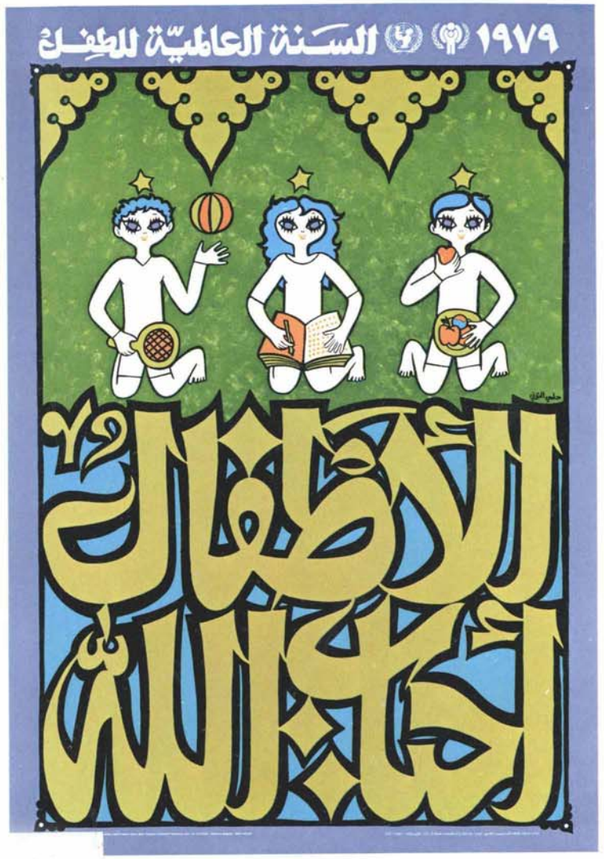

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Their Fathers' Sons

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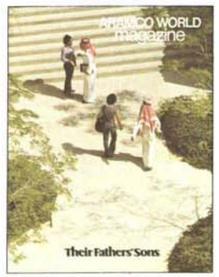


Cover: On the campus of UPM – the University of Petroleum and Minerals in Dhahran, Saudi Arabia – four of the university's 2,700 students, between classes, suggest the character of the university: an embodiment of the kingdom's hopes for the future, and its determination still to maintain the traditions of the past. Photograph by Burnett H. Moody. Rear cover: A similar theme is suggested in UNICEF posters produced to mark the International Year of the Child, celebrated around the world in 1979. Poster courtesy of UNICEF.

◀ Saudi Arab boys at play suggest the goals of the U.N.'s International Year of the Child which just ended: health and happiness for children throughout the world.

Their Fathers' Sons

WRITTEN BY BARRY REYNOLDS
PHOTOGRAPHED BY BURNETT H. MOODY

As in other Saudi universities, the 2,700 students at Saudi Arabia's prestigious University of Petroleum and Minerals in Dhahran are facing challenges their forefathers never dreamed existed. In an underpopulated country facing serious labor shortages, they personify an investment that in terms of the future may be more important than even the kingdom's vast oil wealth. More than that, however, these young men – sons of coastal pearl divers, nomadic shepherds, urban merchants and religious scholars – embody the past and future of a nation determined to have both without destroying either. In one tumultuous decade, hundreds of UPM graduates have emerged with degrees in such fields as petrochemical research, metallurgy, data processing and industrial management. Yet they have held fast to the central traditions loyally maintained and proudly passed on by their fathers and forefathers.

What most impresses visitors to UPM – an architectural gem – is the strength of the ties that link past and present, foster both continuity and change and instill a kind of dynamic traditionalism in its student body. These young men are truly their fathers' sons. At the same time, however, they reflect their country's determined effort to exchange its God-given oil wealth for nothing less than economic self-sufficiency in the future.

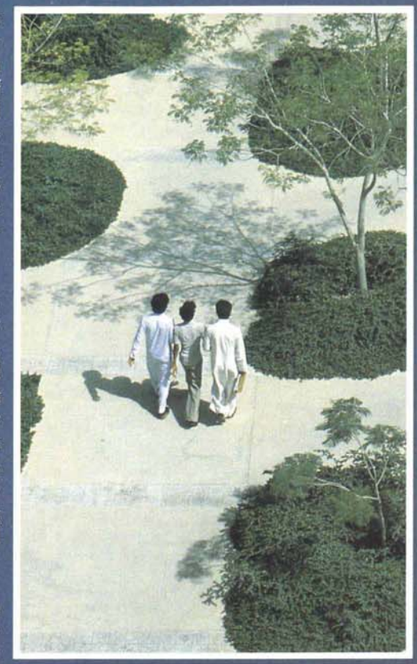
Founded as a small technical college only 15 years ago, UPM today unquestionably ranks among the most striking campuses anywhere. Exemplifying both past and present Arabia, its architecture features a graceful Islamic colonnade, with low closed masses dominated by one traditional vertical line: a striking water tower that is not only handsome but functional; it serves as a reservoir for water and sometimes serves as a navigational landmark for coastal shipping. Growing out the hills of the Dammam Dome and blending with the tones of the earth, UPM is a campus that simultaneously suggests poetry and utility.
The Islamic theme of UPM is neither accidental nor incidental. It reflects a deep commitment to Islam that is at once historical and modern and shapes campus life in forms new and often puzzling to Western visitors. Such people, accustomed to the wide-open lifestyle of American and European campuses, soon notice that there are no dances, no co-ed parties and no demonstrations.
This is partly because some of those activities conflict with the precepts of Islam, but there are other reasons too. As put by one UPM official, "It is not just that Islam forbids ... frivolous things. We are also concerned about students using their time constructively."

They are indeed. At UPM the daily schedule of an orientation-year student is more like a Spartan training camp than an Ivy League exposure to learning. Some candidates for the B.Sc. degree, for instance, must complete five years – rather than the usual four – of undergraduate study, and until 1973 certain engineering degrees required *six* years.
For first-year students, this meant seven class hours daily – compared to three or four in most American colleges – plus laboratory work and copious homework assignments.

Behind this demanding schedule is UPM's pragmatic mandate: to participate in providing the essential instruction, research and technology needed by the kingdom if it is, one day, to manage its industries and at the same time gradually diversify the kingdom's oil-dependent economy. Furthermore, the kingdom's universities are young and UPM is determined that the competitive requirements of the professions, be the pacesetter.

It is, clearly, a demanding regimen. Yet, most students persevere. Encouraged by generous aid – the free tuition, housing, books, meal subsidies and monthly stipend available to all Saudi university students at home and abroad – UPM students consider it a privilege to study at an institution that is sometimes called "the MIT of the Middle East." Significantly, the dropout rate for the orientation year – despite its grueling academic pace – is less than 20 per cent and even lower for the remaining four years.

Since the early 1960's, when the institution was an understaffed college with barely enough funds to prepare candidates for



study abroad, UPM has grown into a full-fledged university of international stature. Academic expansion, moreover, has kept pace with physical growth. The three colleges – Engineering Science, Science, and Industrial Management – send an impressive number of graduates annually to America's top universities for post-graduate study. (See *Aramco World*, May-June 1979) And, since 1973, the university has offered regular graduate courses in selected fields leading to master's degrees – but only when the governing board felt the colleges were able to meet international standards at this level.

To Rector Bakr Abdullah Bakr, the head of UPM, the university also has another role: as a clearinghouse between the predominantly Western technologies that Saudi Arabia needs and the wholly Eastern student body which must master and use them. "The Arab world is not underdeveloped," he insists, "save in its latent technological advances; the Islamic-Arabic contribution to civilization is well known. Nevertheless, the West has developed more sophisticated methods of production

The fathers were traders and farmers and pearl divers...

the sons are geologists, engineers and architects.

and distribution of goods and services for humanity's betterment. Our basic task at UPM is to acquire these new technologies within the context of our own value systems."

In this Bakr typifies the experiences of thousands of other American-educated Saudis who have returned to the kingdom in the last decade – men and women who realize that translating the manuals is only the first stage and not necessarily the most important. As the rector puts it, "Some countries have sacrificed the soul of their culture in order to acquire the tools of Western technology. We want the tools but not at the price of annihilating our religion and cultural values.

"Our basic problem here at UPM," he continues, "is to utilize – to electrify – that fine line separating tradition and progress. Even recognizing their relative merits is difficult. Physical laws such as gravity are stable and predictable, but those of the social sciences are more nebulous. This is the area of Western culture that we must evaluate very carefully against our traditional values if we are to preserve anything of the latter."

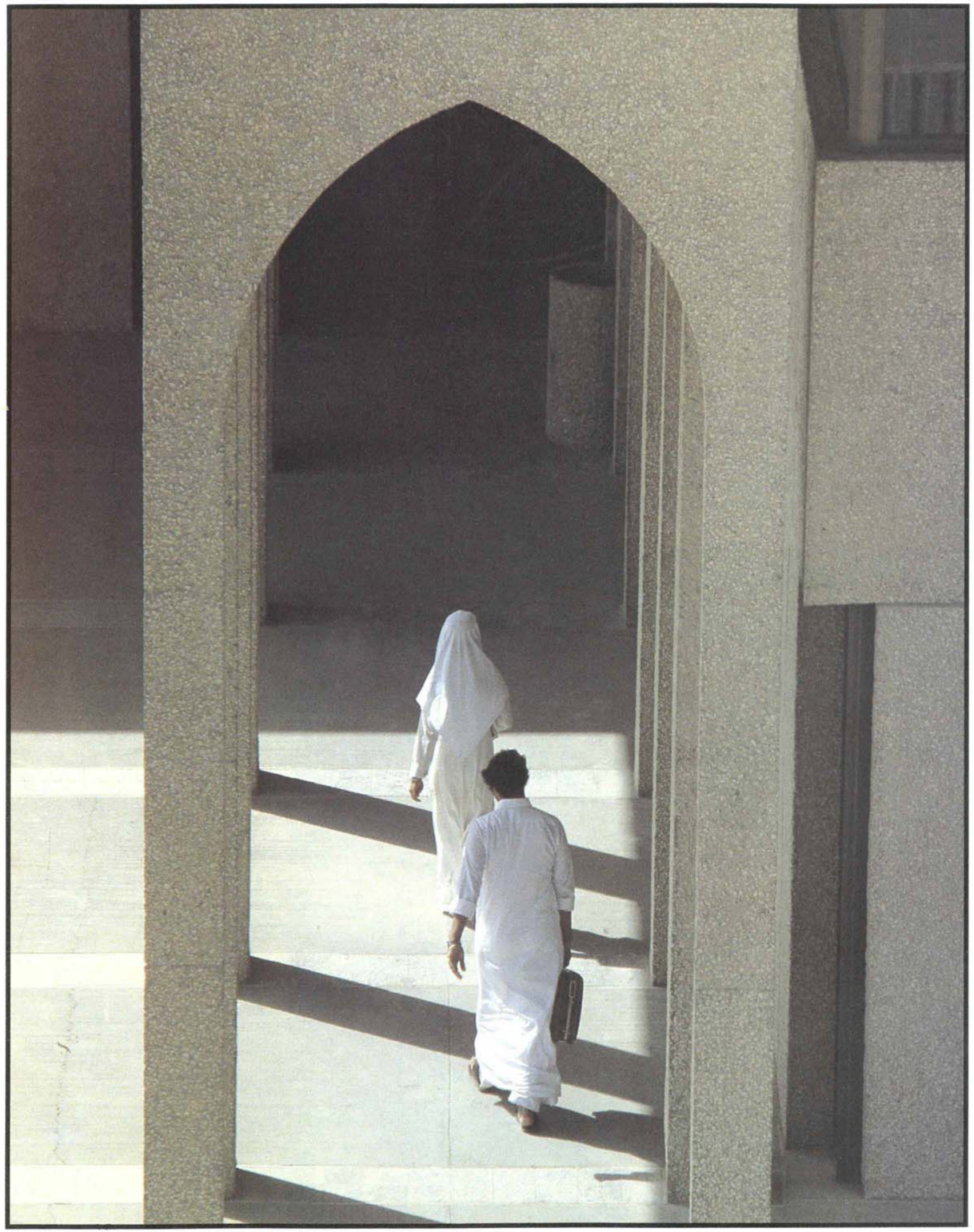
Bakr believes it is impossible to quantify a culture. He feels that the ideals which many Western intellectuals have elevated to the status of universal truths are really only cultural predilections. "We will not slavishly copy what we feel are non-universals just because other developing nations have done so," he adds. "Adjustments are needed. I feel that the possible rejection of our Islamic value system poses the most serious development problem in the Arab world today."

Despite his caution, Dr. Bakr's philosophy, and that of others in the Saudi educational establishment, is hardly xenophobic. Despite the reverence all Arabs feel for their language, for example, they recognize that the international language of business and technology today is English, and feel it necessary, at this time, to demand a fluency in that language. In this respect, the university is unique in the kingdom; it has made English the language of instruction.

For the students, this language requirement is probably the toughest hurdle they face in their five years at UPM. "Just imagine an American student with little formal knowledge of Oriental languages trying to cram, in one year, enough Chinese to enter a chemical engineering program at the University of Hong Kong," says Columbia University's Hubbard Goodrich, a former director of UPM's English Language Center. Apart from the cultural shock, he adds, the sheer workload of that orientation year is a back-breaker.

UPM has introduced other innovations too. Its student-faculty composition, for example, is as international as any campus in the world. Its faculty is drawn from 22 countries and its student body, this year, represents 35 countries – an example of the university's decision, as one instructor put it, "to evaluate our performance by international, not regional, standards."

UPM's first task, then, is the education of students in the technologies of the 20th century, and its curriculum suggests what kind of education that is: B.Sc. and M.Sc. degrees for studies in chemistry, earth sciences, mathematical sciences and physics in the College of Sciences; for studies in architectural, civil, chemical, electrical, mechanical, petroleum and systems

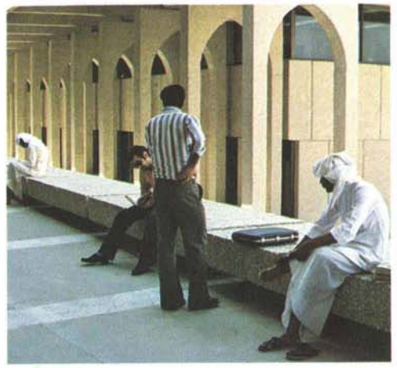


engineering in the College of Engineering Science; and for studies in applied, civil, chemical, electrical and mechanical options.
Because the university believes that the standard of instruction for first- and second-year candidates is vital, the administration demands "vertical teaching" – that is, even professors of the highest rank must teach courses in the lower divisions as well as handle graduate seminars and conduct their own research. With its low 12-to-1 student-teacher ratio and its deliberate tutorial bias, the emphasis at UPM is clearly on quality.

In the long run, of course, research at UPM will, eventually, be as important as it is, and must be, at other top universities. Already, in fact, UPM is involved in ongoing research programs into oil reservoir stimulation, the geochemistry of *sabkhas* (salt flats) and the potential pollution in the Arabian Gulf, and there is little doubt that UPM is to become a key "think tank" for the kingdom's petroleum and minerals industries.

To those who still think of Saudi Arabia in the now-outdated terms of dune and Bedouin, the idea of a Saudi university sponsoring original research in high-technology fields may sound ambitious and premature. In fact, though, UPM's commanding location – atop the Dammam geologic dome where the kingdom's first oil was discovered in 1938 – is strategic as well as symbolic. Situated within a 500-mile swath lies a quarter of the world's petroleum reserves – and UPM plans to take full advantage of that fact. Already, for example, the university has launched construction of a new $100-million research institute building and, simultaneously, announced a research project that its backers believe is novel, bold and particularly well adapted to Saudi Arabia's needs and advantages.

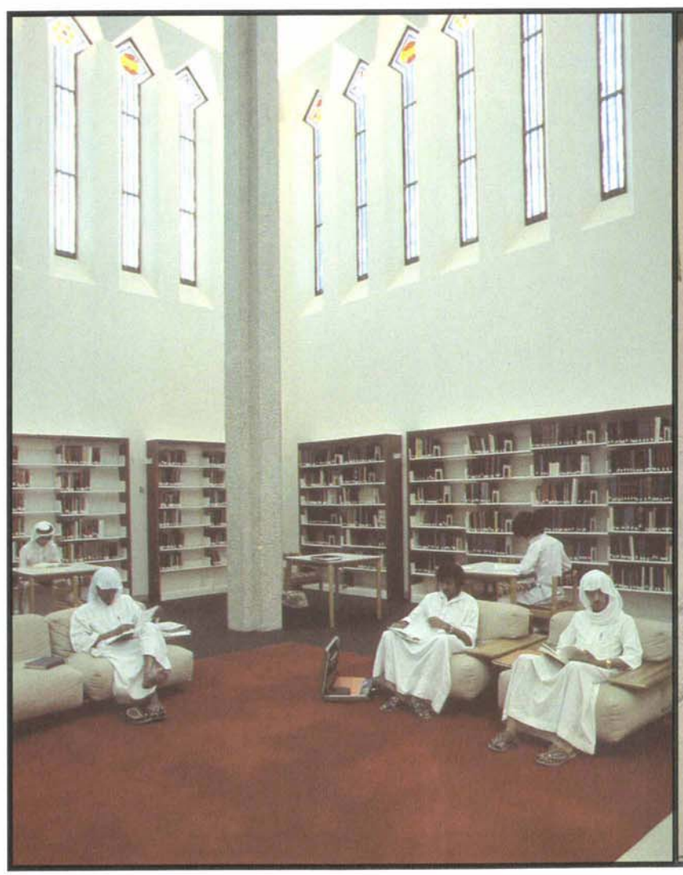
As part of the kingdom's massive Five Year Development Plan (See *Aramco World*, January-February 1977), Aramco has undertaken a huge gas-gathering project which will capture and process vast quantities of the gas that must be separated from

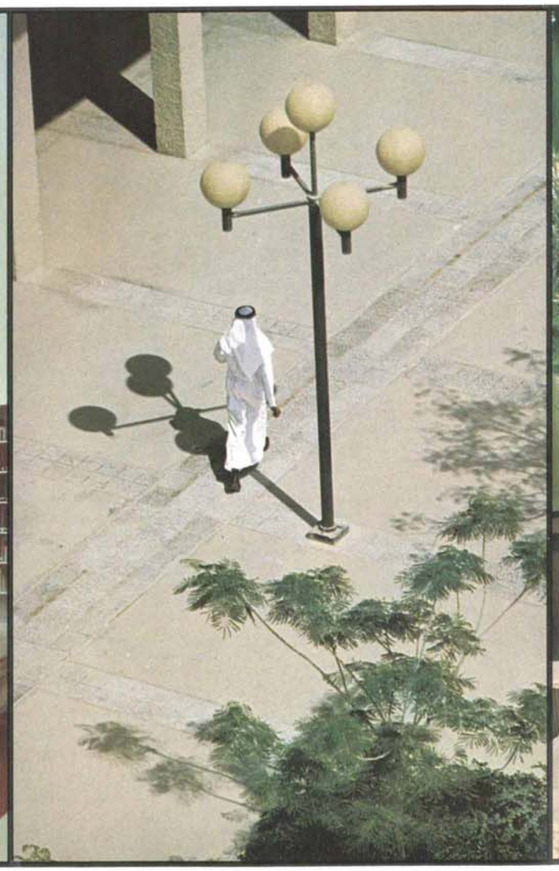


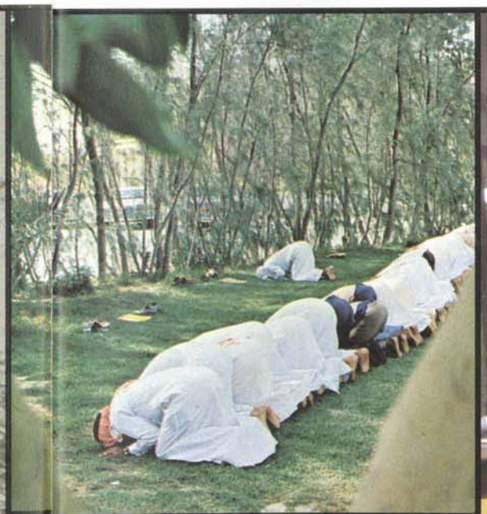
crude oil prior to processing it. In treating the gas, Aramco produces considerable amounts of sulfur, which cannot always be absorbed by the world's chemical industry. At UPM's Research Institute, therefore, scientists have begun to explore the possibility of using the anticipated tonnage of excess sulfur – to build roads.
In one sense this project is peripheral to the oil industry's primary objective: the extraction, shipment, processing and distribution of petroleum and petroleum products. But in today's intricate and interdependent technologies such distinctions have little validity. If the "sulfur road" experiment proves successful, UPM scientists might not only find a market for the excess sulfur but also provide road surfaces better adapted to Saudi Arabia's climate and reduce road building costs by eliminating the need for expensive asphalt.

