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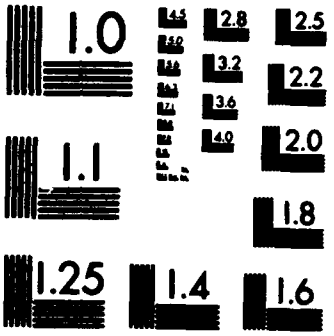

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Fluid Mechanics at the Middle East Technical University and the Istanbul Technical University

Eugene F. Brown

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In surveying the fluid mechanics activity and facilities at two Turkish universities, the author documents the status of the research at these institutions and also reveals the apparent difficulties inherent in the effort to establish satisfactory research activity in a developing country such as Turkey.

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FLUID MECHANICS AT THE MIDDLE EAST TECHNICAL UNIVERSITY AND THE ISTANBUL TECHNICAL UNIVERSITY

1 THE MIDDLE EAST TECHNICAL UNIVERSITY

The Middle East Technical University (METU) is located in Ankara, Turkey. It was founded in 1956 with assistance from the United Nations Educational Scientific and Cultural Organization (UNESCO) to train professionals to serve Turkey in the areas of housing and urban planning. It was quite fitting that the first college at METU was the School of Architecture and City Planning, and when the new campus was built in 1962, that the first building housed the faculty of architecture. Just celebrating its 30th anniversary, the university now accounts for 18,000 students representing five colleges including the faculties of architecture, economic and administrative sciences, arts and sciences, education, and engineering.

METU is set up along the lines of an American university including such features as college athletic facilities, dormitories, a student center, and a faculty senate. Even the language of instruction is English. In addition, METU has its own English language journal, *The METU Journal of Pure and Applied Sciences*. The connection with the US is made even stronger by the fact that 80 percent of the faculty have obtained their doctorates from American universities.

The College of Engineering consists of 14 departments including the departments of chemical, civil, computer, electrical and electronic, environmental, industrial, geological, mechanical, metallurgical, mining, petroleum, food engineering, engineering sciences, and aeronautical engineering. At the present time the College of Engineering includes 240 staff members, 900 M.S. and Ph.D. candidates, and 9000 undergraduates.

The reason for my visit was to collect information about METU's fluid mechanics activities. This is found in three departments: mechanical engineering, civil engineering, and the newly formed Department of Aeronautical Engineering. The mechanical and civil engineering departments are of about equal size, with 25 faculty, and 130 M.S. students and Ph.D. candidates. The Department of Aeronautical Engineering is much smaller, having graduated its first class in 1984. It has four faculty; however, it is actively recruiting more.

At METU, the M.S. program is extremely popular with about 50 percent of the graduating class enrolling in the 2-year program; attractive incentives are provided by Turkish industries to those obtaining this degree. METU candidates are highly sought-after because of their facility with the English language--usually obtained during the course of their studies. Only about a tenth of these students go on into the Ph.D. program. I was told that this was because Turkish industry has not yet recognized the value of the Ph.D. and that prospective employees holding this degree are therefore not offered salaries significantly greater than those offered to students with M.S. degrees. Instead, the students view the Ph.D. primarily as a passport to an academic position, where the low salary level (one-third of that offered by private industry) discourages many students from following this path.

The lack of importance placed by Turkish industry on the Ph.D. degree is indicative of the level of importance which private industry places on research in general. Perhaps this is not too surprising in a developing nation which traditionally has contented itself with copying designs provided by its European neighbors. Several of the engineering faculty with whom I spoke expressed strong dissatisfaction with this attitude. They reported that in some cases the designs copied are far from current. One engineer cited as an example, that the Fiat automobiles being manufactured under license in Turkey are technologically inferior to those being produced in western Europe. Not unsurprisingly, the engineer said, Fiat is unwilling to export its most recent technology to Turkey when a technologically inferior vehicle will still sell in the local market.

The days in which such a product will satisfy Turkish needs may well be numbered. This is because in 3 years

Turkey plans to become a member of the European Economic Community. This means that Turkish industry, if it is to survive, needs to produce products which are technologically equivalent to those made in western Europe. Without placing increased importance on industrial research, Turkey may well find itself in 3 years unable to compete with the rest of western Europe, even within its own borders.

In fact, the need to catch up to western technology has already been seen in connection with the recently signed F-16 agreement which in a few years will see these aircraft being produced in Turkey under license to General Dynamics. As a part of the contract, General Dynamics is offering a considerable amount of valuable computer aided design (CAD) software. One engineering faculty member with whom I spoke expressed dismay that there was almost no one in Turkish industries who could understand, much less use, these programs.

