

Engineering and Engineering Education in Egypt

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Early French Influences

Modern engineering education in Egypt started in the aftermath of the French Expedition led by Napoleon Bonaparte which occupied Egypt from 1798 to 1801. Governing from 1805 to 1848, Mohamed Aly, the founder of Egypt's Royal Dynasty, sought to implement a 'new order' in the administration of the State he inherited from the Ottoman Empire by introducing a Western-style bureaucracy, an imperial soldiery, a system of taxation to support the army, and development of agricultural technologies. French military engineers proved to be very important in Aly's desire to modernize the State. As Timothy Mitchell, Director of the Center for Near Eastern Studies at New York University, explains,

“After the fall of the [Napoleonic] Empire in 1815, defeated officers and engineers of the French armies made their way to Egypt, where the new order was to be established with their help. Egypt was the first province of the Ottoman Empire to introduce successfully the new kind of army The new military order included more than a dozen schools for training specialized military cadres including . . . engineers. Most of them were administered by French and Egyptian military engineers and scholars, many of whom had been trained at the Ecole Polytechnique in Paris, including several disciples of Saint Simon and his secretary Auguste Comte” [1, pp.36-39].

French influence also came via Egyptian students sent to study at the Ecole Polytechnique in Paris. Returning from their first mission in 1826, these students formed the nucleus of the new Egyptian engineering community. Moreover, between 1833 and 1851, the installation into positions of leadership of other disciples of St. Simon, with their strong engineering background, further emphasized the French presence in engineering education and practice. One of them, Lambert Bey, was the Director of the School of Engineering from 1838 to 1851. Moreover French-trained engineers designed and supervised the construction of the Delta Dam Barrages and contributed the first plans of the Suez Canal [2].

With the help of Egyptian engineers educated abroad, French engineers implemented a plan, as Mitchell elaborates, for “a system of private ownership in Egypt, on which production for the European market would depend,” which included the reconstruction of villages, the production of statistical knowledge about population and natural resources, and the construction of infrastructure projects [1, pp. 44-50]. Building an agricultural economy, supported by a significant water irrigation infrastructure, was key for the

modernization of the state. As Clement H. Moore, Professor of Middle East Studies at University of Texas-Austin, explains, “To finance his military and political designs, Mohamed Aly introduced long-staple cotton to the Nile delta and built the first modern (Scottish-designed) barrage to increase water supply. The production of cash crops increased twelvefold from 1832 to 1872, generating a surplus that might have been converted into self-sustaining industrial expansion. Engineering became vital to Egypt, and by 1882 the irrigation specialists were largely Egyptian” [3, p. 24].

To supply the ‘new order’ with engineers, Aly’s government established the first School of Engineering in 1816, located in Saladin's Citadel, as well as a regular school in Bulak (Cairo). In 1858, two new engineering schools were created under the government of Ismail (1848-1863) who, even more so than his grandfather Mohamed Aly, wanted to model Egyptian institutions after those in France. Located at the Delta Barrage, north of Cairo, the first of the new schools was dedicated to irrigation while the second, housed in the Citadel, specialized in architecture. They were replaced in 1866 by a single school that included both disciplines: the School of Irrigation and Architecture. Following the French model of the Ecole Polytechnique and Ecole des Mines, the school curricula privileged theoretical studies, especially mathematics. However, soon the Ecole Centrale des Arts et Manufactures proved a more adequate model since its curriculum was more geared toward industry.

Influence of the British

The arrival of a British occupation force in 1882, motivated by its imperial desires to secure a route to India and to make Egypt a supplier of cotton and an open market for British products, marked the beginning of the end of direct French influence in engineering education and the emergence of a model styled after the British. It also hindered Egypt’s industrial development initiated by Mohamed Ali. “Occupying Egypt primarily to secure her route to India,” explains Donald.M. Reid, historian of modern Egyptian politics at the University of North Carolina, “England wanted to keep the country quiet, minimize European objections to her policies by repaying European creditors, and make Egypt pay for its own occupation” [4, p. 18]. Accordingly, in 1886, under the regressive educational policies of Lord Cromer, the autocratic British Consul General in Egypt from 1883 to 1907, the Ministry of Education and the Ministry of Public Works established new by-laws for the School of Irrigation and Architecture. The new by-laws established tuition fees, limiting access to the School, and replaced French instructors with British ones who emphasized practice over theory in order to prepare its graduates to contribute to maximizing the output of the cotton crop. British irrigation engineers came to supervise the Ministries and the School despite the presence of qualified Egyptian engineers [5].