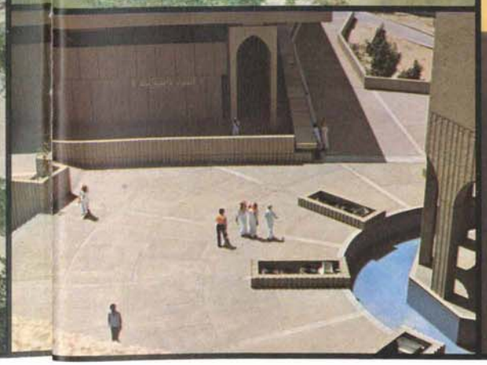
What UPM is looking for specifically is a sulfur-based aggregate that would be more economical – an important factor given the massive road construction program called for by the five-year plan – and stronger than present road-surfacing materials. The new aggregate, it is hoped, will stand up better to the Saudi climate – in which temperatures can vary substantially – and thus provide a new product for export to other arid lands. So far the new "sulfur aggregate" is strictly experimental, but UPM is already planning a test: on a stretch of highway where construction traffic is heaviest. From dawn till dusk the highway will support a thundering fleet of trucks carrying full loads while electronic monitors measure the surface's durability.
UPM researchers are also trying to design a computer-controlled public water system for the municipality of Riyadh and the Ministry of Agriculture. Because of the tremendous physical expansion of the city, the demands for water have exceeded the capacity to provide it and UPM researchers hope to perfect a system by which computers would constantly monitor the city's water flow – in much the same way that Aramco's Tapline regulated its flow of oil from Saudi Arabia to Lebanon-and, researchers say, automatically increase, stop, divert or redirect water during emergencies.

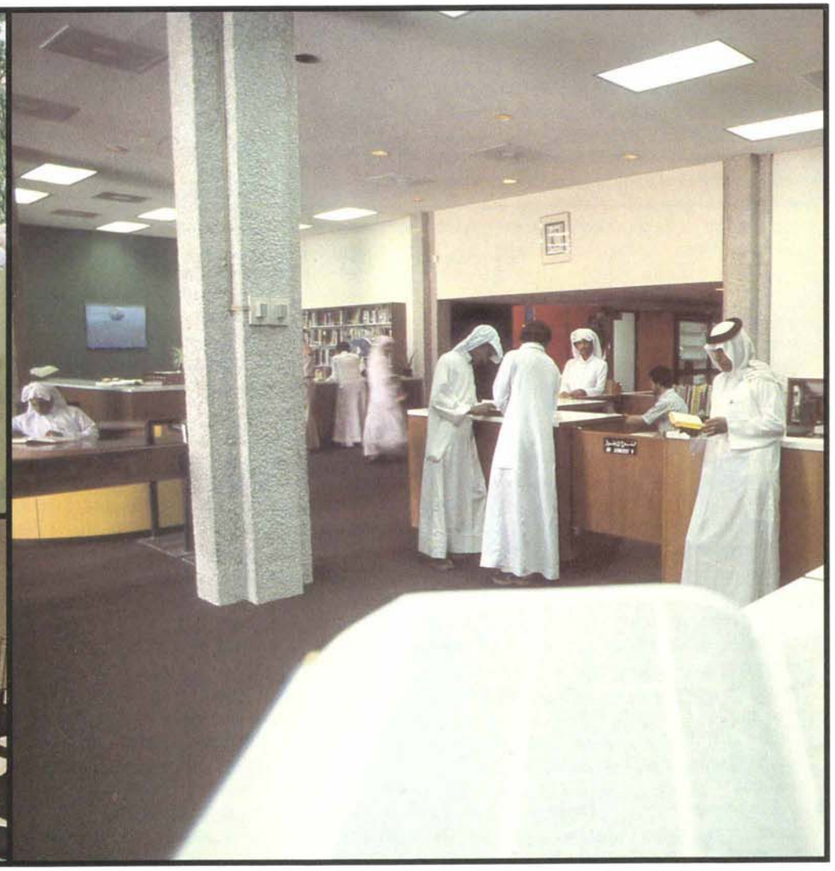
Both those projects, obviously, are tied to local needs and promise tangible returns to both government and industry – and it's no accident. Despite its hefty annual budget – nearly $180 million – UPM is as cost-conscious as a county school board and insists that all research be geared to the practical needs of the local communities. Furthermore, says the Research Institute's head, U.S.-educated Abdullah E. Dabbagh, until the center reaches its full staff capacity of 350 researchers in 1984, it will continue to give priority to such practical, rather than pure, research ventures. It is true, he says frankly, that the U.S. has proven the economic value of massive research and development programs and that Saudi Arabia still spends too little of its oil wealth on pure research. But Saudi Arabia, he adds, is still building an infrastructure, practically from scratch, and must, therefore, direct its energies – and its energy revenues – toward projects promising fast results.











Their Fathers' Sons: Adnan al-Hassan

It is hard to imagine today that Saudi Arabia's eastern seaboard was once an important center of pearls and pearl diving. Those lithe, great-lunged divers have vanished, to give way to the wharves and break-waters of thriving industrial ports; the giant tankers steaming away from the oil terminal at Ras Tanura seen to belong in a different world from that of the few seaworthy dhows still sailing the waters of the turquoise Gulf.

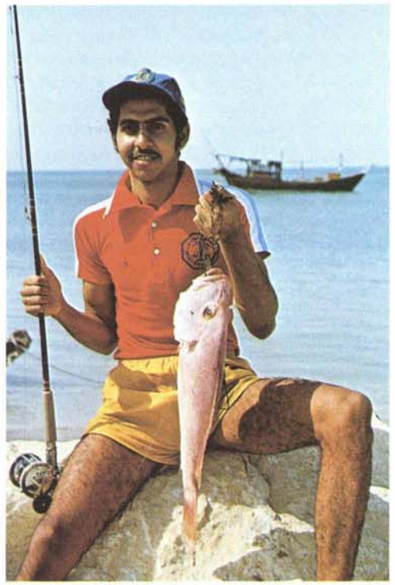
Actually, though, the days of the pearl diver are not as distant as they seem. To Adnan al-Hassan, for example, they still exist in his family's traditions and his own memories. "My grandfather was a pearl diver," he says.

Adnan, a chemical engineering student at UPM, is fully aware of the shattering effect on his grandfather's life when Japanese cultured pearls began to replace the natural Gulf pearls. "The Arabian pearling fleets never recovered," he says.

But it was not, he continued, as bad as it seemed. "My grandfather, of course, is sad about the great changes that have happened, but we all know that life is better now. The pearling captains often stole the best gems from the divers and old pearlers tell frightening stories about man-eating fish."

In fact, Adnan says, the end of pearling was a blessing. "Saudi Arabia's future is not with the sea," he says. "God sent us oil instead."

For Adnan's father the blessings came immediately: he went to work in the Ministry of



Petroleum. And for Adnan himself they will be realized when he leaves UPM and, if all goes well, joins the kingdom's nascent petrochemical industry. He is thinking specifically of going to Jubail, an old fishing hamlet 15 miles up the coast from Ras Tanura, where a modern industrial city is being built. By 1990 Jubail's population, now less than 5,000, is expected to reach 300,000, and Adnan hopes to find employment in one of the petrochemical plants planned there.

To Adnan, the fact that Saudi Arabia is developing its own petrochemical industry in the very area where his grandfather once went pearling is a source of pride. "Other nations tried to discourage us from manufacturing our own petroleum by-products because they feared the competition. But if we are to be self-sufficient, we must develop confidence in our native industries. My grandfather probably wouldn't agree, but I think losing the pearl market was good. It made us look elsewhere."

Growth of the kind now common in the kingdom delights Adnan. "Five years ago," he says, "Saudi Arabia was importing everything. Even the wood for the so-called Arabian dhows came from abroad. And in just five years we have built factories that are processing steel and aluminum and other basic materials."

On the other hand, Adnan himself is still drawn to the sea. Nearly every weekend he and friends close their books at UPM, and go off to the Ras Tanura shore to fish. For a busy student it's a quiet interlude, but for Saudi Arabia it is also a symbol of change: a young chemical engineering student fishing, a dhow that once carried divers to the pearling grounds cruising gracefully offshore, and, in the distance, a great tanker easing toward the Ras Tanura terminal. In that scene – a student, a dhow and a tanker – is the story of Saudi Arabia.

Their Fathers' Sons: Muhammad al-Nasir

Muhammad al-Nasir is a youth with a youthful problem: he can't decide what to become. He is certain of one thing, however. Unlike his father and grandfathers, he will have a choice.

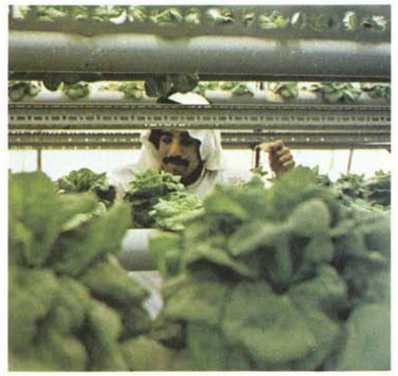
To Muhammad, an industrial management student at UPM, the fact that he can choose is extraordinary. Indeed, he thinks that the chief boon of Saudi Arabia's prosperity is the luxury of choosing one's own profession.

Thirty-five years ago, he said, his father had no choices. He did hold two jobs, one as a mechanic, the other as a farmer, but he couldn't choose between them. He needed both to survive, so he worked as a mechanic for wages and as a farmer, on his own small plot, to feed his family. "You'd have to see how poor our people were in those days to understand our close family relationships and to appreciate why Saudis now want to protect their oil," Muhammad said.

Muhammad, who is trying to decide between farming and industry, is not unusual and neither is his dilemma. Trained in one field, but preferring another, many Saudi students aren't at all certain which way to go. And in Muhammad's case there is still another factor: status. As he puts it, "The problem for young people is one of status. Farming is still associated with mud houses, sheep and poverty – a past most Saudis would like to forget."

Fortunately for Muhammad, the government has recognized the problem and taken steps to make a future in agriculture both attractive and productive for Saudi graduates. In the western provinces, for example, the government has launched a program of widespread dam construction which has raised the kingdom's irrigated tillage from 200,000 acres, five years ago, to nearly 500,000 acres today. And this year the Ministry of Agriculture is offering valuable tracts of land to youths wishing to establish farms, along with a 45 per cent subsidy for the cost of equipment.

Behind such moves is the fact that Saudi Arabia, which still imports nearly 80 percent of



its food, wants to expand its agriculture.

With that in mind the government is encouraging farmers to shift to greater mechanization – a change that has special importance to Muhammad. It means that the days of the poor, independent farmer – that he remembers too well – are ending.

Muhammad is impressed too by Aramco's now successful experimental hydroponics – the cultivation of crops in nutrient baths rather than soil – which has helped solve the problem of climate that has stunted Saudia Arabia's agricultural growth for years. Now, it is possible to increase local yields – tomatoes, lettuce and cucumbers – by prolonging the season in which these crops can be cultivated.

As a result, for a good portion of the year, if hydroponic farming is used on a large scale, it becomes feasible to reduce imports of vegetables. This feat has impressed Muhammad with its provident use of manpower, space and water.

Whether government support and such modern methods as hydroponics will lure graduates back to the land still remains to be seen. But to Muhammad, what's important is that his UPM training gives him choices that were never available to his father. "Besides," he added, "farming needs management too, and management is *my major at UPM".*

Their Fathers' Sons: Nasser Bassam

When Nasser Bassam's father moved his family back to Saudi Arabia from Syria three decades ago, he could never have imagined what lay ahead. He may have expected to have another son, but he certainly couldn't have anticipated that the son, a descendant of an old spice-trading clan, would dream of winning an international swimming match.

In the thawb *he sometimes wears to prayer at UPM's mosque, Nasser, a freshman student, might momentarily resemble the merchant grandfather who, in the 19th century, plied the arduous caravan route between central Arabia's Qasim region and Syria. But in his conversation Nasser soon shows that he is a young man of this century – with aspirations inconceivable to that gentleman in Damascus so many years ago.*

One is a degree in electrical engineering – which requires six class hours a day, plus homework – and the other is a major victory in international swimming. Both challenges are demanding, but neither, Nasser hopes, is beyond him.

In a recent interview Nasser quickly made it clear that he is dead serious in his swimming efforts. Despite his six hours of class and however long it takes to finish the day's assignments, he never fails to put in his three hours of training with the kingdom's swimming team.

Like other developing countries, Saudi Arabia has only recently begun to compete in international athletic events. But in swimming, the kingdom's fledgling stars have already begun to make their mark. In 1978, Alawi Makki of Safwa swam the English Channel in 10 hours and won the first prize in the first international cross-Channel swimming race — a race, incidentally, that was sponsored by Prince Fahd ibn Faisal 'Abd al-'Aziz and the Saudi Youth Federation.

Saudi swimmers, furthermore, did well at the Asian Games in 1977 and Nasser himself broke the national time for the 200-meter butterfly event, as well as improving the breaststroke and medley records. Recently Saudi swimmers have won four long-distance swimming races at the Arabian Gulf championships. And Nasser swam last year in Mexico City's international student games.

For a swimming team that didn't exist five years ago such performances are promising. But Nasser is under no illusions about the grueling pace he will have to maintain. Summers, for example, while fellow students are relaxing after the vigorous academic grind, Nasser must continue his arduous training schedule and during semester breaks, he says, "I swim in the Red Sea and try to forget those hungry sharks I saw in Jaws."

Nasser first learned to swim in the Red Sea near Jiddah, where his father is a spice merchant. Later, in 1976, he traveled to Munich, Montreal and the Arabian Games in Damascus, and in 1977 competed at the Arabian championships in Kuwait and at a European meet in Luxembourg. In 1979 he participated in the Alexandria national meet in Egypt and went on to Edinburgh, Scotland, for further training.

It's a difficult pace, but Nasser, who combines dedication with irony, laughs it off. Asked how he ate with such a schedule, he simply smiled wryly and said, "Running in place."

To Nasser there is a definite link between his own efforts and those of the kingdom itself. "It is exciting to watch the great changes taking place in the kingdom. It is also challenging for me as an athlete to compete for a country that has not won a single Olympic medal."

And later? Nasser grins. "I'd like to swim the English Channel before they build a causeway."

Their Fathers' Sons: Hesham Ahmad Tashkandi

Hesham Ahmad Tashkandi is not a typical student at UPM. There is no typical student. But his list of achievements does suggest what kind of student can be found among the 2,700 young men now attending classes there:

— Admitted to the Ph.D. program, UCLA at Berkeley's Graduate School of Business Administration.

— M.B.A. Finance, UPM (1979).

— B.S. Chemistry, UPM (Honors) (1977).

— Graduate Assistant, UPM College of Industrial Management.

— Former Director, UPM Cooperative Program.

— Former Editor, The Tower *(student scientific magazine, UPM).*

— Experience as computer programmer, lab technician, refinery operator (summers, with Aramco, the Arabian Oil Company and Idemitsu Kosan).

With those credentials in his résumé, Hesham Ahmad Tashkandi could well be expected to head for the executive suite of some corporation when he finishes at Berkeley. And he may. At the moment, however, he wants nothing better than to return to UPM as an instructor.

His reasons? He feels that the real challenges still lie ahead in the field of education. "We in Saudi Arabia face enormous problems," he says. "Although Saudi Arabia is blessed with a vast amount of natural resources, we are handicapped by a low population density, little industrialization, and a generally low level of education. Money alone can't solve these problems, but people can, especially educated Saudis with a personal stake in the kingdom's future."

Although he is only 21 years old, Tashkandi already imparts a professional air – the result, possibly, of nearly a decade of studying or working in some of the country's key industries. In pursuing his education theme, for example, he doesn't simply explain, he lectures: "While establishing a diversified industrial base and improving the material and social well-being of Saudi citizens are the major goals of our government, the refinement of the educational institutions is the most crucial factor contributing to the fulfillment of these goals."

