38. After the war he was appointed chairman of the Engineering Section of the Government Committee for the Reorganisation of University Education. One of the steps proposed for a more effective educational management of universities was the appointment of a Rector Magnificus not on a yearly basis but for a term of five years. Biezeno was so appointed early in 1949, and he took this office on an understanding with the Senate to introduce a number of reforms aiming at an increased efficiency of university education, both from the point

of view of the time spent by students at the university, and of the heavily increased Government expenditure. Strong opposition by many students, who regarded these reforms as an infringement on their liberty of study, or perhaps rather their freedom not to study seriously, led to a dwindling support of Biezeno in the Senate, and he felt compelled to resign after scarcely two years of office. This disappointment, and in particular what he felt as a betrayal by his colleagues, undermined his strength seriously, and he never recovered completely from this blow. It was indeed the first significant set-back in his professional life, and it occurred at an age when most people have lost much of their resilience of earlier years.

Biezeno retained his early interest in geometry all his life, and he always preferred geometric concepts and a vizualisation of mechanical phenomena. The abstraction of energy principles never appealed to him, although he was willing to employ them where necessary, but never beyond the actual need. This is strikingly evident from his fundamental joint work with R. Grammel "Technische Dynamik". The first basic chapter "Fundamental laws of elastomechanics" contains no reference at all to the concept of work, and the second chapter on general theorems does not even mention the basic principle of virtual work in continuum mechanics. As a most conscientious and hard worker himself, he apparently abhorred even the notion of "virtual" work in science.

In the first decade of his professorship Biezeno's research was mostly in the field of graphical statics. The needs of most engineers, and the drawing-board as the most significant tool at their disposal, coincided here with his own preference for a geometric approach to problems of mechanics. In the same period he gave considerable time to a study of analytical methods, still evident from pencilled penetrating questions and comments in older books, in particular in the important volume of the Encyklopädie der mathematischen Wissenschaften and in Love's famous treatise on elasticity. The advent of desk calculators in the twenties persuaded him gradually to move to more analytical approaches that allow a better accuracy in their evaluation than graphical methods. A basic characteristic of all his work, however, has always remained his insistence on an adequate numerical evaluation of the results of analysis. He never lost sight of the subservient role of mechanics as an aid to the engineering profession.

During the twenties and thirties an increasingly close collaboration developed between Biezeno and his former student and later colleague J. J. Koch. They formed indeed the ideal team for effective research in applied mechanics. Koch's uncanny intuition with respect to physical and mechanical phenomena was thus combined with Biezeno's sharp mathematical mind, and the latter also always bore the burden to prepare their joint work for publication in a form accessible to engineers. Equally important was the support given by Biezeno to Koch's experimental work. It was no easy matter in the lean thirties to obtain funds for even the most modest equipment, and the Laboratory of Engineering Mechanics in Delft would never have materialized if Koch's ideas and initiative had not been wholeheartedly supported by Biezeno's drive and fighting spirit.

The same drive was employed in setting up a working group for stress analysis and vibration research within the Organisation for Applied Scientific Research. The need of such a group arose out of an increasing demand for consulting work that a small university department could hardly meet. This working group has now developed into a most effective research establishment, in the immediate proximity of the laboratory of engineering mechanics, under the name TNO Institute for Mechanical Constructions, employing a staff of more than 100 people, including 29 university graduates. After his retirement as head of the working group Biezeno continued as a most influential adviser of the Institute.

Space does not permit a detailed discussion of Biezeno's scientific work. **Buckling problems occupied a**

considerable part of his attention, and he made in collaboration with H. Hencky a fundamental contribution. The three-dimensional theory of neutral equilibrium had been formulated by R. V. Southwell in 1913 in cases where the initial state of stress is homogeneous. The method of analysis employed by Southwell is not easily extended to the general case of an inhomogeneous state of stress. Biezeno and Hencky therefore chose a completely different approach, and their analysis is indeed again typical of Biezeno's approach to all problems of applied mechanics by its careful exploitation of geometric concepts. Simpler but no more accurate descriptions of neutral equilibrium have been developed in later years, and the only application of the equations of Biezeno and Hencky of whlch we are aware is Van der Neut's thesis on buckling of spherical shells.

Biezeno was well aware of the essentially nonlinear aspects of the problems of elastic stability and buckling. The equations of neutral equilibrium purposely ignore these wider aspects that would lead to equations too cumbersome for any application. In special cases, for example shallow arches, and slightly curved circular plates, the nonlinear problem is more tractable, and Biezeno made the first significant contributions to these snap-buckling problems. He also sponsored a thesis by one of his students in which the nonlinear theory of elastic stability was approached by an appeal to energy principles, in the footsteps of his close friend E. Trefftz, even if this type of approach was foreign to his own nature.

After a meeting of scientists in fluid mechanics in Innsbruck in 1922 Theodore von Kármán proposed that the entire field of applied mechanics would be served well by regular international conferences. Biezeno and J. M. Burgers accepted the challenge to organize the first International Congress of Applied Mechanics in Delft in 1924. This meeting was an outstanding success, and it had far-reaching consequences. The fourteenth Congress in this series, normally held at intervals of four years, will again be in Delft, August 30-September 4, 1976. It is sad that Biezeno has not lived long enough to witness this return of the Congress to the city where he presided over the first one. There is no question about the significant impulses that the Congresses of Mechanics and its daughter, the International Union of Theoretical and Applied Mechanics, have given to an effective international collaboration in this field of science. More important, however, are the many friendships and personal relations that have developed in these Meetings, surviving even the unparalleled strains of the last world war. The names of several friends of Biezeno have already occurred quite naturally in this report on his life and work. Here we mention only again the most influential monumental work "Technische Dynamik", written jointly with R. Grammel, which appeared just before World War 2. It was translated into English, Russian, Spanish and Japanese, and the German second edition was again reprinted recently.

This story would not be complete without mention of Biezeno's harmonious marriage and of the most important role his wife has played, both in his private and professional life. More than anyone else she was the central figure in the first Congress of Applied Mechanics. As an accomplished singer she contributed to the further development of his musical qualities. Their home in Delft became a beloved centre for students with a musical interest. The gratitude for this side of their activities was demonstrated in a unique fashion on the occasion of his 40-years' jubilee as a university professor. Faculty and students joined forces to form an orchestra that gave an impressive performance in the Prinsenhof Museum, the most venerable place in Delft where such a manifestation could be held.

Biezeno's achievements have been widely recognized, both at home and abroad. He cherished in particular the honour's degree awarded him by the University of Amsterdam on the occasion of its third centennial in 1932, the time when he was at the height of his creative powers. He was elected a member of the Royal Netherlands Academy of Sciences in 1939, and he attended their meetings with great interest until his health made travel more difficult. In the post-war years he was also awarded honorary degrees by the Universities of Brussels and

Gent. Official recognition came his way by his appointment as Knight of the Netherlands Lion in 1949 and the rare distinction of Commander in the Order of Orange-Nassau after his retirement when the new and expanded Laboratory of Engineering Mechanics in Delft was opened officially. The international community of scientists in mechanics, and the Netherlands world of engineering science, including our Academy, have lost a good and true friend who will be remembered for a long time to come.

---by W. T. Koiter, Levensbericht C.B. Biezeno, in: Jaarboek, 1975, Amsterdam, pp. 193-197, Huygens Institute - Royal Netherlands Academy of Arts and Sciences (KNAW)