With growing economic and geopolitical interests in Egypt, the British supported establishment of the Royal School of Engineering in 1902 to supply the ministries with the necessary technical workforce. British influence in instruction, with its emphasis on workshop training and apprenticeship, was evident at the Royal School. However, the lack of industrial workshops in Egypt forced the School to build its own. One outcome was to continue a model of engineering education entirely in schools, as Moore later lamented:

In Egypt, students of engineering have no opportunities, as their colleagues have in England, of being trained for practices in places other than the School of Engineering... This unfortunate situation prevents students from undergoing an apprenticeship, and the School is compelled, in the circumstances, to consider not only the scientific preparation of students, but, at the same time, their introduction into practical engineering. The graduates, who, in their majority, are appointed to government jobs, must be able to do, straightaway, useful practical engineering work...[Consequently] the School was forced to provide [workshops] within its premises” [3, p. 62].

The British maintained political control in both Egypt and Sudan, in part, by controlling the waters of the Nile. The effect was sometimes to put Egyptian engineers in a difficult position between British interests and engineering work. For example, when the Royal Society of Egyptian Engineers was created in 1920, the government compelled its leader to manage technical criticisms of water projects coming from the growing community of nationalist politicians and engineers. When the Jebel Awlia Dam was constructed in Sudan, for example, another founding engineer of the Society and later a member of Parliament, Hafiz Ramadan, offered no technical objections but, as Moore explains, expressed concern about the political dimensions: “The engineering sciences have some fixed principles which cannot be disputed. But I have many reservations concerning the political implications of this project Many politicians use technical discussion to hide their political motives...Some people may say that Britain has nothing to do with the whole project... [but] the British government hides behind technical advisors in our Ministry of Public Works. This way the Egyptian government will seem to be the one who is calling for the project, not Britain”[3, p. 150].

Initial Influence of Nationalism

After World War I, a nationalist movement in Egypt (the Wafd party) increased demands for independence from British control. Witnessing the nationalist unrest of the 1919 Revolution but reluctant to lose control over the Suez Canal, the British maintained their occupation of Egypt but compromised with nationalist demands by declaring it an independent monarchy and allowing Fuad I to become King (1922-1936). Reserving the right to intervene in Egyptian affairs but yielding to the growing nationalism, the British trusted King Fuad’s resistance to republicanism and redirected their interests away from the Egyptian University (later renamed Cairo University) and the Royal School of Engineering. Drawing on his own continental European education, King Fuad decided to reduce British influence and highlight Egypt’s Greek heritage and continental European institutions at both schools[4]. Following three British directors from 1902 to 1924, Dr. Charles Andrea, a former professor and dean of the Zurich School of Engineering, was chosen to direct the Royal School of Engineering from 1928 to 1937. He introduced new curricula and built a large number of labs and workshops, and reorganized the curriculum to include five departments: Irrigation, Architecture, Public Works, Mechanical and Electrical Engineering [6]. In 1935, the Royal School was incorporated as the Faculty of Engineering in Cairo University. It remained the sole Faculty of Engineering in Egypt until the creation of the Faculty of Engineering of Alexandria University in 1942.

The post-World War II period marked the reorganization of the engineering profession with the creation of the Engineering Syndicate in 1946-9. Moving away from the British-styled Royal Society, key engineers in King Faruq's government (1936-52), such as Minister of Public Works Osman Muharram, drafted legislation to create a syndicate that would provide engineers with a pension and annuity system. A pension system for all civil servants had been revoked in 1930, during the early stages of the Depression [3, p. 29]. However, as Moore explains, "the syndicate never succeeded in getting legislation passed to define activities in either government or the private sector. It was never allowed to organize joint employment contract[s] for engineers inspecting various companies, banks, and contracting agencies to enforce existing legislation. Indeed the syndicate never seemed to have regulated the profession the way a bar or medical association might, by disbarring an incompetent or negligent engineer from practice" [3, p. 35]. The promise of a pension, along with professional recognition and a growing sense of nationalism, led more than 70% of engineering graduates to join the Syndicate. Social status was particularly important in the growth of the Syndicate. "Creating the syndicate," reports Moore, involved legally defining an engineer or specifying, in other words, who had the right to add to his name the prestigious title *Muhandis*. The custom of being addressed as 'Engineer so-and-so' had no precedent in either the French or British traditions that had developed Egyptian engineering, but it survived in Egypt on the grounds that the title is exactly similar to the title of Doctor used by physicians" [3, p. 32]. By the end of the 1940s, Egyptian engineering education and practice had moved away from British interests and begun to address the needs of an emerging nation.