Tashkandi, who has benefited from extensive travel with his father, who worked abroad as a government official, feels that the kingdom offers greater scope for what he terms "instant wealth" than any other country in the world. But he insists that he himself is indifferent to riches and that the opportunities offered by his UPM training are also opportunities for the kingdom:

"The opportunity to contribute effectively to the development of Saudi Arabia is, by itself, its own reward. But there is more to it than that. There is so much more to be done, and so much more that can *be done, in Saudi Arabia, that there is much more room for success and self-fulfillment here than anywhere else in the world. I can be interested in studying the country's financial institutions with the objective of increasing their efficiency, and feel certain that I would be succeeding in contributing to the development and improvement of my country. I feel that it is my duty to my country to succeed."*

Some studies, fortunately, straddle the boundaries of both pure and practical research. One such project – which Dabbagh considers a linchpin of future development in the kingdom – is the Institute's Sand Research Program. As the Rub' al-Khali – the Empty Quarter – is the largest sand desert in the world, it is easy to see why sand, pure and simple, would fascinate researchers. But there is a sound practical reason too, says Dabbagh. "We must pursue this question because our government is spending billions in planning new cities. A showcase community could be buried in a lifetime if these ever-shifting sand patterns are not fully understood."

Thus UPM scientists, working closely with Dr. Edwin McKee of the U.S. Geological Survey, are hard at work trying to unravel the ancient mysteries of Saudi sand's structures, its accumulation, its rate of movement and the role of wind direction in its movement. Progress has been slow, but already McKee has found that the "layering" of sand indicates the directions the wind has been blowing throughout history. The exact nature and scope of this interaction has yet to be determined, but the personal interest of Dr. Dabbagh and other Saudi scientists promises intensive future research into what he terms "Arabia's elusive sand regime" – and conceivably a more effective solution to the slow envelopment that once threatened the very existence of the al-Hasa Oasis. (See *Aramco World*, May-June 1965)

Another field under enthusiastic study at UPM is, interestingly, solar energy – a reflection of what is surely one of the most foresighted national policies in the history of energy development: Saudi Arabia's insistence on exploring alternate sources of energy long before its own immense reserves of oil are depleted.

As with its sand study, UPM's solar energy research encompasses pure and practical elements. As Dabbagh put it, "Our oil won't last forever, and solar research may well prove a paying proposition in diversifying the kingdom's petroleum-based economy."

By funding solar energy experiments in the United States – such as a solar-heated school in Reston, Virginia – Saudi Arabia, several years ago, showed that its interest in solar energy was more than astute public relations. But UPM has done even more. In 1978, in the neighboring island state of Bahrain, UPM sponsored an important international conference on solar energy, the second such conference recently backed by the kingdom.

At the conference Saudi Arab scientists pointed out why Saudi Arabia, despite its reserves of oil, is also the ideal place to experiment with solar energy – and why UPM research is therefore a quite practical undertaking. The Arabian Peninsula alone, they said, receives more solar energy in a year than the energy contained in *all* the oil, gas and coal still buried in the earth.

Trapping and storing that energy efficiently, therefore, is the focus of solar research today and UPM's energy experts are doing their part in testing various solar collectors to determine which performs best in Saudi Arabia's unique climate. "We're still a long way from building a major demonstration system here," admits Dabbagh, "but it's our job as scientists to give a strong impetus to Saudi industries, which must become competitive."

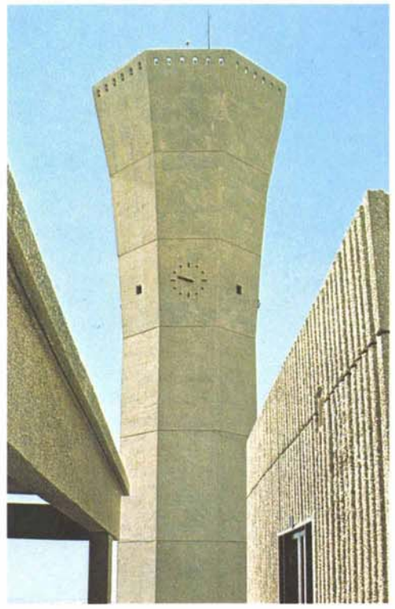
The solar energy conference, however, was only one of the international conferences sponsored by UPM in recent years. Last year, for example, UPM played host to conferences on computers and – of particular interest in the kingdom – housing.

Held on the UPM campus, the week-long seminar on housing appeared in international headlines, fired the imaginations of Saudi and foreign visitor alike, produced bold new building designs and, indirectly, provided a clear example of the University's attempt to foster continuity amid change.

Brian McCloskey, for example, a Canadian architect and chairman of the architecture department, showed designs made by him with Saudi architectural students which successfully combined the beauty and spaciousness of the old, latticed *mashrabiya* home with modern ventilation methods using local materials. "There is no reason" he said, "why traditional esthetics, efficiency or economy need be sacrificed in Saudi homes to accommodate Western technology. Both can be had at a reasonable cost".

This theme – the advantages of traditional methods and local materials – surfaced more than once during the conference. Imported, pre-fabricated buildings, for example, were acknowledged to be essential given the critical housing needs of the current boom, but were criticized nonetheless as being unrelated to regional demands and McCloskey proposed that an inexpensive quartz by-product readily available in Saudi Arabia be used as a replacement for both the traditional mud bricks and imported pre-fab housing units. McCloskey and the Saudi architectural contingent also advanced innovative models synthesizing modern building technologies with indigenous architecture. When perfected, it was suggested, designs could make Saudi Arabia a Third World pioneer in this approach.

Those models reflect what many observers have long known and what Saudi architects firmly believe: that traditional Arabian Gulf architecture is often more suitable to the region than imported ideas.



Ottoman-era homes in Hofuf and Qatif, they argue, are generally better architectural prototypes for this area than Western models. For instance, the *mashrabiya* (See *Aramco World*, July-August, 1974), the historic window lattice, does much more than allow the occupants to gaze out unseen. It allows for maximum circulation of cool or warm air, filters both dust and glare and is esthetically attractive. Similarly, in such places as Dubai, Sharjah and Iran, ancient architects developed the wind tower, a vertical, rooftop shaft ingeniously designed to catch the wind and channel it into the rooms below. It was by no means as cool as air conditioning but it required no energy either. (See *Aramco World*, September-October, 1972.)

To encourage innovative thinking, McCloskey says, he has been urging his 125 architectural engineering students "to develop their critical attitudes towards what is being built here, for whom, and at what socio-economic price. When they discover that they are able to design a home that preserves the traditional Arab style yet uses advanced technology, they are ecstatic."

UPM, then, is a striking example of Saudi Arabia's commitment to education. But it is not a solitary example; in Saudi Arabia the progress in education has been meteoric by any standards. As recently as 25 years ago there was no official school system and no university in the kingdom. Today some 700,000 children are enrolled in secondary schools, and six modern universities and numerous specialized colleges are well funded by the Government.

In addition, an estimated 20,000 students are now abroad for advanced training – 15,000 of them in the United States at one point (See *Aramco World*, May-June 1979) – almost all of whom plan to return and take up posts in a society facing rapid change.

UPM, however, is a showcase – a unique blend of Western know-how and Islamic traditionalism. Although the university houses one of the country's most sophisticated computer centers – the current symbol of advanced technology – UPM students are still manifestly their fathers' sons. Perhaps no scene more poignantly expresses this continuity linking past and present Arabia than the afternoon prayer call. In groups of tens – or hundreds – they openly profess their faith in a common Creator in a manner rarely seen in Western youth today.

In the West, such a scene might suggest a dreary Dickens schoolhouse: unremitting drudgery and stern piety. But nothing could be further from the truth: while there are no dances and no drinking, and while the academic schedule is hard, there are numerous activities: sports, films, poetry readings, folkloric activities and – that Arab staple – lively conversation.

UPM's recreational facilities, furthermore, are rarely matched in the Gulf: an Olympic-size swimming pool, a 40,000-square-foot gymnasium, tennis and squash courts and numerous synthetic-surfaced playing fields. In addition, a 10,000-seat stadium will be completed this year.

More than its mere physical expansion, however, UPM embodies the dynamism of contrasts that mark civilized thought everywhere: a dynamic religion that exists harmoniously within an innovative scientific community, and students who stubbornly work to make technology the handmaiden rather than the master of tradition.

Barry Reynolds, who spent two years in Saudi Arabia teaching at UPM and free-lancing for several publications, has returned to his job as an instructor at John Abbot College in Montreal.

In the shadow of the Great Pyramid, they chipped away at the gypsum seal...

THE SMELL OF TIME

WRITTEN BY NANCY JENKINS PHOTOGRAPHED BY JOHN G. ROSS

Outside Cairo, the oldest boat in the world sits in a dusty, glass-walled museum next to the largest of the three pyramids on the Giza plateau. Built as part of the funerary equipment of King Cheops, second ruler of the Fourth Dynasty of Egypt's Old Kingdom, the boat, just over 142 feet long, is a majestic curve of age-darkened cedar, its aroma still pungent some 46 centuries after it was buried in a pit near the great pyramid.

One of the most exciting archeological finds of all time, the boat was discovered in 1954 when workmen from the Egyptian antiquities department were clearing a great mound of wind-blown debris from the south side of the pyramid thought to be the burial place of Cheops. Beneath the debris they found an ancient wall and, beneath the wall, 41 massive stone blocks, each weighing more than 15 tons, set side by side into the bedrock of the plateau and chinked with a hard gypsum plaster.

To the man in charge of clearing the debris, Kamal al-Mallakh – now an editor in Cairo, but then a young and enthusiastic architect-archeologist – the discovery of the stone blocks demanded a closer look. Years before, archeologists had found three empty "boat pits" on the east side of the same pyramid – one of them with fragments of gilded wood in the bottom – and believed that ceremonial boats had been buried in them in ancient times. But until the workmen found the limestone blocks at the Cheops pyramid – and then another 40 blocks adjacent to the first lot – few archeologists really hoped to find an actual boat. In archeology, time and vandals often get there first.

Al-Mallakh, however, was certain that the pits contained boats. Aligned so that the rocky partition in the bedrock separating them fell precisely along the axis of the Great Pyramid's south face, the great blocks, he says, immediately suggested the supremely confident stonework of the Fourth Dynasty. And the untouched plaster chinking suggested that – possibly – there might still be boats, or the remnants of boats, in the pit beneath the great blocks.

Whether the pits actually contained boats, however, and, if they did, what their condition would be after 46 centuries, were questions that could only be answered by opening them. Despite some initial resistance, therefore, al-Mallakh received permission to open a hole in the middle of the easternmost row of blocks and in the spring of 1954, near the end of the archeological season, his workmen began to chisel into the stone.

The workmen proceeded slowly and cautiously at first, al-Mallakh said, because there was no way of knowing how thick the stone was or what damage might be inflicted by a falling fragment on whatever was concealed inside. Eventually, though, on May 26, 1954, they reached the shelf, nearly six feet down, on which the megalith rested.

It was towards noon, al-Mallakh recalled recently, a time when the white desert light glares on the Giza plateau and the dense volumes of the pyramids seem to shimmer in the nearly intolerable heat. As they were only inches away from their goal, al-Mallakh took over the chisel himself, until, finally, the last fragment fell away, leaving a small black hole, its darkness a sharp contrast to the glare outside.

"I closed my eyes..." al-Mallakh said, "like a cat. And then, with my eyes closed, I smelled incense, a very holy, holy, holy smell. I smelled time. I smelled centuries. I smelled history. And then I was sure the boat was there."

It was. Minutes later, using his own shaving mirror as a reflector, al-Mallakh flashed a beam of sunlight into the darkness of the pit; with incredible good fortune it fell precisely on the tip of a blade, one of a pair of great steering oars or rudders, each more than eight feet long and carved, shaft and blade alike, from a single piece of Lebanese cedar, each lying just where it had been placed by the workmen of the king Djedefre, the son of Cheops, 4,600 years before.

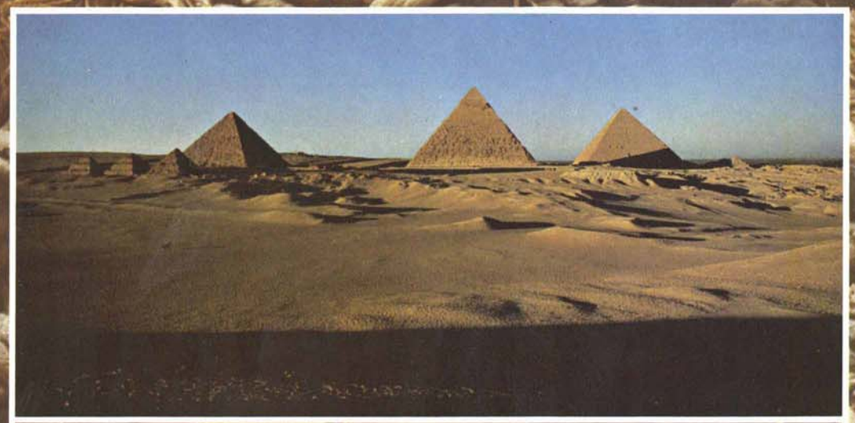
It was, obviously, an important discovery and the Department of Antiquities, quick to realize it, immediately appointed a commission to oversee the excavation of the pit – and the adjacent pit where, they assumed, there was a sister ship. The commission, in turn, quickly set to work removing the huge 15-ton blocks of limestone that covered the pit, a job that took 18 months. Finally, though, the pit was open and the boat was exposed to the Egyptian sunlight for the first time in 46 centuries, its timbers, according to one witness, "as hard and new as if they had been buried a year ago."

Although the Cheops Boat was intact, however, her timbers had been dismantled and were carefully laid out – 1,224 pieces – like a giant do-it-yourself kit. The next project, therefore, was to reassemble the boat. But as this do-it-yourself kit, unfortunately, came without instructions, the antiquities department had to turn to Hag Ahmed Youssef, one of Egypt's masters in the difficult field of restoration.

One of a rare breed of restorers, Hag Ahmed has not only skill and technology at his command, but also an instinctive feel for the material and the period in which he is working. Hag Ahmed, indeed, concentrates so intensely on his work that, he himself admits, he sometimes identifies totally with a 12th-Dynasty sculptor or a Ramesside goldsmith and is startled when he leaves his labors to find himself in the modern world.

Restorer Hag Ahmed Youssef at work on Cheops Boat.

Nevertheless, the reconstruction of the Cheops Boat was to be his most difficult assignment. Before he even picked up a fragment of wood from the boat, however, he had to become an expert on the almost unknown subject of ancient Egyptian boat-building.



There were, to be sure, some clues. From the reliefs carved on walls and tombs, and from hundreds of little wooden models found in tombs, he could get a pretty clear idea of what a finished boat looked like. But as there was almost no information available on the construction process, Hag Ahmed, hoping that modern shipwrights might have retained methods that would suggest how the ancients had built their craft, visited the Nile boatyards of Old Cairo and Ma'adi and went to Alexandria, where wooden river boats were still being made. Then, when he found that the differences between ancient and modern boat building – in Egypt, at least – were perhaps greater than the similarities, he investigated the work of shipwrights who built in a different tradition.

What he found is that modern boats are "frame-built" boats; the keel and ribs are built first and the outer "skin" of hull planks is attached later, whereas, in the older tradition, called "shell construction," the hull planking, or shell, is put together first, after which the frames, or ribs, are inserted to give strength and rigidity. The hull timbers are attached to each other, but the strengthening members are independent of the overall construction. And this, it turns out, is the method by which the ancients built the Cheops Boat and, archeologists now believe, most ancient boats.

During his research, Hag Ahmed found another difference in boat-building that would not become apparent until the Cheops Boat timbers were excavated; the hull timbers were literally *stitched* together with yards and yards of hemp rope, an ancient tradition maintained until very recently by shipwrights on the coasts of the Arabian Gulf, the Indian Ocean and the Red Sea.

This technique – used to build the Arab merchantmen that sailed to China in the seventh and eighth centuries (See *Aramco World,* July-August 1975) – seems flimsy, but the construction, in fact, is sound. In the water the wood swells, the cords shrink and a watertight, yet flexible, hull is achieved – precisely the way, Hag Ahmed learned, the shipwrights of the Fourth Dynasty built the funerary boat of King Cheops.

Having made himself an expert in both ancient and modern boat-building techniques, Hag Ahmed was at last ready for the task of lifting the timbers and fragments from the pit. As the pieces varied in size from a few inches to 66-foot sections of the hull – and as they were

buried in 13 well-defined layers – it was an exacting task. Each of the 1,224 pieces, for example, had to be photographed, drawn and catalogued. In addition, Dr. Zaki Iskander, then head of the antiquities department's chemical laboratories, had to treat each piece of wood with polyvinyl acetate, a plastic preservative, and, in some cases, treat the pieces with insecticide and fungicide as a protection against insects and mold.

Altogether, the first restoration took four years, but since then Hag Ahmed, a devout Muslim and a man of intelligence and humor, has taken the ship apart and put it together three more times as authorities changed plans for the site of the museum. And despite the problems – of research on ancient boat-building and in constructing it directly without a completed model – experts agree that it was a masterly job which, in the process of reconstruction, revealed much new information about ancient boats as well as the ancient society that built them.

On completion, the boat measured 142 feet long with a beam of 18 feet and a maximum draft of nearly five feet. Called a "papyriform boat" by Egyptologists, it is an imitation in wood of the early papyrus reed rafts in which, the ancient Egyptians believed, the Egyptian sun-god voyaged across the heavens daily.

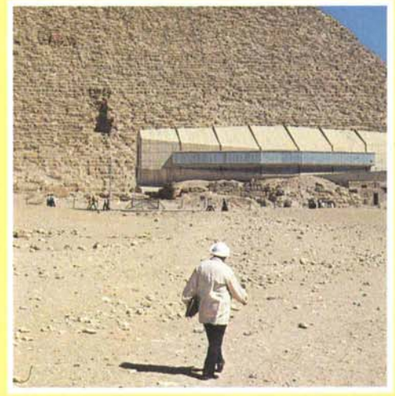
Because of its shape, the boat is called the "Solar Boat" and many have assumed, as a result, that its purpose was to provide Cheops with transport in accompanying the sun-god. Others, however, disagree. Indeed, the use of the Cheops Boat has been a subject of spirited controversy since it was discovered. Hag Ahmed, for example, categorically rejects the official designation of the "Solar Boat".

Although in ancient Egypt, it is true, the deified king was said to accompany the sun-god on his eternal rounds, Hag Ahmed has pointed out that the dead king would not need a separate boat of his own; he would have joined the sun-god in the god's own barge.

Hag Ahmed, with the authority of his 25 years' association with the boat, says firmly that the boat was used to transport the king's embalmed body from Memphis – then the capital of Upper and Lower Egypt – to the Giza plateau for burial beneath the pyramid. This, he says, would have taken place at the time of the Nile flood.

Others, however, state flatly that the boat was never used at all. The boat, they say, was built, dismantled and laid in the pit all at the same time for the king's use in any voyage he might make in the after-life. And if the adjacent pit is ever opened, they add, it will probably hold a boat that has sails rather than oars, so that the dead king would be able to sail upstream with the prevailing north wind, as well as travel downstream in the oared boat.