As a consequence of situations such as these, several engineering faculty members with whom I spoke expressed a strong dedication to the development of research programs within their engineering departments which would build up a base of familiarity and experience with western technology so that when Turkish industry recognizes the need to bring their products up to western standards, the expertise would be available to help them to do this. As a consequence, the research projects currently being carried on in fluid mechanics were of a strongly applied rather than fundamental character. In fact, a better term might be "engineering studies" or "projects" rather than research. This was particularly characteristic of projects which I saw in the areas of turbomachinery and internal combustion engines in the Department of Mechanical Engineering.

Recognizing that fundamental research in fluid mechanics is at the present time inconsistent with the needs of the country, it is perhaps well worth asking if the university has at its disposal resources which would enable it to accomplish its applied research mission. The answer, sadly, is no. As might be expected, little industrial money is available. In fact, industrial support accounts for only 6 percent of the research expenditures of the faculty of engineering. Additional support comes from the Turkish National Science Foundation (TUBITAK), but this is sufficient to purchase only a small amount of much-needed instrumentation. In fact, the faculty relies heavily on home-built instrumentation, home-built educational and research equipment (such as a 4-stage axial flow compressor), and homemade data acquisition systems. Not only is their inventory of instrumentation extremely limited (I did not see a single laser Doppler anemometer (LDA) system in the course of my visits), it is almost impossible for them to maintain the small amount of research instrumentation which they have. For example, for months they have had disk problems with their small DEC MINC 23 data acquisition system. Despite payments already made to the distributor they have not been able to get technicians to come out and fix the problem. As a consequence of this and similar experiences, faculty have come to hoard the little instrumentation which they have and are extremely reluctant to share it with colleagues for fear that if it is returned in unserviceable condition the chances are slim that it can ever be repaired. This hoarding, of course, makes the problem of limited instrumentation even worse.

The lack of modern instrumentation affects METU's research program in two ways. First, without high-frequency-response transducers and LDA equipment, it is virtually impossible for them to collect data on most fluid mechanics problems of current engineering interest. Secondly, the brightest Turkish graduates quickly size up this situation and leave for the US for their postgraduate studies. This leaves Turkey without either the equipment or the personnel to carry on a modern research program.

The aerospace business seems to be an area in which Turkish involvement will continue to grow. In acknowledgement of this, the new Department of Aeronautical

Engineering was founded. Its head--who was my host during my visit--is Professor C. Ciray who formerly headed the hydraulics program in the Department of Civil Engineering. Professor Ciray is well known in the fluid mechanics area through his own pioneering research in the area of rotating hot-wire measurements (Ciray, 1969), his turbulent wall shear stress technique (Ciray, 1970), and his contributions to the field of applied mathematics in the area of the solution of large sets of nonlinear algebraic equations (Ciray, 1972). In addition, he brings to his newly formed department good connections with the North Atlantic Treaty Organization (NATO) through his service on the Advisory Group for Aeronautical Research and Development (AGARD) Fluid Dynamics Panel.

Being a new department and with only a small number of permanent staff members, the Department of Aeronautical Engineering depends heavily upon other departments, not only to fulfill its teaching responsibilities but also for laboratory facilities. In this regard, connections with the mechanical engineering and civil engineering departments are particularly close.

At the present time, the department's principal research facility is a large subsonic wind tunnel having a test section of 6×1.5 m and velocities ranging from 0.25 to 25 m/s. In addition, the department has two small, open-return subsonic wind tunnels with test sections of approximately 0.5×0.5 m^2 cross section for oscillating airfoil and boundary layer studies. Both of the small wind tunnels are equipped with adaptive walls to provide proper free-stream conditions. In the boundary-layer experiments, work is being done on the combined effect of pressure gradient and free-stream turbulence level on boundary layer characteristics in support of the AGARD Working Group (WG) 9 on transition and boundary layer characteristics. These experiments will be aided by a Scanivalve pressure measuring system recently donated by Deutsche Forschung und Versuchanstalt fÜr Luft und Raumfahrt (DFVLR) and a recently arrived Victor-9000-based data acquisition system. It is hoped to develop a 4-channel data acquisition system with frequency response up to 5000 Hz.

Ciray is actively recruiting faculty members for his department. His job is not made easy by the fact that talented young people, when he can find them, can triple their salaries by accepting an industrial position instead. Nevertheless, there are enough people of sufficient financial independence and a strong personal commitment to the Turkish nation for Professor Ciray to have a reasonable hope of eventually filling his vacant positions. A good example is Professor I. Akmandor. He joined the department last year after completing his doctorate and 1 year of postdoctoral studies at the Massachusetts Institute of Technology. His interests are in subsonic and supersonic reacting flows, the aerodynamics of wing-body interactions, and high angle-of-attack flows.