Supporting a New Nation

With the support of the Free Officers, a secret nationalist and revolutionary society that opposed British influence in Egypt and monarchic rule, Gamal Abdel Nasser forced the abdication of King Faruq in 1952. After Egypt proclaimed itself a republic in 1953, Nasser proposed intensive industrialization, the nationalization of the Suez Canal, natural-resource exploitation to fund the domestic economy, and construction of an impressive water and energy infrastructure, including the Aswan Dam.

Seeking large number of workers to carry out these projects, Nasser's educational policies were aimed at reforming higher education to produce new high levels of technical workforce with an emphasis on three main technical branches: engineering, commerce, and agriculture. This emphasis was key to the rapid creation of new faculties and a nearly 400% increase in the higher education community between 1952 and 1969 [7, p. 432]. Furthermore, as Reid elaborates, Nasser and other Free Officers believed that "[p]rogressive army officers and expert technicians, not civilian humanists or lawyer-politicians, would lead Egypt into the industrial promised land" [4, p. 189]. And as explained by Ninette S. Fahmy, Lecturer in Politics and Public Administration at the Sadat Academy for Management Sciences in Cairo, engineers under Nasser "gained a prestige they had never acquired before. Two major factors, Nasser's close relationship with the Engineering Corps and his industrialization drive, account for their ascendancy to this advantageous position . . ." [8, pp.127-8]. No longer able nor wanting to rely exclusively on the production of elite graduates from the Faculty of Engineering at Cairo University, Nasser's administration founded eleven new technical institutes, eventually increasing the production of engineers from 4,000 to 25,000 [7].

Nasser, along with Joseph Broz Tito of Yugoslavia and Jawaharlal Nehru of India, supported the creation of the non-aligned countries to counteract American and Soviet geopolitical dominance while promoting sovereignty and economic development in the then called Third World. This non-alignment allowed Nasser to seek aid and models for technical education from both capitalist and socialist countries without having to declare alliance with either bloc. As a result, both West German and Soviet technical aid and models of engineering education entered Egypt via large projects such as the Aswan High Dam and new technical institutes, ending the longstanding privileged positions in engineering education held by models adapted from the French and British. In India, Nehru had imported technical institutes from Germany and the Soviet Union, calling them “the temples of modern India” and considering them key features of his socialist project [4, p. 192]. Sharing Nehru’s faith in modern science and technology to achieve both nationalist and socialist objectives, Nasser followed a similar path. The establishment of technical institutes should also be understood in relation to the Cold War. West Germany used technical aid, including the technical institutes, as a foreign policy tool to isolate East Germany from establishing relations with oil-rich countries, help develop the Third World, and advance Germany’s image as a technologically advanced society: “Confident in Germany’s image as a technologically innovative society,” explains William G. Gray, Professor of 20th Century European History at Purdue University, “Adenauer’s government offered scholarships for training in Germany’s factories and vocational schools and, in some cases, even built and staffed industrial training centers in developing countries. To West German officials, technical assistance appeared to be a suitable means of advancing the Third World toward self-reliance...By the mid-1960 the Federal Republic has opened trade schools or workshops in 31 cities throughout the developing world, including Cairo and Aleppo in UAR [Egypt’s name at the time], New Delhi and Madras in India, and Colombo in Ceylon. These were sites of intense competition with the GDR”[9].

In theory, the development of technical institutes alongside the universities was supposed to produce two distinctly different types of engineer: a research-oriented university graduate and an applied engineer for industry. University faculties, particularly at Cairo University, were supposed to graduate engineers for government and research positions. On the other side, the higher institutes were supposed to offer three-year programs and introduce shorter courses to convert more high school graduates into technicians in order to account for the growing need for highly specialized personnel. Ultimately, technical high schools and on-the-job training would replace the higher institutes and shorter academic programs [3, p. 66].