There is no certainty, of course, that there *is* a boat in the second boat pit, and although the second pit seems to be as well sealed with gypsum plaster as the first – suggesting that there is a boat in it – the Egyptians have wisely decided not to open the pit until the question of the first boat's preservation is settled – a question that has distressed all archeologists, and Hag Ahmed in particular, since the museum was built.



The question is actually quite simple: will the boat, now housed in a specially-designed, glass-walled museum, survive or deteriorate? Because installation of temperature controls in the museum was never finished, some archeologists, and Hag Ahmed, think the fluctuating temperatures of the area may eventually destroy what is unquestionably one of the greatest archeological finds of all time and one of the world's irreplaceable treasures. If so, the second boat, if there is one, would be much safer left where it is: the first boat, after all, suffered less in 4,600 years in the boat pit than in the few years it has been in the museum.

Meanwhile, the museum has been closed, and except for an occasional glimpse through the dusty windows, virtually no one sees the boat any more except, occasionally, the worried Hag Ahmed – who still hopes a solution can be found before it is too late.

Nancy Jenkins, a Rome-based correspondent for Aramco World, *has recently completed a book on the famous Cheops Boat, with photographs by Ross. The book,* The Boat Beneath the Pyramids, *will be published this fall by Holt Rinehart and Winston.*

From the archives of the Ottoman Empire an intriguing—and irresistible—mystery . . .

PIRI REIS AND THE HAPGOOD HYPOTHESES

WRITTEN BY PAUL F. HOYE WITH PAUL LUNDE

In 1929, scholars working in the archives of the Ottoman Empire in Turkey's Topkapi Palace Museum made an exciting discovery: a section of an early 16th-century Ottoman map based in part, apparently, on an original chart drawn or used by Christopher Columbus and showing his historic discoveries in the New World. The map, signed by an Ottoman captain named Piri Reis, was dated 1513, just 21 years after Columbus discovered America.

This find – disclosed two years later in Holland by German Orientalist Paul Kahle – astonished the 18th Congress of Orientalists. For if a notation on the map were true – "The coasts and islands on this map are taken from Colombo's map" – the Turkish map might finally settle a centuries-old debate: did Columbus know he had found a new world? Or did he die thinking he had found a new route to China?

As it turned out, the map did not settle the question. To the contrary, it has raised new and far more perplexing questions, and, in recent years, has sparked a rash of quasi-scientific and popular theories and hypotheses that attempt to answer those questions. Some of those theories, to be sure, verge on the ludicrous. But others, even when startling, have raised fascinating and sometimes disturbing possibilities.

Those developments, however, came later. In 1931, historians of cartography had quite enough to do trying to cope with the immediate questions posed by the discovery in Istanbul. Was the Piri Reis map authentic? If so, how did it get into the hands of Christian Spain's feared Muslim rivals? And just who, incidentally, was this Piri Reis?

According to subsequent research, the story of the Piri Reis map began in 1501, just nine years after Columbus discovered the New World, when Kemal Reis, a captain in the Ottoman fleet, captured seven ships off the coast of Spain, interrogated the crews and discovered that one man had sailed with Columbus on his great voyages of discovery. More important, in an age when maps were secret and maritime information invaluable, the sailor had in his possession a map of the New World drawn by Columbus himself. Kemal Reis seized the map, kept it and subsequently willed it to his nephew Piri Reis, also an Ottoman naval captain, and a cartographer.

In 1511, the story goes on, Piri Reis began to draw a new map of the world which was to incorporate all of the recent Spanish and Portuguese discoveries. To do so, he used about 20 source maps. Among them, he wrote, were eight maps of the world done in the time of Alexander the Great (the fourth century B.C.), an Arab map of India, four Portuguese maps of the Indian Ocean and China, and his uncle Kemal's bequest, "a map drawn by Colombo in the western region." He did not, however, say what the other six source maps were.

In Gallipoli, where he temporarily retired, Piri Reis reduced his source maps to a single scale – a difficult task in those days – and spent three years producing his map. When it was finished he added this inscription: "The author of this is the humble Piri ibn Hajji Muhammad, known as the nephew of Kemal Reis, in the town of Gallipoli in the Holy Month of Muharram of the year 919 [A.D. 1513]." (See *Aramco World*, July-August 1979)

This map, presented to Sultan Selim, seems to have helped the career of Piri Reis. He was made an admiral. But it was not Piri Reis' only contribution to cartography. In 1521 he also wrote a mariner's guide to the coasts and islands of the Mediterranean – which was to interest the cartographers trying to authenticate the map found in Istanbul. Called *Kitab-i Bahriye* ("Book of the Mariner," or "The Naval Handbook"), this book contained an account of the discovery of America by Columbus that was virtually identical to a long inscription on the left hand side of the map (see page 19) found in the archives of Istanbul.

The map found in Istanbul, therefore, is authentic. Although research has never disclosed what the six unlisted sources were, or further identified the eight "done in the time of Alexander the Great," there is no doubt that one source was a map drawn or used by Christopher Columbus himself.

There is little doubt, either, that both Piri Reis' map and book were valuable to the Ottoman Empire. Focusing, as they both did, on the discoveries by Spanish and Portuguese mariners, they probably alerted the sultan to the growing threat to Ottoman power posed by European exploration of the Indian Ocean and the Arabian Gulf.

Ironically, Piri Reis' book – in which he urged Suleiman the Magnificent to drive the Portuguese out of the Red Sea and the Gulf – also led to his death. Put in command of a fleet to drive the Portuguese out of the Gulf in 1551, he lost most of his ships and, although in his 80's, was executed. By 1929 both Piri Reis and his map had been virtually forgotten.

Even then the enthusiasm aroused by the map was short. Once the initial excitement over the discovery had faded, relatively few historians of cartography, with the exception of Kahle, paid much attention to the map or tried seriously to determine exactly what it proved – even with regard to Columbus. *Imago Mundi*, for example, one of the more important journals devoted to the history of cartography, has never run a full-length article on the Piri Reis map.

THE PIRI REIS MAP, PHOTOGRAPHED BY ARA GÜLER. REPRODUCED COURTESY THE TOPKAPI PALACE MUSEUM

In 1954, however, a Harvard-trained teacher of the history of science named Charles Hapgood assigned his class at Keene State College in New Hampshire to the task of examining the Piri Reis map more closely. Starting with little knowledge of the subject – and, says Professor Hapgood emphatically, "no preconceived notions" – he and his students eventually spent seven years on the project. During that time, Hapgood says, "we discarded hundreds of hypotheses" before arriving at those advanced in a book called *Maps of the Ancient Sea Kings*.

Two years later those hypotheses became unexpectedly famous when they were incorporated in the controversial best-seller *Chariots of the Gods*. Written by Erich von Däniken, *Chariots* went into at least 18 English editions and was translated into numerous other languages. Presented as fact, and written in a pseudo-scientific tone, *Chariots* described and briefly examined what the author called "the unsolved mysteries of the past." Among the "unsolved mysteries," von Däniken said, was the appearance on the Piri Reis map of information that 16th-century cartographers could not possibly have known. Citing Hapgood, von Däniken said that the map showed the coast of Antarctica, not discovered for centuries afterward, and certain mountains in Antarctica that were not discovered until modern sonar made it possible to locate them beneath the ice cap.

For the author – if not for his legions of critics – it was obvious how Piri Reis got such information: astronauts from another planet had provided it on maps. The astronauts, he claimed, had made numerous appearances on earth before and during the period of recorded history, and left traces all over the world.

Despite inaccuracies in describing what in some cases *are* mysteries – and in citing Hapgood – and despite frequently debatable logic, *Chariots* sold millions of copies. It also persuaded thousands of readers – brought up during a period of intense public interest in "flying saucers" and "UFO's" – that its premises were valid. *Chariots*, indeed, attracted such attention that BBC Television filmed and showed a two-part refutation of the book.

The BBC, moreover, was not alone; most serious observers scorned the book. Yet one of the points raised by Hapgood and quoted by von Däniken went stubbornly unanswered: how *did* Piri Reis know about Antarctica and its mountains in the 16th century, if, in fact, his map did show them?

One answer, in science-fiction form, was put forth by author Allan W. Eckert in a ponderous 1977 novel called *The Hab Theory* in which the Ottoman admiral's map was a focal point of the plot and in which other, apparently true, phenomena were described in great detail. Among them was the undeniable fact that mammoths – extinct for 18,000 years – were found in Siberia embedded in the permafrost, the frozen subsoil of Arctic and Antarctic regions.

According to Eckert, the mammoths were "quick-frozen" rather the way orange juice is today, thus explaining why the meat was still edible. Furthermore, some mammoths were found in an upright position with undigested grasses in their stomachs – facts confirmed last July by a spokesman at the British Museum. The grasses, moreover, were *tropical* grasses.

To Eckert, this suggested that Siberia was once a tropical region and that the shift in climate from tropic to arctic was very swift: in a matter of hours.

This occurred, *The Hab Theory* goes on, because every 6,000 years or so the polar regions accumulate so much ice that the earth begins to wobble on its axis. At a critical point the wobble becomes so bad that the earth capsizes, leaving the polar regions at the equator and the equatorial regions at the poles. The earth's normal rotation then resumes until the new polar regions accumulate enough ice to cause another wobble and another cataclysm.

This process, the book continues, explains what characters in the book call scientific mysteries. One is that the ancient Berbers, in what is now the Sahara, left cave paintings showing people swimming and sailing in "a vast body of water." This, according to *The Hab Theory*, was a sea created when the earth capsized and the polar ice cap, now close to the equator, melted, creating a large sea – now reduced to today's Lake Chad.

Even for science fiction, it is a startling idea. Yet it is not entirely without a basis in fact. In the *New Scientist* issue of May 17, 1979, two professors from Cardiff and Oxford Universities in Britain were quoted as saying that the last ice age may have come on quite swiftly and cited the mammoths in Siberia as proof. "Their excellent state of preservation is also evidence that they were quickly frozen after death," the article said.

Science fiction, of course, is as much fiction as science. Still, at the heart of *The Hab Theory* there were some ascertainable facts. The Piri Reis map *does* exist, there *were* mammoths preserved in Siberian permafrost, and cave paintings of some sort *have* been found in the Sahara, though whether they show "vast seas" or not could not be determined. Even more to the point, there is a *real* Hab theory. In fact, according to Professor Hapgood, the real Hab theory – as distinct from Eckert's science-fiction treatment – was what launched him on his first studies of Antarctic "mysteries" and led, in a curious chain of events, to the Piri Reis map.

The real Hab theory was first proposed by an engineer specializing in centrifugal force: the late Hugh Auchincloss Brown, whose initials are the same as the fictional proponent of Eckert's book. In a book called *Cataclysms of the Earth*, Brown suggested what is basically the same theory presented in the novel: that massive accumulation of ice at the poles, especially the South Pole, caused the earth to wobble on its axis and then, about every 7,000 years, to "careen." Like the novel, it has some basis in fact. A spokesman at the Scott Polar Research Institute in Cambridge, England – who says "careening" is impossible – confirmed last month that the ice *does* accumulate at the South Pole in massive quantities: *2,000 billion tons a year*, enough to build a wall 10 inches thick and half a mile high from New York to California.

For Charles Hapgood in New Hampshire, Brown's theory was fascinating. "I spent about 10 years looking into it," he said in a recent interview, "until mathematical calculations proved it impossible." But as his research had raised certain questions in his own mind, Hapgood continued to work on the subject and eventually came up with his *own* theory, which he outlined in *Earth's Shifting Crust* (Pantheon Books, New York, 1958). Essentially, he said, the earth's crust "slips" over its core, thus periodically changing the positions of the poles.

Aware that ideas that deviate from traditional scientific beliefs get short shrift in the scientific community – as did, for instance, Wegener's theory of continental drift, now widely accepted – Hapgood took the precaution of submitting his manuscript to a scientist whose views were generally thought to be acceptable: Albert Einstein. Though neither cartographer nor geographer, Einstein read the manuscript, agreed to write the introduction and said Hapgood's ideas "electrified" him. He also said that if Hapgood's theory "continued to prove itself," it would be "of great importance to everything that is related to the history of the earth's surface."

Meanwhile, Hapgood had heard of the Piri Reis map. A U.S. Navy cartographer, engineer and ancient-map specialist – Captain Arlington H. Mallery – had come across a copy of the map, studied it and said publicly that the map seemed to show Antarctica – unknown at the time the map was drawn – and that, furthermore, the coast seemed to have been mapped at a time when it was free of ice, an apparent impossibility. Furthermore, Mallery's opinions had been endorsed by the directors of the astronomical observatories at Boston College and Georgetown University, Daniel Linehan and Francis Heyden.

To Hapgood, already caught up in the subject of Antarctica, the questions raised by Mallery and the Piri Reis map were an irresistible challenge. As Antarctica was not discovered until 1820 – 307 years after Piri Reis drew his map – how could Piri Reis possibly have included Antarctica – if he did? And, since Antarctica had, presumably, been covered with ice for millennia, why would he have shown it *without* ice? And why does the notation on the map read as follows: "There is no trace of cultivation in this country. Everything is desolate, and big snakes are said to be there. For this reason the Portuguese did not land on these shores, *which are said to be very hot*"?

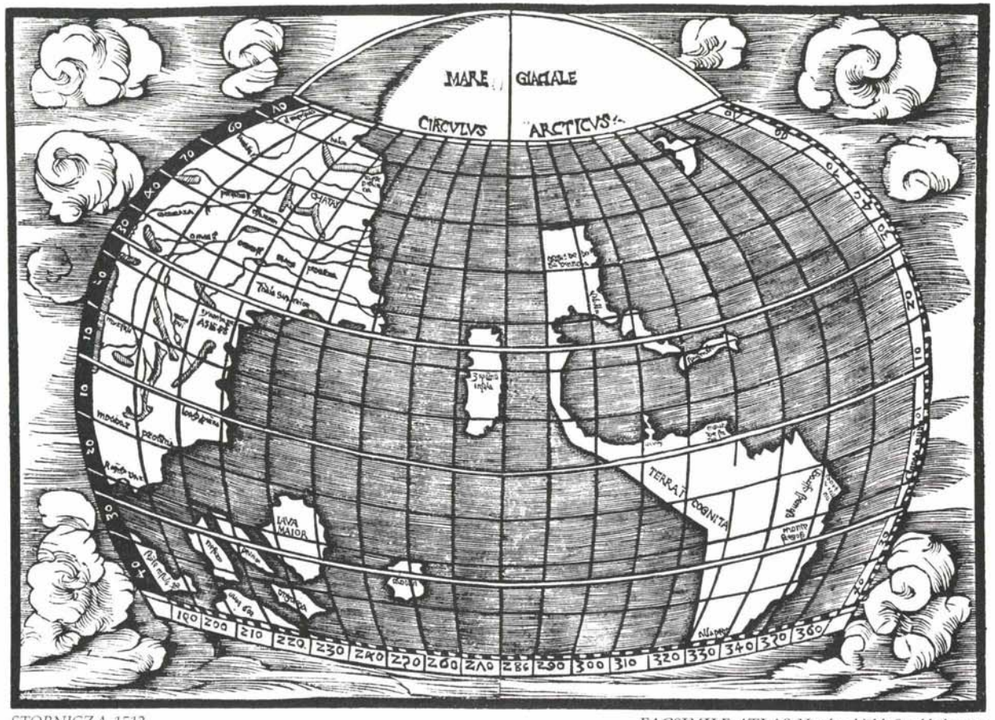
Hapgood thought that investigation of these ideas would be an interesting challenge for his students. Accordingly, he presented it to them as a class project and began to work with them himself.

As the investigation began, Hapgood and his students immediately came across several puzzling facts. One was that, on the Piri Reis map, the mountains in the western region of what is obviously South America seemed to be the Andes. But since Magellan did not find a way around the continent, through the strait named after him, until 1520 – seven years after the map was finished – and since Pizarro did not sight the Andes until 1527 – 14 years afterwards – how could Piri Reis have known about the Andes? The answer, obviously, was that one of Piri Reis' 20-odd source maps must have shown them.

But which map? Hapgood concluded it was probably one of the eight maps of the world done in the time of Alexander the Great, or one of the six other "unknown" maps – which meant someone had not only *known* of the Americas, but had mapped them at least 1,700 years before Columbus.

PIRI REIS AND THE COLUMBIAN THEORY

WRITTEN BY PAUL LUNDE



STOBNICZA, 1512

FACSIMILE-ATLAS, Nordenskjöld; Stockholm 1889

Until the discovery of the Piri Reis map, there were only two cartographical sources, both indirect, for how Columbus viewed his discoveries.

One was a sketch made about 1525 by a certain Alessandro Zorzi of Venice, who said it was based on a map brought to Italy by Columbus' brother Bartholomew in 1506. Unfortunately, Zorzi's map also embodies information not known in 1506 and cannot, therefore, be used as evidence of Columbus' geographical notions, although it does show the New World as a part of the Asian mainland.

The only other surviving map going back to Columbus' own voyages is one drawn by Juan de la Cosa, who was a member of Columbus' first expedition of 1492 and who later sailed with Vespucci. But this map too, traditionally dated 1500, incorporates information that was not known to Columbus. For example, it shows Cuba as an island – yet Columbus not only believed Cuba to be part of the mainland of Asia but made each of his crew members swear that it was not an island.

This is why Kahle's 1931 lecture on the Piri Reis map so electrified his audience. It seemed almost miraculous that the only direct cartographical record of the greatest discovery of all time should have been preserved in a library in Istanbul, and that we should owe its preservation to an admiral of the Ottoman navy.

Oddly enough, however, few scholars since Paul Kahle seem to have carefully examined the "Columbian" portions of the Piri Reis map, and the question of whether or not – and to what degree – it represents Columbus' ideas is still far from settled.

The Map. The Piri Reis map is drawn on gazelle hide, with a web of lines criss-crossing the Atlantic. Called "rhumb lines," they are typical of late medieval mariners' charts, and most scholars believe do not indicate latitude and longitude, but were used as an aid in laying a course.

Among the map's illustrations are two lozenges, which give the scale, and beautifully drawn ships, some accompanied by inscriptions which record important discoveries (see pages 24 and 25). One is almost certainly an account of the expedition of Cabral in 1500; Cabral discovered Brazil when he was blown off course across the Atlantic while on his way to India.

The Iberian Peninsula and the coast of west Africa are carefully drawn, in a manner suggesting the style of the practical mariners' charts called "portolanos." Here many of the place names are given in Turkish, rather than being merely transliterated from Portuguese or Spanish — showing that the Ottomans had practical experience of their own along those coasts.