Turkey must capitalize on the talents of people such as Akmandor. Unfortunately, there is a strong possibility that this will not take place. Of greatest concern to me is the almost complete lack of travel money made available to METU faculty. Because of this, there is a distinct possibility that people like Akmandor will lose contact with their US colleagues and be reduced to depending upon the published literature for the stimulation and guidance of their research programs. Such isolation from the US (and European) research communities is almost guaranteed to keep Turkey a decade behind in their research and development programs.

As I left, the Dean of the Faculty of Engineering, Professor A. Birand, asked me if I knew of any US source of funds to sponsor visits of Turkish scientists and engineers to the US for the purpose of exchanging technical information or attending meetings. There are cooperative research programs sponsored by NATO, and the NSF has plans to extend their international activities--but I know of no sources of short-term travel support. If you or any of your colleagues

know of any sources which I have overlooked, I would very much appreciate hearing from you.

2 ISTANBUL TECHNICAL UNIVERSITY

The fluid mechanics activities at the Istanbul Technical University (ITU) are contained within the Mechanical Engineering Department, located on the downtown Gümüssuyu campus, and the Aeronautics and Astronautics Department located on the main Ayazaga campus approximately 10 miles northeast of the city center. ITU and METU are approximately the same size; however, ITU predates METU by almost 200 years, having been founded in 1773.

It was no surprise that the engineering faculty face many of the same problems and frustrations I encountered in discussions at METU. These included low salaries, industrial and governmental suspicion of the importance of research, limited travel funds, and a shortage of instrumentation.

However, at ITU, unlike METU, the language of instruction is Turkish, and only a small number (10 percent) of the faculty have obtained their degrees from overseas universities. Their use of Turkish as the language of instruction has recently caused some problems due to the emergence of universities such as METU, which offer instruction in English. As I indicated above, Turkish industry is now placing a high importance on its engineers having competence in the English language and their recruiting for new employees often expresses this as a requirement. There are those who claim that ITU has a national commitment to promote Turkish as a technical language and should refuse to change regardless of the pressures of the market-place. Others have advocated adopting the course of more recently established universities. Attempting to produce marketable graduates has prompted a good deal of soul searching at ITU. Finally, a compromise was worked out in which ITU will begin offering 50 percent of its programs in English.

At ITU the familiar problem of obtaining repair and maintenance service for scientific instrumentation re-emerged in a slightly different light. The aeronautical and astronautical engineering department's new trisonic, (subsonic-transonic-supersonic) wind tunnel has stood idle for 2 years now because of the refusal of the local IBM distributor to service the computer which controls the tunnel's operation. In fact, this $1 million facility, designed by Sessia in France, has been plagued with difficulties from the very beginning. At this stage, the tunnel is complete, but inoperable. It has taken more than 7 years to reach this point with the delays attributable in almost equal measure to the Turks and the French. It is hoped that this facility will eventually be put in operation in 4 months with the arrival of a new IBM-PC-based computer which will replace the IBM Series-1 computer originally supplied with the tunnel.

When this facility is finally commissioned, ITU will have the finest wind tunnel in Turkey. It is a 50-bar, blow-down wind tunnel with operating times which range from 0.5 to 2.00 minutes at Mach numbers ranging from 0.4 to 4. The test section is 30×60 mm with perforated walls to minimize interference effects.

The Aeronautical and Astronautical Engineering Department, just like that at METU, was only recently established. The department is much larger than the one at METU, having a faculty of 21, 263 undergraduates, and 17 graduate students. The head of the department is Professor M. Dökmegi who obtained his Ph.D. from Cornell University. His department is unusual in that unlike the rest of the university, the majority of the faculty have obtained their degrees from US universities including Stanford, Cornell, Lehigh, Duke, and Berkeley.

Some of the interesting work being done in the department is:

- An experimental study of glancing shock-wave/boundary-layer interaction at a Mach number of 2.2 using a small suction-type, atmospheric wind tunnel.
- An experimental study of the wake behind a wing/body at high angle of attack at subsonic Mach numbers using a 50×50 cm^2 low-speed wind tunnel (Ozcan and Olcmen, 1986).

- An experimental study and discrete vortex calculation of unsteady vortex leading/trailing edge interactions (Kaykayoglu and Rockwell, 1986).

Just as at METU the virtually non-existent travel budget and lack of modern instrumentation make it difficult for the young people doing this research to remain professionally competent. At the same time, the pitifully low salaries (one faculty member told me that he now earns less as a department head than he earned 23 years ago as a part-time graduate student in the US) make it difficult to add new faculty. It is hard to be optimistic about the future of fluid mechanics research in Turkey.

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