However, the challenges of Egypt’s social and political realities dictated a different future for this differentiated system of higher technical education. First, Nasser ordered open admission to the university for all high school graduates qualified for higher education, bringing unprecedented numbers of students to the doorsteps of university engineering programs. Second, attracted by the higher status of university degrees, particularly in engineering, parents, students and teachers pressured officials to include additional years of schooling in the higher institutes to make their degrees equivalent to university degrees. Third, Nasser decreed that the government had to employ every college graduate, irrespective of functional activity, creating a huge demand for engineers that would, nonetheless, prove difficult to sustain [3, p. 78].

As a result, from the 1950s to the 1970s, the technical education offered at higher technical institutes was transformed into a university education. New curricula supplemented an existing focus on workshop experience with a new emphasis on micro-specialization brought from the Soviet Union. Indeed, in 1950 the Higher Institute of Applied Engineering, which was supposed to train technicians, became another faculty of engineering at Ain Shams University [3, p. 65]. In the 1970s Helwan Technical Institute, funded by West Germany, became the Faculty of Engineering at Helwan University situated in the south of Cairo and an Engineering Institute, first created in Shubra (Cairo) to serve African students as part of Nasser's support for the emancipation of African countries, was integrated into the University of Zagazig at Behna.

Both types of institutions experienced great demand from students, for at a time when Egypt needed more technicians, aspiring students and their parents wanted the recognition brought by an engineering degree.

By the 1960s, most aspiring technicians and engineers became university men and women. Two effects were to create a surplus of degreed engineers within Egypt and to increase the migration of Egyptian engineers to other Arab countries. The movement of technical experts to other Arab countries served Nasser's project of Pan Arabism. Pan Arabism also stimulated the flow of Arab students into Egypt. Whereas Al-Azhar University, as an important center for Islamic learning, drew students from Nigeria and as far away as Indonesia, Cairo University's foreign enrollment was dominated by Sudanese and Palestinians, with Saudis, Syrians, Iraqis, and Lebanese making up much of the remainder [4, p. 199]. The pressure of large numbers in engineering education has been a continuing issue in Egypt.

Recent Developments

Following Nasser's sudden death in 1970, President Anwar al-Sadat continued Nasser's policies of promoting rapid industrialization while developing trade under administrative direction and supervision. Sadat reinforced the presence of engineers in the state bureaucracy in order to give the government a technocratic aura of political neutrality. The portfolios of ministers were increasingly linked to technical domains, such as industry, transport, electricity, irrigation, housing, petroleum and mining. Also the presence of engineers affirmed the administrative commitment to industrialization and trade [3, p. 168]. Kirk J. Beattie, Professor of Political Science and International Relations, shows how technocrats during the Sadat years "approved many of Sadat's major economic and political reorientations but obviously opposed any change that would challenge the privileged positions that had acquired in the state [during Nasser's government] and the attendant social status. While many grew increasingly attracted by the opportunities to link up with foreign capital through joint ventures, they neither sought nor desired changes that would undercut their continued ability to appropriate state assets" [10].

The oil booms of 1974 and 1979 offered many Egyptian engineers enhanced opportunities to work in Arab Gulf states [3, p. 211]. Indeed, by 1974 Egypt was supplying 60% of all foreign labor in Arab countries, particularly in Saudi Arabia, Kuwait and Libya. In the same year, 30% of all Egyptian engineers were working in Arab countries [7].

Engineering faculties continued to proliferate during the 1970s, partly as a response to a new openness to the United States. The U.S. Agency for International Development (USAID) and other Western agencies provided funding for labs, computers, and faculty training. As Moore reports, “The professors, roughly 40% of whom had been trained in England and the U.S., 30% in the Soviet Bloc, and only 18% in Egypt, were no longer isolated from international technological developments. USAID, for instance, promoted links between Egyptian and American universities and disbursed 30% of their funding to the engineers”[3, p. 216].

The 1980s brought significant political and economic changes to Egypt. After the assassination of Sadat in 1981, Hosni Mubarak became President, instituting a vigorous economic recovery program and working to build stronger relations with other Arab states. Meanwhile, a plummeting of oil prices halted the construction boom in the Arab region and diminished employment opportunities for Egyptian engineers in the Arab Gulf states [3, p. 215]. Nevertheless, the popular guarantee of government employment, along with the high status of an engineering degree, promoted a continuing high level of enrollment in engineering programs throughout the country.