At the top of the map is a ship anchored near a fish, with two people sitting on its back. The accompanying inscription tells a tale from the life of the Irish Saint Brandon, a charming medieval legend. Faithfully copied by Piri Reis from one of his source maps, it is evidence that at least one of the mappaemundi – maps of the world – mentioned as sources by Piri Reis was a medieval European production and not a map of the "ancient sea kings."

Another immediately striking feature of the map is the number of islands, most of them legendary, and some of them adorned with parrots. Maps showing islands scattered through the Atlantic were current in the later Middle Ages, and a globe made by Martin Behaim in 1492 – the same year Columbus first set off – shows a quantity of them; so does the Toscanelli map, which we know Columbus used.

The Caribbean. With regard to the Hapgood hypotheses, the Caribbean portion of the Piri Reis map is particularly important. In its northwest corner, for example, there is a large island labeled Hispaniola – today the home of Haiti and the Dominican Republic – which Columbus discovered on his first voyage and where he set up a colony, marked by the three towers on the map. Immediately below Hispaniola is Puerto Rico, and to the northeast is a group of 11 islands labeled Undizi Vergine – "The Eleven Virgins." The fact that this name is in a recognizable form of Italian – as opposed to Portuguese – is evidence, as Kahle pointed out, of its Columbian origin. This part of the Piri Reis map is thus not based on maps from the ancient civilization postulated by Hapgood.

Further evidence is the fact that the map of the Caribbean area is so wildly inaccurate. Hapgood attempted to bring it into line with geographic reality by postulating an equidistant projection based on a point near Cairo, identifying the island clearly labeled Hispaniola as Cuba, and re-orienting the entire Caribbean regions — which is seriously forcing the evidence. Not only is Hispaniola — Hapgood's "Cuba" — grossly out of proportion to Brazil, for example, but it is oriented north-south rather than east-west. Most striking of all, it is almost identical to the conventional representations of Marco Polo's "Cipangu" – that is, Japan – on late medieval maps such as Behaim's and Toscanelli's. Why? Probably because Columbus was convinced, on his first voyage at least, that he had found the fabled Cipangu (Japan), and he may have drawn Hispaniola in this shape to support his claim.

An even more important argument for the Columbian origin of this part of the map and against its classical or "ancient" origin – unless Hapgood's ancient mariners were very bad cartographers indeed – is the fact that the real Cuba, as an island, is missing. And so it should be on a Columbian map, for Columbus thought Cuba was part of the mainland of Asia, and drew it accordingly. On Piri Reis' map, the wedge-shaped projection on the mainland opposite Hispaniola is almost certainly the eastern tip of Cuba; the southward-trending coast below is an attempt to draw Cuba as if it ran north and south — as Columbus believed it did. It is interesting that Behaim's globe and other maps influenced by Marco Polo's description of Cathay show a very similar wedge-shaped projection opposite the island of Cipangu; if Columbus thought he was off the coast of Asia, he may have drawn the mainland this way to correspond to its then conventional representation.

South America. The delineation of the coast of Brazil on the Piri Reis map is much more accurate than that of the Caribbean. The relationship and distance between South America and the west African coast, for example, is much more correct than on most European maps of the time – and the place names along the coast, clearly transliterated from Italian and Spanish names, are taken from accounts of the voyages of Amerigo Vespucci and others.

The most striking topographical detail, and the one that has caused the most discussion, is the chain of mountains running through South America – the mountains which Hapgood identified as the Andes. The rivers which issue from their base are obviously meant to be the Amazon, the Orinoco and the Rio Plata, and the animal with two horns standing on the mountains is Hapgood's "llama". Interestingly, though, the Piri Reis map is not the only early map – nor the first – to show mountains in the interior of South America. The Nicolò de Canerio map, now in the Bibliothèque Nationale in Paris, and the Waldseemüller chart both show the east coast of South America, though schematically drawn, and a chain of mountains adorned with trees. The de Canerio map was drawn between 1502 and 1504 – long before the eastern coast of South America had been explored. As there is a striking similarity between this map and the Piri Reis map, it is therefore possible that one of Piri Reis' source maps was based on that of de Canerio rather than on one produced by an ancient civilization. Other maps showing the east coast of South America may also have been available in some form to Piri Reis – such as the maps of Martin Waldseemüller (1507), Glareanus (1510) and Johannes de Stobnicza (1512). All of these are related to each other and, almost without question, ultimately derive from a de Canerio-derived map.

The map by Johannes de Stobnicza, in particular, could have been available to Piri Reis, for it was printed in Cracow, Poland, in an edition of Ptolemy, in 1512, the year before the Piri Reis map was drawn. Thus it could have been one of the maps "drawn in the time of Alexander the Great" which Piri Reis refers to — especially considering the confusion that existed between the two Ptolemies.

Antarctica and the Eastward-Trending Coast. This portion of the map was crucial to Hapgood's hypotheses, yet it too could have been derived from sources other than a forgotten advanced civilization. While none of the maps derived from de Canerio's shows an Antarctic continent, other groups of early maps do. Beginning in the early 15th century, mapmakers often indicated a huge southern landmass that linked Africa to Asia and made a landlocked sea of the Indian Ocean – a geographical notion derived from Ptolemy's references to a "southern land". When Magellan passed through the strait that now bears his name, he sighted Tierra del Fuego to the south and assumed that it was a promontory of Ptolemy's southern landmass; it was not until Drake's southern voyage of 1578 that this idea too was exploded.

The search for terra australis went on for centuries – incidentally leading to the discovery of the land which now fittingly bears the name that so fascinated Renaissance cartographers: Australia. But Antarctica itself eluded the great discoverers.

There are, however, some indications that the coast of Antarctica was sighted before its "official" discovery in 1820. The great Amerigo Vespucci related how, blown off course and driven 500 miles south, he sighted a land which he named Terra da Vista – "Land Seen" – and which was possibly the Falklands or even Antarctica. In 1514, the year after the completion of the Piri Reis map, two Portuguese ships reported something similar, as did two Dutch ships about the same time: also blown off course, they sighted land and named it "Pressillgtlandt". Whatever land was sighted on these obscure voyages, the accounts prove one thing: there was no inherent impossibility in a 16th-century ship getting a long way south.

There may, in fact, be an even simpler explanation of the presence of "Antarctica" on the Piri Reis map. To start with, as Hapgood admits, about 900 miles of South American coastline are missing from the map: below the Rio de la Plata the coast simply turns eastward. And, interestingly, if this eastward section of coast is looked at vertically – that is, as continuing south instead of east (see page 21) – it does bear a remarkable resemblance to the actual east coast of South America from below Rio de la Plata down to Tierra del Fuego. Some of the smaller coastal features, moreover, jibe with a modern map as well, and the small group of three islands (Isla de Sara) could then be identified as the Falkland Islands, and the wedge-shaped projection at the most easterly point of the line could correspond to the tip of South America.

To put it more simply, Piri Reis, or the scribe who copied his work, may have realized, as he came to the Rio de la Plata, that he was going to run off the edge of his valuable parchment if he continued south. So he did the logical thing and turned the coastline to the east, marking the turn with a semicircle of crenelations, so that he could fit the entire coastline on his page. If that was the case, then the elaborate Hapgood hypotheses – or at least those elements based entirely on the Piri Reis map – would have no foundation whatever.

It was possible, of course, that the mountains were not – and were not supposed to be – the Andes at all. Still, the map did show them roughly in the right place, and included a drawing of a creature that Kahle had tentatively identified as a llama. As the llama is exclusive to the Andes and was not known in Europe in 1513, when Piri Reis finished his map, Hapgood concluded that the mountains were indeed the Andes.

As the study went on, the Hapgood team noticed, toward the south, what looked very much like the Falkland Islands – even though the Falklands were not discovered until 1592 – and reasoned that if they *were* the Falklands, the land south of them would almost surely be the coast of Queen Maud Land – Antarctica – not discovered until more than three centuries after the Piri Reis map.

As it was this feature that had fascinated Hapgood originally, his team made a particularly careful comparison of "Antarctica" on the Piri Reis map with Antarctica on a modern globe. They concluded that there was "a striking similarity" between the Piri Reis coastline and the Queen Maud Land coast. Later, after a series of complicated calculations, they also came to believe that the Piri Reis map, in that area, was accurate to within 20 miles.

In what was a vital aspect of the developing hypotheses, they also concluded that Mallery's "mountains" – the mountains not discovered until this century – were, on the Piri Reis map, the small cluster of islands shown at the bottom toward the right (see page 19). According to Hapgood, the "heavy shading of some of the islands" was, in 16th-century map-making techniques, an indication of mountainous terrain. In addition, he said, a seismic profile made by a Norwegian-British-Swedish expedition in 1949 disclosed a range of *undersea* mountains. Some of these, the Hapgood team concluded, would emerge from the sea as islands if there were no ice cap – another indication that Antarctica had really been explored and mapped earlier, at a time when no ice cap existed.

By then, of course, Hapgood and his students were captivated by the mystery of the map. They proceeded cautiously, however, because they knew that many cartographers in ancient times vaguely believed in the existence of a landmass in the southern regions and, with or without evidence, might have added something to their charts out of blind faith – or even out of a preference for esthetic balance.

Partial translation of inscriptions on the Piri Reis map

They say that long ago a priest named San Vulrandan [Saint Brandon] sailed the seven seas . . . encountered this fish and, taking it for dry land, lit a fire on its back . . . These events . . . have been taken from old mappaemundi.

"This region is called the Province of Antilia, and lies to the west. Here are found four kinds of parrots: white, red, green and black. The inhabitants . . . make head-dresses of the feathers of the same varieties of parrots . . ."

This island is called the Island of Antilia. It contains many animals, parrots and wood, but is uninhabited."

"This bark . . . was driven to these shores by a storm, and stayed there. It is written on his map that these rivers, here depicted . . contain gold dust . . ."

"In the mountains of this territory were creatures like this, and human beings came out on the seacoast. The goldmines are endless."

"The author of this [map] is the humble Piri ibn Hajji Muhammad, known as the nephew of Kemal Reis . . . in the town of Gallipoli in the holy month of Muharram of the year 919 [1513]."

"These beings are seven spans high. The space between their eyes is one span. They are, however, harmless."

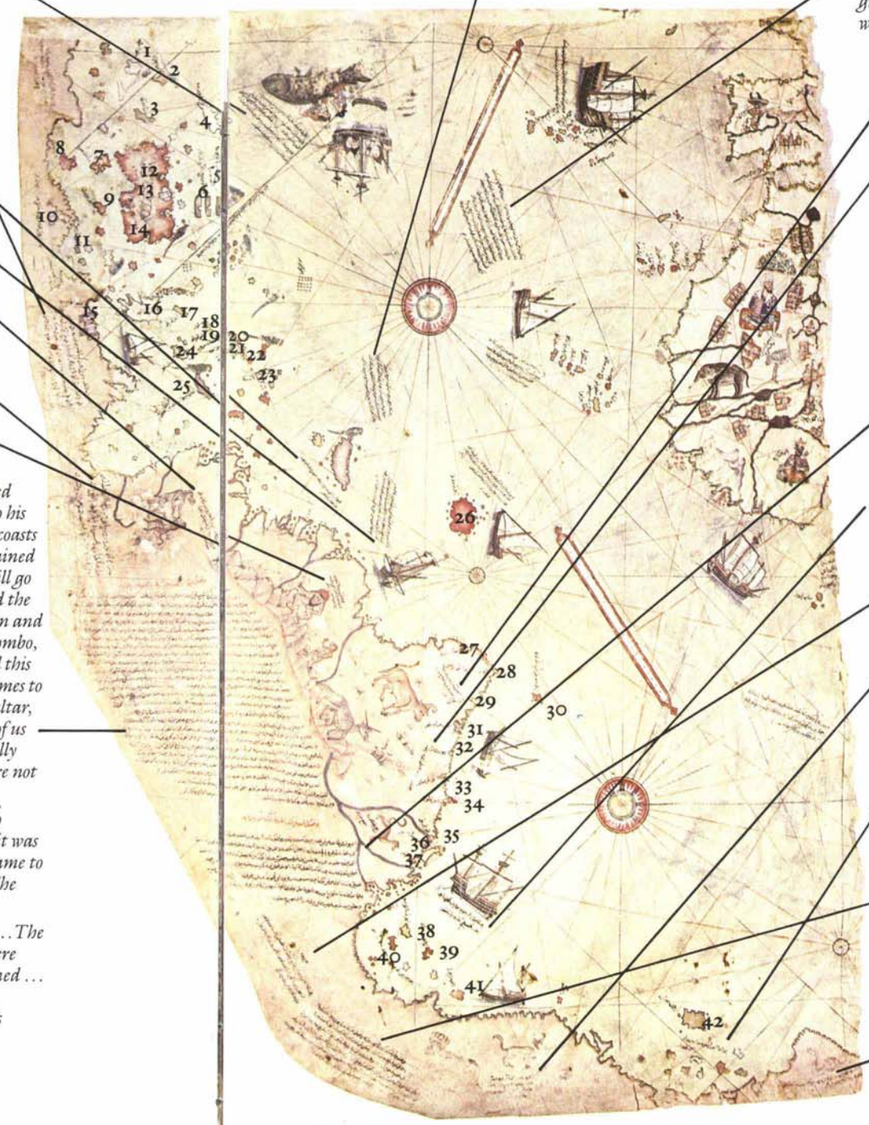
These coasts are called the shores of Antilia . . . It is reported that a Genoese called Colombo was the first to discover these territories. It is said that a book came into his hands which stated that at the end of the Western Sea, on its western side, were coasts and islands and different kinds of metals and precious gems. This man . . . explained these things . . . to the great men of Genoa and said: 'Give me two ships, and I will go and find these regions.' They said, 'O foolish man! In the west is only to be found the end and limit of the world! It is full of darkness.' . . . so he went to the Bey of Spain and told him his story . . . At last . . . the king gave him two ships . . . and said: 'O Colombo, if what you say is true, I will make you Admiral over that country.' Having said this he sent the said Colombo to the Western Sea. [A seaman who] had been three times to that land with Colombo . . . said: "First we traveled through the Strait of Gibraltar, then we journeyed straight ahead 4,000 miles . . . We then saw an island ahead of us and the waves became still and the sea becalmed and the North Star . . . gradually became veiled and finally invisible." He also said that the stars in that region are not disposed as they are here . . .

The inhabitants of this island . . . shot arrows at them and did not allow them to land . . . The said Colombo saw another island; they drew near it and saw that it was covered with large snakes . . . The inhabitants of this island saw that no harm came to them from this ship so they caught fish and brought them in their small boats. The Spaniards were pleased and gave them glass beads . . .

One day they saw gold on the arm of a woman; they took it and gave her beads . . . The natives went and brought them more gold. It seems that in their mountains were gold mines . . . They loaded their ships . . . took two natives with them and returned . . . to . . . the King of Spain . . . Now these regions have been opened to all and have become famous . . . The coasts and islands on this map are taken from Colombo's map."

Place names as given by Piri Reis:

1. Istunasid *(unidentified).*
2. Tris Puzeh *(Tres ———?).*
3. Sandani *(unidentified).*
4. Ila Verde *(Cape Verde on Long Island?).*
5. Barburah *(Babeque? [Great Inagua Island]).*
6. Tris Matus *(Tres Matos = Three Fools).*
7. Santa Maria.
8. Purta Fanda *(Puerto Grande?).*
9. Barbanith *(unidentified).*
10. Qaw Punta Arofi *(Cape Punte Ornofoy).*
11. Ila Tarsumanye *(unidentified).*
12. Jazira *(Arabic word for island).*
13. Ila de Spanya *(Hispaniola, modern Haiti).*
14. Paksin Vidada *(Puerto Navidad?).*
15. Qal'at Faridat *(Fort "Faridat").*
16. San Juan Batishdu *(San Juan Bautista, Puerto Rico).*



"The Portuguese do not pass from here to the western territories. All this territory belongs to Spain. They agreed to make a boundary 2,000 miles west of the Strait of Gibraltar . . ."

"This sea is called The Western Sea, *but the Europeans call it* Mar de Espana, *"The Sea of Spain." It has hitherto been known by these names, but Colombo, who opened up this sea, and first made known the existence of these islands, together with the Portuguese who have opened up the Indian Sea, agreed among themselves that they would give a new name to this sea. They decided upon* Ovosano [Oceano], *which means 'sound egg'."*

"Here there are one-horned cattle, as well as creatures shaped like this."

"This region is inhabited; human beings are plentiful."

"This section tells how this map was composed. No one in this age has seen a map like this.
I composed this map, compiling it from about 20 charts and mappaemundi *– maps drawn in the days of Alexander of the Two Horns – which depict the inhabited quarter of the world. These maps are called* ja'fariyya *by the Arabs. I have used eight of these* ja'fariyya *maps, one Arab map of India, and four up-to-date Portuguese maps, showing the countries of India, Sind and China, drawn in accordance with geometry. I have also employed a map drawn by Colombo in the western region. This final form was arrived at by reducing all these maps to a single scale. The present map is thus as correct and reliable for the Seven Seas, as the map of our countries is considered by seamen to be correct and reliable."*

"This is the Portuguese bark which ran into a storm and was driven to these regions. It has been described in detail in the margin."

"The Portuguese relate that in this place night and day last two hours at their shortest period and 22 hours at their longest. The day is very warm, and there is much dew at night."

"In this country are found white-haired creatures like this, as well as six-horned cattle. The Portuguese have written this on their maps."

"Island of Sara. These islands are uninhabited, but spices abound."

"A Portuguese ship on the way to India met a contrary wind blowing from the coast . . . After being driven south by the storm, they sighted a coast opposite them . . . and saw that there were good anchorages, so they dropped anchor . . . They saw naked people walking about, who shot arrows tipped with fishbone. They stayed eight days, trading with these people by signs. That bark visited these lands, and they were described. The said bark returned to Portugal without going to India, and made a report. Eight caravels were sent. They described these coasts in detail, and this has been copied from them."

"There is no trace of cultivation in this country. Everything is desolate, and big snakes are said to be there. For this reason the Portuguese did not land on these shores, which are said to be very hot."

17. Izla Balah *(Isla Bela? Isabela?).*
18. Qawaw *(unidentified).*
19. Samu Qristu *(Santa Cruz?).*
20. Santa Mardiya Ghalanda *(Santa Maria Galante).*
21. Wasiyat *(Santa Lucia?).*
22. Wadluq *(Guadalupe).*
23. Qalerat *(Punte Galera, Trinidad?).*
24. Sant Elmo.
25. San Juan Batishdu *(San Juan Bautista; see 16).*
26. Izla de Vaca *("Cow Island"; unidentified).*
27. Sant Luqa *(Cape São Roque).*
28. Qaw de Santa Agustini *(Cape São Agostinho).*
29. San Mighali *(San Miguel).*
30. Ila de Firnam de Lonje *(Fernão de Noronha).*
31. San Franjisqu *(Rio San Francisco).*
32. Port Reali *(Rio Real).*
33. Tutal Sante *(Bahia de Todos os Santos).*
34. Abarqluq *(Abrolhas?).*
35. Qaw Friyu *(Cape Frio).*
36. Sanu Saniyru *(Rio de Janeiro?).*
37. Qatinu *(Cananea?; southernmost point reached by Vespucci).*
38. Izla Matus *(Isla Matos; unidentified).*
39. Ila de Dasane *(unidentified).*
40. *(There are gold mines in these islands.)*
41. Ila de Viyola *(unidentified).*
42. Ila de Sara *(Unidentified. Falklands?).*

In 1959, however, in the Library of Congress, Hapgood noticed a presumably authentic map that instantly wiped out his doubts: a map of what was almost certainly Antarctica, done in 1531 by the French cartographer Oronce Finé, also known as Oronteus Finaeus. To even the most skeptical, the Oronteus Finaeus map (see pages 28-29) is startling. Although it was printed in a book in 1531 – and was thus not subject to subsequent amendment – it is remarkably similar to today's maps of Antarctica (see page 29). Admittedly it is too close to the tip of South America, and it is incorrectly oriented, yet the proportions seem similar, the coastal mountains, found in the 1957 geophysical study, are in roughly the right places and so are many bays and rivers. Furthermore, the shape of South America itself seems right, and the close resemblance between a modern, scientifically exact map of the Ross Sea and Finaeus' unnamed gulf is striking.

What *is* different, however, is that the Oronteus Finaeus map does not seem to show the great shelves of ice that, today, surround the continent, nor the great glaciers that fringe the coastal regions.

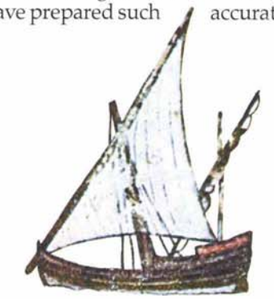
Instead there seem to be estuaries and inlets, suggesting great rivers. To Hapgood and his team, that meant that at some time in the past the Ross Sea and its coasts – scene of the November, 1979 air disaster on Mount Erebus – and some of the hinterland of Antarctica were free of ice. It also suggested to Hapgood that since the Antarctic was certainly ice-bound in 1531 – when Oronteus Finaeus made his map – Finaeus must have had access to very ancient maps indeed: maps made when Antarctica was largely free of the mile-thick ice cap that buries it today, and presumably has covered it for millennia.

Those observations, however, were just the beginning. "We had to have more than a resemblance," Professor Hapgood said recently. The evidence – "the only evidence" – is in the mathematical calculations by which Hapgood and his team – with the help of an M.I.T. mathematician – converted the "rhumb" lines on the map (see page 19) into modern lines of latitude and longitude. This, briefly, involved the assumption that a system of lines of longitude and latitude underlies the network of rhumb lines which radiate from the five wind roses located in the Atlantic. These wind roses lie on the perimeter of a circle whose center would be near Cairo on the missing portion of the map. Hapgood postulated from this that the map was drawn on what is called an "equidistant projection" centered on Cairo.

This conversion required years of trial and error and eventually involved a cartographic unit of the Strategic Air Command (SAC). But the results, Hapgood says, were startling. They seemed to show an accuracy impossible at the time Piri Reis drew the map and inconceivable in the time of Alexander the Great when, presumably, Piri Reis' sources drew *their* maps.

To Professor Hapgood the conversions of the underlying lines of latitude and longitude are vital. "They establish beyond any doubt the extraordinary accuracy of the maps, clearly beyond the capability of any medieval or ancient cartographers known to us."

Hapgood and his students also examined the late medieval and early Renaissance maps called "portulans" or "portolanos." These were highly accurate mariners' charts of the Mediterranean area – sometimes including the Black Sea – made by Portuguese, Venetian, Spanish, Catalan and Arab seamen. They are extremely beautiful maps, but what struck Hapgood was their accuracy. How, Hapgood asked, could medieval sailors, with no navigational aids but the compass, have prepared such accurate charts?



Hapgood was not the only one – nor the first – to have been puzzled by portolano maps. Years before, the Norwegian scholar Nordenskjöld – the leading authority on them – had shown that all portolanos appear to be based on a single prototype – that had vanished. But, says Hapgood, Nordenskjöld did not check the mathematical foundation and so postulated that the lost prototype was a product of classical Greece or Phoenicia, whereas Hapgood's researchers concluded that the Greek geographers, from whom Piri Reis had taken certain basic data, *had* to have used still other maps as sources because the data on the *Greeks'* maps was drawn with a precision that predated Greece's own development – about 200 B.C. – of plane geometry and trigonometry. And without knowledge of geometry and trigonometry, they said, no one *could* have produced such accurate maps.

The matter of accuracy, in fact, is debatable. (See pages 22-23.) But according to Hapgood, his examination of one portolano – the Dulcert Portolano of 1339, drawn 153 years before Columbus – is conclusive proof that the Portolanos, at least, are "scientific products." Although this portolano covers an area measuring 3,000 miles by 1,000 miles, 50 localities in the area are pin-pointed with less than one degree of error in longitude and latitude, as reprojected by Hapgood.

The researchers also examined, compared and recalculated the work of numerous geographers from Ptolemy through the Renaissance – including the first world map made by Mercator, a seminal figure in cartography, and a remarkable map dated 1380 called the "Zeno Map." It seemed to show Greenland *too* without an ice cap.

Thus, gradually, Hapgood, after exhaustive research and imaginative mathematical and cartographic experiments, came to his conclusions and, eventually, published them in a book called *Maps of the Ancient Sea Kings* (Chilton Books, Philadelphia, 1966). Briefly these are the conclusions:

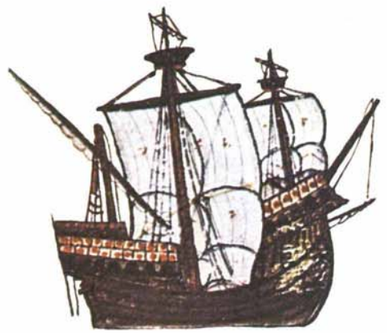
– that the Piri Reis map, the portolano charts and many other ancient maps include information supposedly unknown in the 16th century and, in some cases, information that was not confirmed until the middle of this century.

– that the Piri Reis map and other maps were inexplicably accurate, particularly with regard to longitudes, which neither mariners nor cartographers could calculate until spherical trigonometry was developed in the 17th and 18th centuries.

– that some civilization or culture still unknown to archeology – and pre-dating any civilization known so far – had mapped North America, China, Greenland, South America and Antarctica long before the rise of any known civilization – and at a time when Greenland and Antarctica were not covered with their millennia-old ice caps.

– that to have done this, the ancient civilization had to have developed astronomy, navigational instruments – such as the chronometer – and mathematics, particularly plane geometry and trigonometry, long before Greece or any other known civilization.

– that the advanced cartographic knowledge appearing on the Piri Reis map, the Oronteus Finaeus map and other maps came down in garbled and incomplete fragments that somehow survived the destruction of the unknown civilization itself and the repeated destruction of such ancient repositories of knowledge as the library at Alexandria.



These hypotheses, obviously, were revolutionary and some reviews of *Maps of the Ancient Sea Kings* were, predictably, skeptical in tone. Yet one American reviewer called it a "seminal book," an English reviewer called it "provocative" and Kenneth R. Stunkel, who challenged the conclusions in Britain's *Geographical Review,* admitted that Hapgood's work on ancient maps was "... a model of thoroughness and meticulous engagement with a complex and elusive subject." Furthermore, Hapgood, before publishing his book, had submitted it to John K. Wright, director of the American Geographical Society for 11 years. Wright – a geographer and cartographer – said that Hapgood "posed hypotheses that cry aloud for further testing."

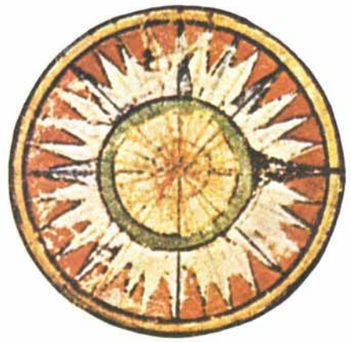
Unfortunately, from Hapgood's point of view, his theories were *not* tested. Most scholars, in fact, seem to have ignored them. As noted, there is relatively little – with the exception of Paul Kahle's book – written on the Piri Reis maps by scholars. This may be because Hapgood himself, quoting Thomas Edison, had said that some problems are too difficult for specialists and must be left to amateurs – and most scientists took him at his word. They largely ignored him.

This was not entirely unexpected. As writer J. Enterline put it, in discussing the response of science to the Hapgood hypotheses, acceptance "engendered the necessity of so many accessory explanations, rationalizations and postulates that it became untenable." But their basis for rejecting it, said Enterline – who was also skeptical – was *not* because of any demonstrated counter proof but because it seemed to violate common sense and probability – which, he added, is also true of modern physics.

To put it another away, Hapgood's work simply cannot be lumped with the lunatic fringe and he certainly cannot be held responsible for the *Chariots*-level offshoots that fed on his research. Although unquestionably an amateur theoretician, he did do his homework and had it thoroughly checked by professionals. The U.S. Air Force SAC cartographers, for example, worked with him for two years and fully endorsed his conclusions about Antarctica.

Nonetheless, there are serious weaknesses in Hapgood's case. For one thing, Hapgood's theses depend entirely on mathematical projections and logic. While he admittedly reasons carefully from observation to conclusion – and had his calculations done by an M.I.T mathematician – he obviously cannot produce any of the "advanced" maps or display a single artifact from the "lost" civilization that supposedly mapped the Americas and Antarctica. For another, he may not have accorded enough importance, at least in the Caribbean portions of the Piri Reis map, to the Christopher Columbus map – as a close examination of the Piri Reis map may show (see pages 22-23). Lastly, he was led by his own logic into postulating an ice-free Antarctic – which conflicts totally with accepted geological theory that says the Antarctic ice cap has been in place for 50 *million* years.

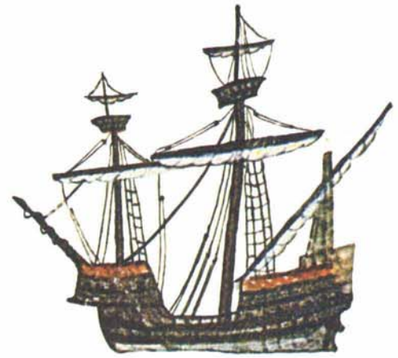
There are other arguments too. One is that many place names on the map, written in the Turco-Arabic script, are clearly transliterations of Portuguese and Spanish. If, as the Hapgood hypotheses suggest, Piri Reis used maps drawn by ancient cartographers, why don't the place names at least reflect their language?



The most compelling arguments against the Hapgood hypotheses, however, concern the Andes and – above all – Antarctica, both vital to Hapgood's conclusions. Is the chain of mountains to the left of the map really the Andes? Is the coastline at the bottom really Antarctica? Are there any mountains shown there? And is Antarctica free of ice?

A cursory examination would certainly suggest that the mountains are the Andes; they are the most striking topographical feature on the map. But beside the mountains there is an inscription (see pages 24-25) that doesn't quite fit into Hapgood's scenario. It reads: "In the mountains of this territory were creatures like this, and human beings came out on the seacoast..."

Assuming the inscription refers to the eastern coast, this means that "to come out on the seacoast," those "human beings" would have had to walk all the way from, say, Peru, rather than from one of the ranges near the Brazilian coast. And as to the llama, is it really a llama? The animal shown on the map definitely has horns and the llama definitely does not (see page 19).



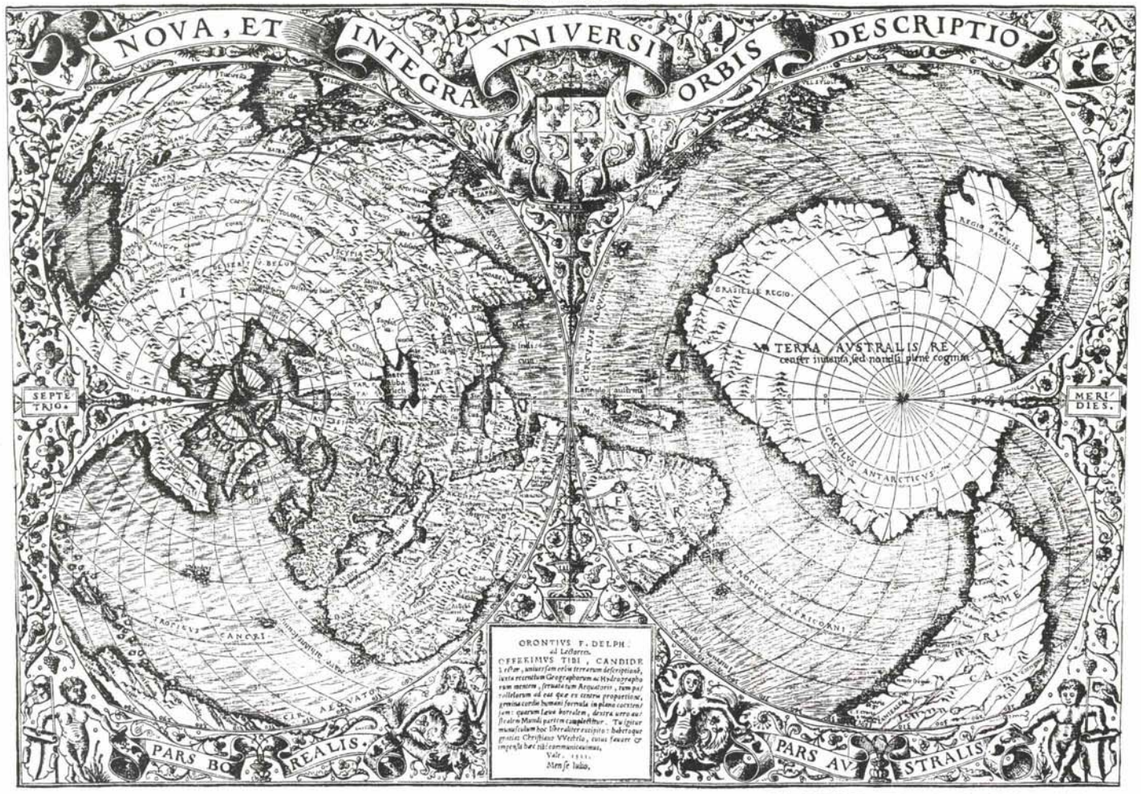
The reference, of course, might have been to the Pacific coast. But that also poses an awkward problem – as a look at the map suggests. Hapgood assumed that the western base of the mountain chain coincided with the Pacific coast of South America. If so, Hapgood is correct that the west coast, the Pacific and the Andes must have been known *before* Balboa and Magellan. And thus those "human beings" *could* have come down from the Andes.

Unfortunately the heavy black line to the south of the mountains and the reddish line at the base of the mountains probably do *not* indicate the west coast. For one thing, the long inscription (see pages 24-25) covers *terra incognita* – "unknown land" – and for another, neither the Pacific Ocean nor the Strait of Magellan are shown. Is it reasonable to suppose that the advanced mariners of ancient times could locate the Andes and miss the Pacific Ocean?

A similar argument applies to the section of coast which by rights should correspond with the Isthmus of Panama, Central America, the Gulf of Mexico and Florida. Even allowing for the necessary

THE ORONTEUS FINAEUS MAP

WRITTEN BY PAUL LUNDE



FACSIMILE-ATLAS, Nordenskjöld; Stockholm 1889

Whatever one may think of the Hapgood hypotheses, the Oronteus Finaeus – or Finé – map poses questions that are difficult to answer.

Oronteus Finaeus Delphinas – his vernacular name was Oronce Finé – was born two years after the discovery of America. A Frenchman, he taught mathematics at the University of Paris, published a number of important works and was one of the first "modern" cartographers. His careful maps of Europe are models of their kind and superseded all those which had gone before.

Finé's world map, done on a "cordiform" or heart-shaped projection, was drawn in 1531 and published for the first time in Grynaeus' Novus Orbis. Quite apart from its scientific interest, this map is a thing of great beauty. It influenced – both in projection and design – many later maps, including the famous world map of Mercator himself (see page 29). The most striking feature of the Finé map, and the one that particularly struck Charles Hapgood, is its representation of Antarctica. The continent of Antarctica, as is well known, was not discovered until 1820, by seal hunters and neither its true extent nor its major geographical features, including the Transantarctic Mountains, were fully known until as recently as 1957-1958, when the continent as a whole was scrutinized by scientists on the occasion of the International Geophysical Year.

Yet here is a map, published 426 years before the IGY and 289 years before the discovery of the continent, which fully outlines Antarctica – and even seems to show such features as the Ross Sea, which is normally hidden by great sheets of ice. That this is so can be seen immediately by comparing the reproduction of the Finaeus map with the outline of Antarctica as shown in modern atlases (see page 29). It is no wonder that Hapgood was amazed, as it is difficult indeed to explain away the similarity between Finé's Antarctica – called on his map, Terra Australis, "the southern land" – and today's Antarctica.

Classical geographers, it is true, had hypothesized the existence of just such a southern land, but in doing so they appear to have been led by esthetic – or logical – considerations. Since they knew the earth was a globe and that the land mass to the north was frozen, it was logical that there should be a land to the far south, balancing that to the north. But it is a long way from a general hypothesis such as this to the delineation of a continent.

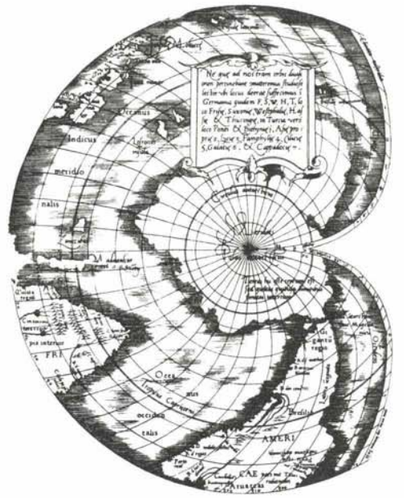
This is not to deny that there are differences – important differences – between Finé's "southern land" and Antarctica as we know it. The most obvious of these is the distance between the southern tip of South America and Antarctica. In Finé's map the two continents are virtually touching, when in fact they are separated by some 600 miles. He appears to have thought that the "southern land" lay immediately south of the Strait of Magellan and that it was much bigger than it really is.