Now in his fourth six-year term, President Mubarak continues to challenge engineers with major development projects for Egypt. Among these, the New Delta Project was inaugurated in 1997 with the goal of increasing the proportion of its land under irrigation from 5% to 25%. Mubarak City for Scientific Research and Technology Application (MUCSAT) was inaugurated in 2000 with the goal of developing and expanding private industry. Also, a brain child of Egyptian Prime Minister and former engineering professor at Cairo University Ahmed Nazif, “Smart Village” is a technopole dedicated to the development of information and communication technology at the outskirts of Cairo which brings together relevant governmental institutions (e.g., Telecom Regulatory Authority, Information Technology Industry Development Agency), foreign high tech companies (e.g., Alcatel, Microsoft, Vodaphone, Ericson) and national research institutes (e.g., National Telecommunication Institute (NTI)). To improve the quality of the technical workforce supporting this projects, the Ministry of Education has invested heavily in the engineering education infrastructure, as can be seen in the construction of new buildings for new departments and laboratories at the Cairo University Faculty of Engineering. Furthermore, the government also approved the establishment of Nile University, a graduate, research oriented, private university focused on technology and management with the objective of graduating future industrialists and entrepreneurs and promoting applied research leading to industrial partnerships and technology startups. Foreign aid from the United States continues to play a major role in the development of technical personnel, with USAID-funded certified training.

A Supply Center for Engineers

Engineering education in Egypt is a mirror of the country’s history, a result of the confluence of foreign influences (French, British, Swiss, German, Soviet, American) and national desires for sovereignty, development, and Pan-Arabism. American political and economic influence in the most recent period can be seen in the current dominance of the Anglo-Saxon model in engineering education, particularly in such disciplines as

electronics, telecommunications, computer engineering, petroleum engineering, biomedical engineering and aeronautical engineering.

However, the legacy of the Revolution and Nasser's commitment to Pan-Arabism can still be seen in engineering education. For example, on the demand side, the high prestige that the profession achieved during the Nasser era, the commitment of the State to employ engineers that lasted many decades, and increased economic activity in Egypt and the region help explain the continuing growth of engineering enrollments during the past two decades. On the supply side, increasing numbers of high school graduates continue to fuel engineering enrollments. The number of engineering graduates from Egyptian state universities grew from 140 in four disciplines in 1941 to over 12,000 in 2001 in 14 different disciplines (see Fig.1). During this period, the number of students graduating from the Faculty of Engineering, Cairo University grew from 140 to 1613, and the size of the staff increased from 209 in 1970 to 717 in 2001[11]. The distribution of graduates in different disciplines has varied over the years according to government priorities for technology areas as well as job markets across in the region. Accordingly, in 2002 32% of the graduating students from the Faculty of Engineering, Cairo University specialized in Electrical Engineering, 21% in Civil Engineering, 13% in Mechanical and Aeronautical Engineering, 13% Architecture, 13% Petroleum, Mining and Material Engineering 8%, Chemical Engineering 5% (see Fig.2).

The legacy of Nasser's policies for open access to higher education, which included equal access to men and women, also helps the large representation of female students in Egyptian engineering education. While in the early years of the Nasser era female participation was approximately 10%, by 1999/2000 the percentage had increased to 25% in Assiout University (South Egypt) and 35% in Alexandria University, with a national average of 30.5%. (Fig.3). Female graduates represent more than 50% of graduates in Architecture and Chemical Engineering, 30% of those in Electrical Engineering, 25% of Civil Engineering graduates, and approximately 15% of graduates in Mechanical Engineering.

The longstanding problem of brain drain of engineers from Egypt to both the West and to other Arab countries can also be traced back to the 1950s policies to establish a Pan Arab region with engineers trained in Egypt and taught by faculty with degrees from the North. During the government of Sadat, brain drain was accelerated by high salaries and investment in the Gulf region brought by the oil boom of the 1970s. Currently, a significant proportion of potential university faculty studying for Ph.D.s in European and North American countries stay there or return there after a short stay in Egypt. This phenomenon is especially pronounced in the fields of information and communications technology. Also, Arab countries, especially in the Gulf, attract nearly 25% of the Egyptian engineering faculty to teach in their engineering schools. Tens of thousands of practicing engineers in all disciplines are currently working in Egyptian, local, and international engineering firms operating in the Arab World, as Egypt supplies 60% of foreign Arab labor force in engineering [12]. Recognizing the attractiveness of these opportunities, Egyptian law allows university staff to be detached for periods up to 10 years.