Furthermore, there is nothing on the Finé map that could correspond to the Palmer Peninsula. If a charitable critic should say that this is because it is partially obscured by sheet ice, and its true outline could not have been visible, then why is the Ross Sea shown – as it apparently is – without ice? And there are smaller differences as well, such as the slightly mistaken orientation of Byrd Land.

On the other hand there is no denying that Finé's "southern land" closely resembles Antarctica – nor the fact that Finaeus had added a Latin inscription that reads: "The recently discovered southern land; it is not yet fully known."

As far as is known, the first cartography to indicate a southern continent was by the great Leonardo da Vinci himself, who depicted it on a globe and the planispheric map made by Francesco Rosselli. Dated to about 1508, the globe shows a vast land below Africa, labelled Antarcticus. In 1515 a southern continent was shown on another globe made by Schöner. But Finé's continent is more exactly drawn than those of his predecessors and in fact – as can be seen from the illustrations – the great Mercator adopted Finé's version of the shape of the continent wholesale, along with a similar Latin inscription: "It is certain that there is a land here, but what its limits and boundaries are is unknown."

One possible explanation appeared in a longer inscription on a map by Cornelius de Judaeis dated 1593. It says that a promontory of this land was "discovered by the Portuguese, but they did not explore the interior." This reference to the Portuguese is interesting, for Finé inscribes a portion of the Antarctic continent, "Regio Brasilis", "the region of Brazil" – which might imply Portuguese discovery.



GERARDUS MERCATOR 1538.

Furthermore, the coastline that turns eastward on the Piri Reis map – identified by Hapgood with the coast of Queen Maud Land – also bears a curious inscription referring to the Portuguese. It reads: "It is related by the Portuguese that on this spot, night and day are, at their shortest period, of two hours duration, and at longest phase, of twenty-two hours." Unfortunately, this tantalizing bit of information – which would certainly suggest Antarctic latitudes – is vitiated by what immediately follows: "But the day is very warm and in the night there is much dew."

Put together, those clues suggest that some unknown Portuguese navigator, before 1513, reached Antarctica, mapped part of its northern coast and left only maps as the record of the expedition.

It is a tempting explanation. But it does not, unfortunately, explain warm days and dewy nights in Antarctica, the details of the Ross Sea or the outline of Antarctica as a whole on Finé's map.

Another possibility is that the Portuguese – who occupied Timor, only 285 miles away – may have mapped the northern coast of Australia; it does resemble the far coast of Antarctica. Because of the intense rivalry with Spain, such a map not only could have been kept secret, but most likely would have been. If Finé had a copy of that map his map of Antarctica could have been a composite: of rumored Portuguese sightings of the coast below South America and the secret Portuguese map of the Australian coast. If Finé did combine them, it would account for the otherwise inexplicable – and incorrect – size of Finé's Antarctica. This theory would also account for its resemblance to modern maps – there is at least some resemblance between the northern coast of Australia and the opposite coast of Finé's Antarctica – and explain the inscriptions referring to the Portuguese.

It is, certainly, simpler than Hapgood's hypotheses. But it still involves missing maps and undocumented voyages. Major historical and cartographical problems, therefore, remain unsolved. The mystery is still there.

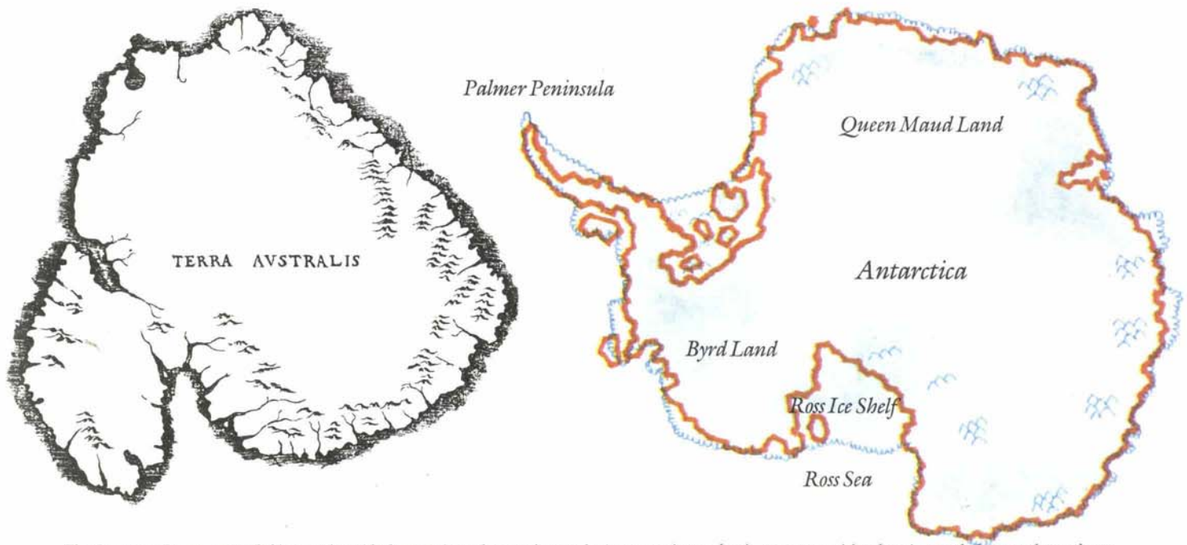


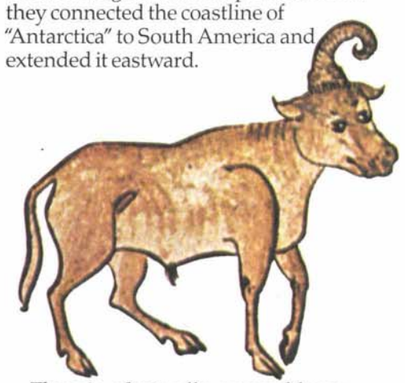
ILLUSTRATION BY BRIAN SMITH

The Oronteus Finaeus map (left) turned upside down so it can be seen from today's perspective, and as it compares with a drawing made from modern atlases.

distortions that Hapgood's "equidistant projection" would entail, this section of coast bears only the most tenuous relationship to reality – and raises still another doubt. Would Hapgood's hypothetical, highly advanced civilization – capable of sailing to the New World and mapping it – have done such an incredibly bad job? (See pages 22-23.)

The same question applies to the coast of South America where – as Hapgood admits – his advanced cartographers lost 900 miles of coastline. As a look at the map will show, the coast, below the Rio de la Plata, simply turns east and becomes, according to Hapgood, Antarctica.

This part of the Antarctica hypothesis – the key part – is actually the weakest. First, the hypothetical cartographers left out the Strait of Magellan and Cape Horn. Next, they connected the coastline of "Antarctica" to South America and extended it eastward.



There is, admittedly, a resemblance between the Piri Reis "Antarctic" coast and modern maps of the area. But the resemblance is slight. Indeed if this section of the map were to run *vertically* – that is, to the south – it would bear a much closer resemblance to the east coast of South America and could thus restore some of the missing 900 miles (see page 21).

This is by no means impossible: some of the more distinctive coastal features of the Piri Reis' "Antarctica" do jibe remarkably well with those on a modern map of South America (see page 21). But if it were true, "Antarctica" would not be Antarctica after all; it would be South America – which, of course, was never covered with ice – and the animals drawn on the map would not be in an ice-free Antarctica, but in South America. Last – and a key point – the famous "mountains" in Antarctica that so excited Mallery and Hapgood, and were presumably "clearly indicated," appear as islands, not mountains.

On the other hand . . .

On the other hand, some of the objections are themselves open to debate and Hapgood himself anticipated and answered many of them.

To start with, Hapgood and his advocates knew full well that to suggest a "lost world," with its echoes of Sir Arthur Conan Doyle and subsequent science-fiction elaborations, might well evoke merciless public scorn from scholars and scientists – as the writings of the late Immanuel Velikovsky had in the 1950's and as *Chariots of the Gods* did in 1968. The existence of this "lost civilization," after all, could only be inferred; there were no artifacts.

Hapgood, therefore, pointed out in *Maps of the Ancient Sea Kings* that civilizations *have* vanished before. No one knew where Sumer, Akkad, Nineveh and Babylon were until 19th-century archeologists dug them up. And as late as 1970 – only 10 years ago – no one even suspected the existence of a civilization called Ebla (See *Aramco World*, March-April 1978). It had existed. It was real. But it vanished without a trace. Why then, argue Hapgood advocates, couldn't there have been other civilizations that vanished?

The same is true of Hapgood's unspecified advanced technology. Greek fire – something like napalm – was developed in the ninth century but its composition has never been duplicated. Arab scientists of the Golden Age were able to perform delicate eye surgery – using advanced instruments – but these skills were later lost. And in 1900, according to *Scientific American*, archeologists discovered an astoundingly advanced gearing system in a Greek navigational instrument. It dated back to 65 B.C. and its existence had never been suspected.

Hapgood addressed more specific criticisms too. He had not overlooked the fact that on the map the Andes seemed to be in the center of South America, nor ignored the possibility that, maybe, they were mountains on the east coast drawn out of proportion, or drawn on the basis of information, rather than observation – or even drawn in to account for the great rivers emptying into the sea. And his answer is persuasive: could Piri Reis, entirely by chance, have placed a range of enormous mountains in approximately the same place where there *is* a range of enormous mountains? Furthermore, there is the notation on the Piri Reis map: "The gold mines are endless." Doesn't this suggest Peru, which *is* rich in gold?

With regard to Antarctica, there is also the inscription on "Antarctica" describing nights "two hours" long (see pages 28-29) – which does suggest Antarctic latitudes.

There is, moreover, the perplexing problem of the Oronteus Finaeus map. Even if Piri Reis' "Antarctica" turns out to be South America – drawn horizontally – or even Australia, the Finnaeus "Antarctica" is surely Antarctica and his map was *also* drawn in the 16th century: 1531. Where did Oronteus Finaeus get *his* far more detailed and accurate information? And why does Finaeus *also* show Antarctica without an ice cap?

Furthermore, the Hapgood team identified 50 geographical points on the Finaeus map, as re-projected, whose latitudes and longitudes were located quite accurately in latitude and longitude, some of them quite close to the pole. "The mathematical probability against this being accidental," says Hapgood, "is astronomical."

There are other factors too. The cartography of the Age of Discovery, for instance, often seems to have been independent of the voyages themselves; that is, certain early maps of America contain features *before* their supposed date of discovery.

The most notable example of this is the map of America made by Glareanus, a famous Swiss poet, mathematician and theoretical geographer, in the year 1510. This map, which was probably based on the 1504 de Canerio map, clearly shows the west coast of America 12 years *before* Magellan passed through the strait that bears his name. In other words, Piri Reis was not the only one to include anachronous information.

The map of Glareanus, furthermore, was reproduced in Johannes de Stobnicza's famous 1512 Cracow edition of Ptolemy and is unquestionably similar to the map of Piri Reis. Did Piri Reis have a copy of this early printed edition of

Ptolemy before him when he drew his map? Is this what Piri Reis meant by "maps drawn in the time of Alexander the Great"?

Again, this is plausible, since to the Arabs – and later the Ottomans – the second century (A.D.) *geographer* Ptolemy was often confused with the earlier General Ptolemy – Alexander's general, Ptolemy I, who became king in Egypt in the fourth century B.C. and was an ancestor of Cleopatra. Still, where did de Canerio and Glareanus get *their* information?

The subject of the Piri Reis map, obviously, is enormously complex – as well as a great deal of fun. It involves Christopher Columbus, his sources of information, his conclusions and even his motives. It involves two Ottoman naval captains and 20 unknown or vaguely identified maps. It involves the portolano charts that seem to be based on a single lost source, the Zeno map – with an ice-free Greenland – and the Finaeus map, possibly the most inexplicable of all. It involves, in sum, questions that are not only fascinating but, so far, unanswered – except by Charles Hapgood.

The Hapgood hypotheses, therefore, cannot be just dismissed – if only because it is indisputable that famous maps known to have existed have been lost. *None* of the maps from the classical world, in fact, have survived. The maps accompanying Ptolemy's great work on geography, for example, were quickly lost and the earliest maps based upon his text were drawn 1,000 years after he wrote. Marinus of Tyre, a precursor of Ptolemy, is a shadowy figure whose works have perished. And the great library at Alexandria, the chief depository of classical learning, was repeatedly destroyed.

It is reliably reported by an Arab author, moreover, that a globe of the world by Ptolemy – the geographer – existed in Cairo in the 14th century. Arabic literature contains numerous tantalizing mentions of "lost maps." The 10th century author Ibn Nadim, for example, speaks of a Persian map of the world drawn on silk in colored paints – conceivably a copy of a classical map, but in any case lost to history.

As maps by their nature are perishable – even maps by such well-known and relatively recent cartographers as Mercator are extremely rare – is it so improbable that Hapgood's mysterious maps *did* exist and did vanish?

Admittedly, the answer of many cartographers and historians would be, yes it *is* improbable. The Hapgood hypotheses, after all, challenge basic and long-standing historical and geological premises. But Hapgood, now retired and living in Florida, remains confident that his theories will be accepted eventually. "After all," he said, "they haven't even been examined yet."

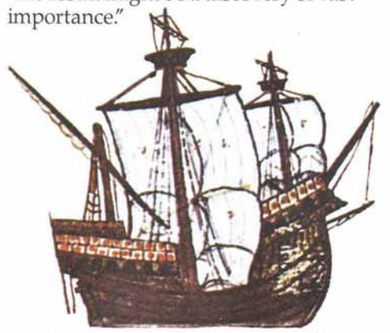
Hapgood, furthermore, is still working on his hypotheses. Last year he finished revisions of both books and one of them, *Sea Kings*, was published by E. P. Dutton & Company, New York and by Turnstone Books, London, in October. The other will be published this year. Beyond that, however, he has no plans to fight for either attention or acceptance. "I will not wear myself out trying to persuade people with pre-fixed ideas. My books speak for themselves and someday, I think, they will be acknowledged."

It is unlikely, of course, that such acknowledgment will be forthcoming soon, if ever; as the supplementary articles on pages 22 and 28 suggest, there could be other explanations. Furthermore, the work of an obscure 16th-century Ottoman admiral does not command a high priority on science's crowded calendars.

But it is not impossible either. Increasingly, scientific writers and critics are beginning to re-examine some of the traditional premises and several, as recently as last year, have openly objected to the kind of cool dismissal that the Hapgood theories received on publication. In the magazine *New Scientist*, for example, several articles in 1979 focused on what they call "deviant science" and one critic said that it is from deviant science "that seminal ideas sometimes arise, later to be accepted as scientific orthodoxy." One example is the highly controversial Velikovsky – who died just two months ago. In addition to other, admittedly fanciful theories, Velikovsky hypothesized that Venus and Mars had once disturbed the rotation of the earth on its axis; he was not only belittled but threatened. Yet, according to the *Encyclopaedia Britannica*, space probes have subsequently verified some details of his theory.

Verification of the Hapgood hypotheses of course, would require highly persuasive evidence. As a *New Scientist* writer quoted, "extraordinary claims demand extraordinary proof," and in the case of Professor Hapgood that means location of the "lost" civilization or least one of the "advanced" source maps presumably used by Piri Reis.

But this, says Hapgood, is not impossible. Somewhere, he thinks, those source maps exist: hidden, perhaps, amid the massive collections of documents crammed into museums and archives in Istanbul, many still unexamined. No search for the source maps has ever been made, Hapgood says, but when there is "the result might be a discovery of vast importance."



His view, given the reception of his hypotheses, is natural. But it is by no means implausible. In 1955, a cartographer named M. Destombes announced the discovery of Ferdinand Magellan's own chart of his epochal circumnavigation of the world. No one had known it existed, but Destombes found it – in the archives of Istanbul.

Paul F. Hoye, Editor of Aramco World *and formerly a reporter and columnist on* The Providence Journal, *studied Middle East affairs at Columbia University under the Advanced International Reporting Program. Paul Lunde is a graduate of London's School of Oriental and African Studies, and is currently working on Arabic manuscripts in the Vatican Library in Rome.*

Windmills: from Jiddah to Yorkshire

WRITTEN BY PAUL LUNDE PHOTOGRAPHED BY BRIAN SMITH, HAROLD SEQUEIRA AND U.S. DEPARTMENT OF ENERGY

In what might seem to be an ironic footnote to the history of energy, mining engineer Karl Twitchell, in 1931, put up a 16-foot windmill in Jiddah to help pump water. It raised, Twitchell says in his book *Saudi Arabia*, "an average of 40 gallons a minute."

Today, however, Twitchell's windmill no longer seems even slightly odd, because the windmill, as a source of energy, is re-entering history.

Last autumn, for example, the government of Quebec announced it would build an experimental $17.5-million, 327-foot-high windmill to generate electricity – a recognition of the continuing energy crisis. And Quebec's windmill is only one of many that governments, companies and individuals were constructing in late 1979.

In Yorkshire, England, Sir Henry Lawson-Tancred of Aldborough Manor has already built two experimental windmills and plans, eventually, to manufacture and sell them.

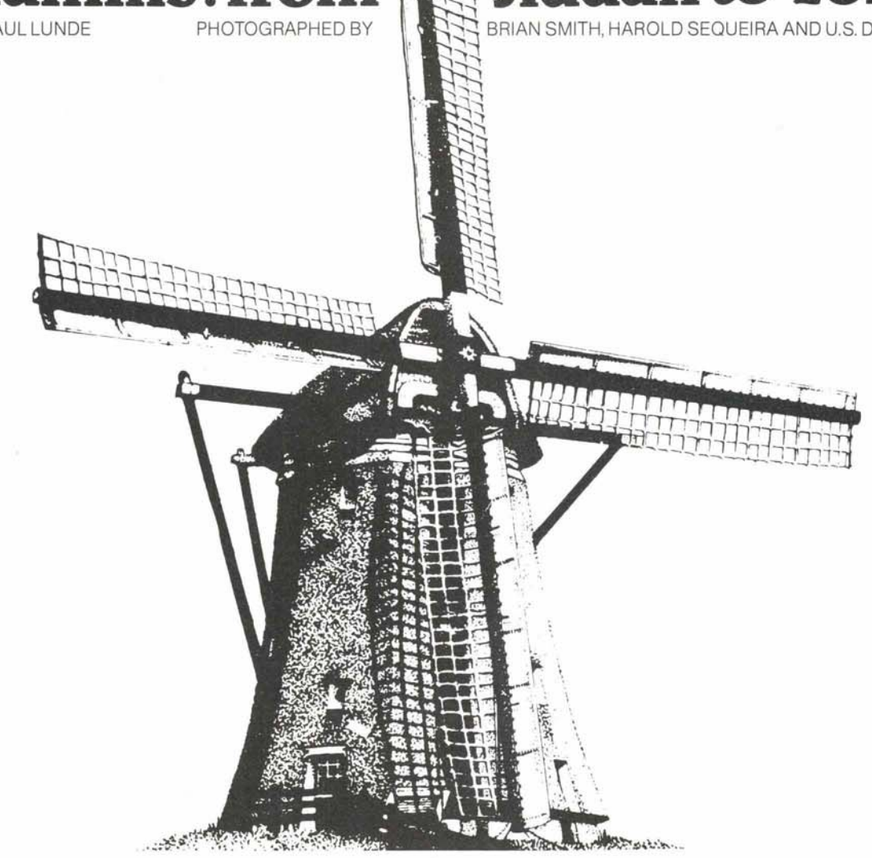
Standing on a rise amid the rolling farmland of Yorkshire, Sir Henry's windmill – or, more accurately, wind turbine – is distinctly different from the windmills of the past. Its blades – 56 feet in diameter – are bigger, its ball bearings are more efficient and its gearing and alternator systems are adjusted to permit unattended, wholly automatic operation.