It remains to be seen if the growing presence of multi-national companies and foreign engineers in Egypt and the Gulf region, as well as the growing number of Egyptian

companies operating internationally in need of hiring foreign engineers, begin to challenge Egypt's status as the main provider of engineering personnel in the region. Egyptian engineering educators are now contemplating the adoption and standardization of quality assurance and assessment processes, maybe motivated by the increasing competition that Egyptian engineering graduates are beginning to find in the high-tech labor markets in Egypt and the Arab region.

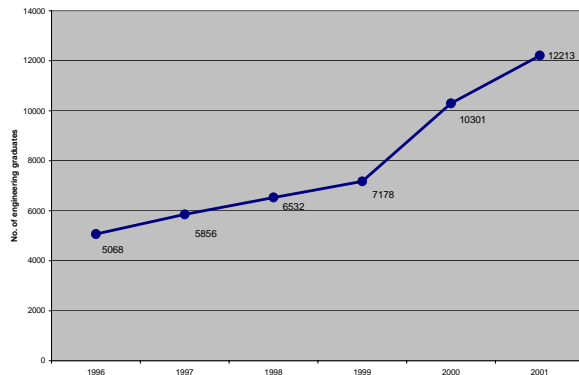


Fig 1. Total no. of engineering graduates (1996 - 2001)

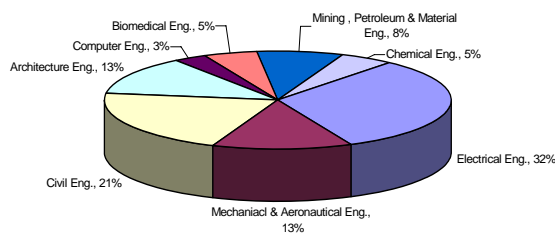


Fig.2 Distribution of engineers graduating from Cairo university in 2002 among different specializations

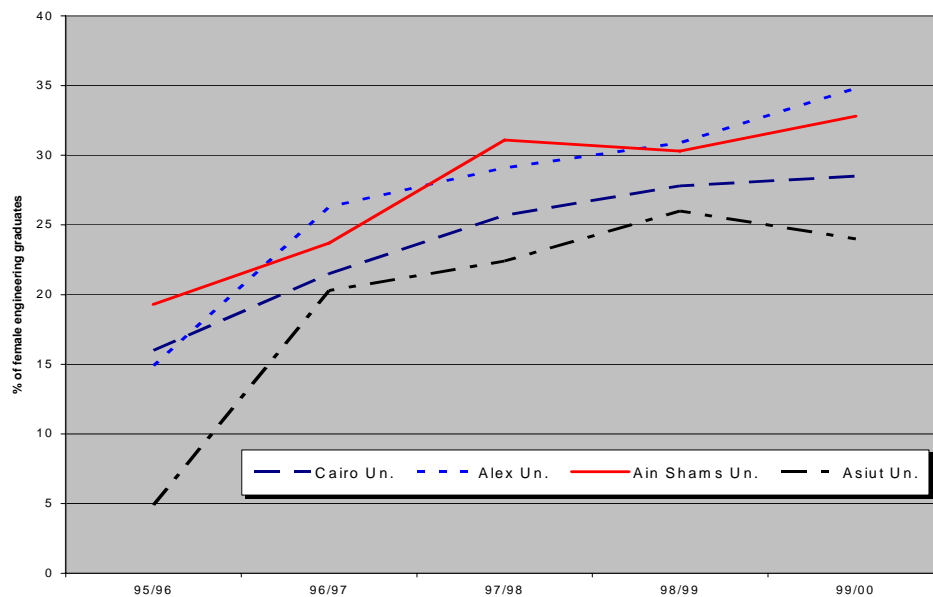


Fig.3 Evolution of percentage of female engineering graduates in the main state universities

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