The blades, moreover, unlike the windmills of Holland in other days, are exceptionally light; they are built of hollow fibreglass panels affixed to a steel frame. At speeds of about 30 miles per hour, they can generate an estimated 100 kilowatts – enough electricity for 25 average American homes.

Because the problems of storing power have yet to be solved, Sir Henry's wind turbines – called "Aldborough aerogenerators" – may have a limited market; batteries would cost nearly as much as the turbines. But in some areas of Britain, such as the Hebrides, Wales and the west coast of Scotland, the wind is so strong and constant that wind turbines could prove invaluable, says Rupert Nichols, an aide to Sir Henry. Because the turbine is almost wholly automatic – a satellite windmill on the top of the tower, for example, turns the main blades into the wind automatically – and because it can be shut down in high winds, the turbines could provide small communities and farms with electricity as efficiently as central urban generators do now.

Another, much bigger, experiment is underway in Boone, North Carolina, where the Department of Energy and NASA have built the world's largest wind turbine: a $21-million giant with blades 200 feet in diameter. This turbine, part of the U.S. government's experiments with wind power, can generate two megawatts of electricity – two million watts – from winds of 25 mph, enough to service 500 homes.

Despite the differences in size and output, however, the purpose of the windmills in Quebec, Yorkshire and Boone is the same: to produce power for the present with the technology of the past.



At Aldborough Manor in Yorkshire, Sir Henry Lawson-Tancred is experimenting with a 56-foot diameter "aerogenerator" able to produce 100 kilowatts of power at 30 mph.

Until the energy crisis reminded the industrialized world that petroleum reserves were not inexhaustible, windmills, to most people, were quaint relics of the past – charming structures that were particularly popular in The Netherlands or associated with the story of the gallant Don Quixote – who mistook windmills for giants, charged one with his lance and was knocked from his horse by one of the sails. Yet windmills, when Cervantes wrote in the 16th century, were a common feature of Renaissance technology in Europe – a technology which would eventually culminate in the Industrial Revolution.

The Industrial Revolution, of course, had to await the invention of the steam engine. In the meantime man's sources of power were limited to his own muscles, draft animals, the watermill and – from the 12th century on – the windmill.

The most ancient of these sources was the watermill – it was known to the Romans. But the windmill did not appear in Europe until the beginning of the 12th century, when it was used for grinding wheat in Normandy. Thereafter windmills spread rapidly throughout Europe and in the early 15th century the Dutch began to use them to pump water out of the marshes and reclaim land from the sea.

Oddly, the windmill, like the tulip – both of which Holland made famous – came from the East: the tulip in the 16th century from Turkey (See *Aramco World*, May-June 1977), and the windmill via a longer and more circuitous route.

The first known reference to windmills is in a Hindu book written about 400 B.C., and Hero of Alexandria, a Greek inventor of the third century B.C., once described a small wind-driven "motor" which he had designed to provide air pressure for an organ. There are also references, in A.D. 400, to wind-driven prayer wheels in central Asia, where they are still used today. But Hero's "motor" was really just a toy and although the prayer wheels did embody the principle of the windmill, they never seem to have been developed beyond their initial function. Like other innovations in technology, the windmill was brought to the West by the Islamic world.

The first definite reference to the use of the windmill came early in the Islamic period. 'Umar, the second caliph, had heard that a Persian in his entourage had boasted of being able to construct a wind-driven

A windmill of the future now in the experimental stage at Boone, North Carolina, with blades 200 feet long and a capacity of two megawatts at 25 mph.

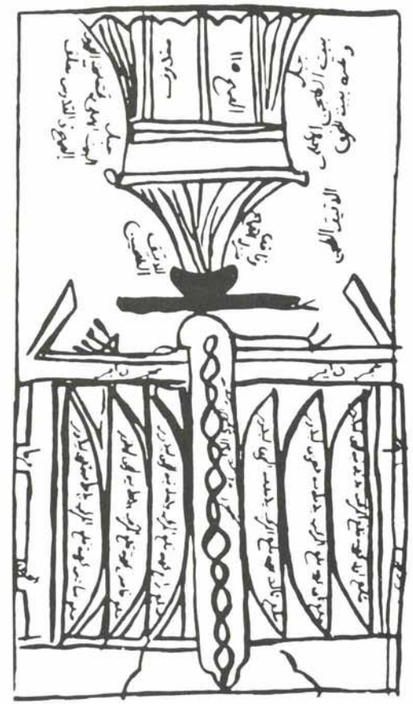
mill. When challenged to do so, the Persian said, "I will build a mill of which the whole world will talk". Unfortunately, he never did, but the story shows that windmills were known in Persia in the early seventh century – a fact confirmed by Arab geographers writing somewhat later.

Al-Mas'udi, for example, writing in the 10th century, notes that windmills were used in Sijistan to raise water for irrigation, as well as for grinding corn. Still visible today, these mills are scattered through the huge arid expanse between Mashhad and the eastern border of India where, probably, the windmill was invented.

In the 13th century, the Arab writer al-Dimashqi described a typical mill of Sijistan:

When building mills that rotate by the wind, they proceed as follows. They erect a high building, like a minaret, or they take the top of a high mountain or hill or a tower of a castle. They build one building on top of another. The upper structure contains the mill that turns and grinds, the lower one contains a wheel rotated by the enclosed wind. When the lower wheel turns, the mill stone above turns too. Whatever wind may blow, the mill works, though only one stone moves. After they have completed the two structures, as shown in the drawing, they make four slits or embrasures like those in walls, only they are reversed, for the wider part opens outward and the narrow slit is inside, forming a channel for the air in such a way that the wind penetrates the interior with force, as in the case of the goldsmith's bellows. The wider end is at the entrance and the narrower end on the inside so that it is more suitable for the entry of the wind, which penetrates the mill house from whatever direction the wind may blow – hence the four openings in the structure. If the wind has entered this house through the entrance prepared for it, it finds in its way a reel like that on which weavers wind thread. This device has 12 ribs; these could be diminished to six. Fabric is nailed over them, like the covering of a lantern, only in this case the fabric is divided over the different ribs, so that each one is covered. The fabric has a hump which the air fills and by which the rib is pushed forward. Then the air fills the next one and pushes it on, then it fills the third. The reel then turns, and its rotation moves the mill stone and grinds the corn. Such mills are suitable on high castles and in regions which have no water, but have a lively movement of the air.

Obviously, from this description and the illustration accompanying it, these mills were very simple. A hopper filled with



A 13th or 14th century windmill shown in al-Dimashqi's manuscript. Unlike later European windmills, the "sails" rotated horizontally and the grinding stone was mounted above the sails.

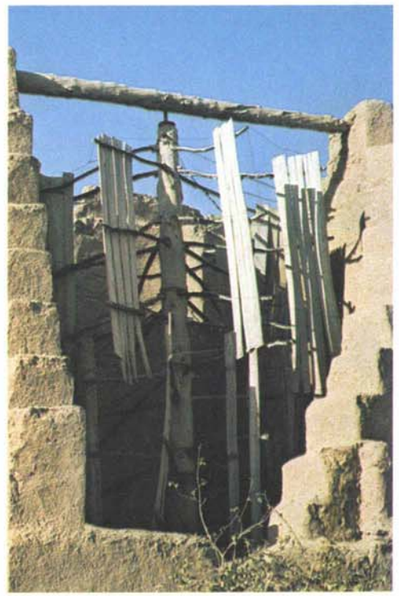
grain rested on a fixed stone which had a hole in the middle to allow the grain to sift onto the surface of the lower, moving, stone. That was in turn attached to a vertical axle to which sails – fabric-covered ribs – were affixed. But at some unknown date, this arrangement was reversed so that the sails were above, the hopper and the millstones were below, and the top millstone was the one that moved.

Windmills like this are still used in some parts of Iran and Afghanistan, and it has been estimated that they generate about 75 horsepower and can grind a ton of wheat every 24 hours.

During the Middle Ages improvements in gearing, and the development of watermills with a horizontal shaft and a vertical wheel, led to an increased power output. These improvements were applied to the windmills when they were introduced to the West and gave them their characteristic form. In the Middle East, windmills were used more extensively than watermills. Although tidal mills were used in Basra, at the head of the Arabian Gulf, there were few fast-running streams elsewhere that would make the construction of watermills practical.

Windmills were used, for example, in today's Iraq, as part of the elaborate irrigation systems in that area, and in Egypt, for crushing sugar cane on a large scale. It was from Egypt, in fact, that the Spanish, in the early 16th century, recruited technicians to build windmills in the West Indies.

Today, windmills are not found in the Middle East, except in Iran and Afghanistan. The Mongol conquests of the 13th century destroyed the irrigation systems, and with the decline of the sugar industry in Egypt they fell out of use there as well. The availability of cheap fuels has done the rest, and even in Iran and Afghanistan, today, the old windmills have for the most part fallen to ruins.

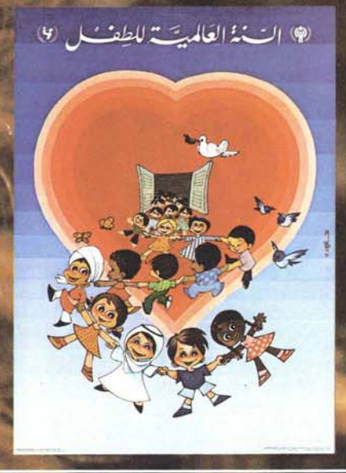


In Herat, Afghanistan, a precursor of the modern windmill still stands.

Fortunately, the principle of the windmill had been brought to Spain and Portugal by the Arabs before the Mongol invasions, and this principle, combined with the technical advances which had previously been made in watermill construction, gave Europe an inexpensive and efficient source of power. The windmills tilted at by Don Quixote, like so much in Spanish culture, had an Arab ancestry.

It is ironic, therefore, that when Karl Twitchell set up his windmill in Jiddah, in the western region of Saudi Arabia, in the 1930's, he was unwittingly bringing the windmill full circle.

WRITTEN BY JOHN LAWTON – WITH
KATRINA THOMAS
PHOTOGRAPHED BY KATRINA THOMAS
POSTERS COURTESY OF UNICEF



YEARS OF THE CHILD

The International Year of the Child, with its committees, slogans and good intentions, is over, but not – at least in the Arab world – forgotten. In the Arab world, every year is the Year of the Child.

Sponsored by the United Nations, the International Year of the Child – 1979 – was an effort to focus world attention on the plight of children everywhere; to a large extent it was successful. Virtually all the countries belonging to the U.N. set up special committees to stimulate action in the fields of legislation, recreation and culture during the Year of the Child.

In many of the Arab countries, however, the public ceremonies launching the children's year were, as one group put it, "but a stimulant for further action". And that action is continuing as national committees set up for 1979 – in the fields of education, health, nutrition, social services, recreation, and culture – are turned into permanent bodies.

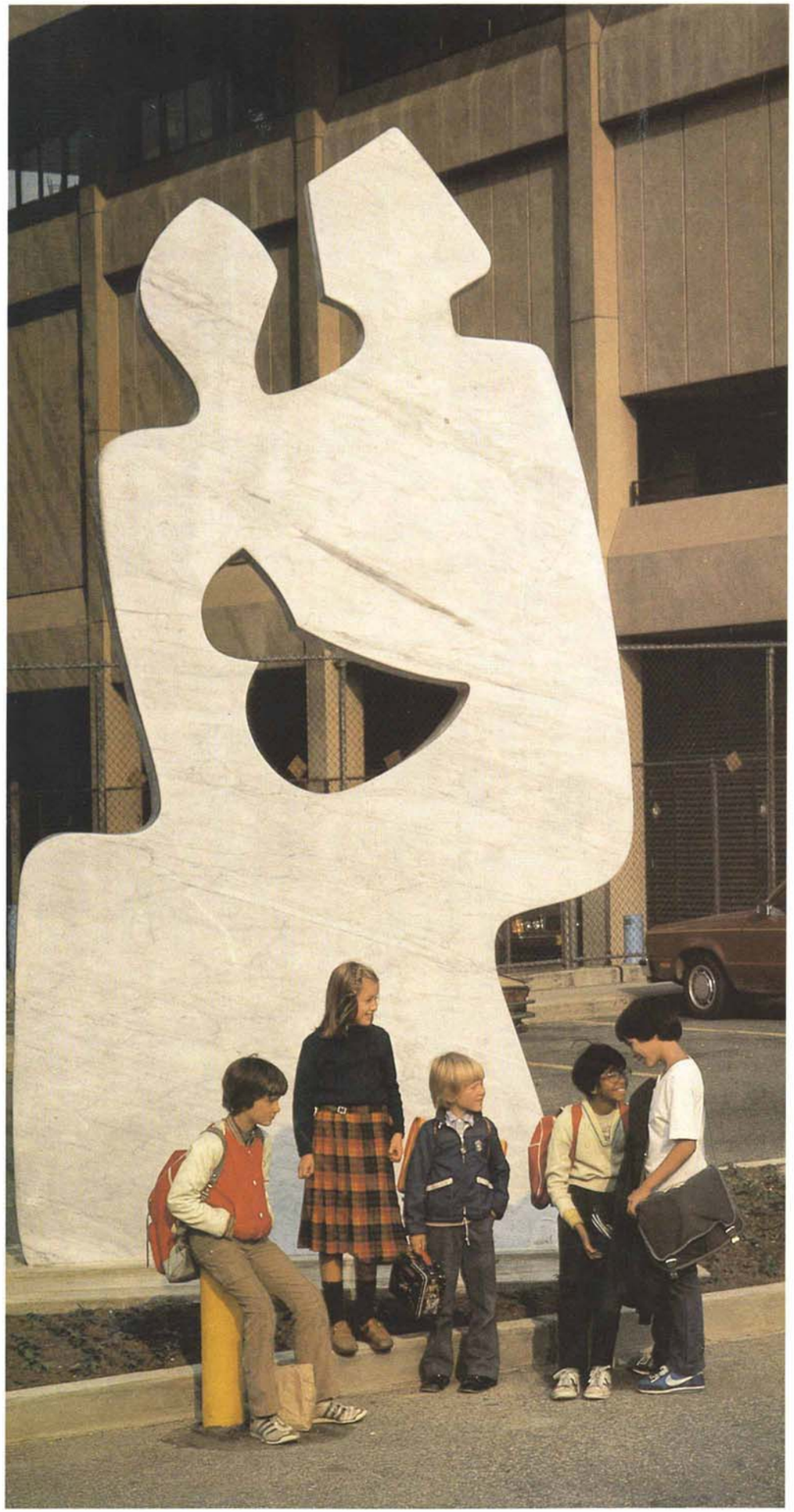
In Saudi Arabia, for example, the National Committee for the International Year of the Child has been renamed – it has become the Saudi National Commission for Child Welfare – and established as a permanent advocacy body for children. Headed by the Minister of Education, the commission is composed of two councils. The first is the Supreme Council of Child Welfare, consisting of nine deputy ministers and one vice-president of the ministries and agencies involved in child welfare.

The second is the Planning and Follow-up Council, composed of 13 directors general and heads of departments of the same institutions. As its name suggests the council's job will be to guarantee that the momentum generated during 1979 is not lost and that the work begun then continues. This includes nationwide vaccination campaigns, the creation of public parks for children in all cities, plus a program to intensify maternity and child care in existing hospitals and extend it to the far corners of the kingdom.

Saudi Arabia's neighbours, moreover, are following suit – as the United Nations Children's Fund (UNICEF) noted in monitoring the transition from temporary enthusiasm to permanent commitment in Bahrain, Kuwait, Oman, Qatar, and the United Arab Emirates.

"Early International Year of the Child activities in the countries in the area concentrated mainly on ceremonies, festivals, and parades. Later, however, the trend turned towards activities of direct long-term impact on children, assessment of children's needs, review of policies and programs in the fields of health, nutrition and education, determining priorities and providing for the most needy and neglected groups".

Furthermore, the U.N. reported,



"Members of almost all national commissions realized they should turn their committees into permanent bodies to provide for the harmonious continuation and, where appropriate, expansion of initiatives undertaken during 1979."

These initiatives included the establishment in Sharjah of a regional rehabilitation center for mentally retarded and physically handicapped children, a program to set up 178 kindergartens and day-care centers in Qatar, and establishment of a children's cultural center in Bahrain. Other plans included extensions of child welfare services to 35 villages in Oman, and construction of a children's village in the city of Kuwait.

In fact, says the United Nations, the response to International Children's Year by organizations, authorities and individuals in the Gulf was nothing short of "overwhelming".

Nor was it restricted to children of their own lands. It included "a very generous government allocation for deprived children of other developing countries in the Arab world, Africa, and Asia".

Elsewhere in the Arab world, response to the International Year of the Child was also enthusiastic and, besides the concerts and contests, surveys and seminars, included many novel schemes. Morocco, for example, set up kindergartens in women's prisons in Casablanca, Marrakech and Fez. Syria abolished import taxes on children's toys. Somalia composed a special children's anthem. Yemen gave "top priority" to children's programs in its current five-year development plan and Jordan set up a children's shop foundation aimed at providing basic commodities for children at minimum cost.

In Lebanon, a campaign was launched to remove from identity cards of illegitimate children the words "father unknown" in order not to harm the child's future, while in Egypt the government opened 225 new pre-school centers, including three foreign-language kindergartens. Egypt also set up a toy workshop in Alexandria using nothing but waste material.

Private organizations also made major contributions to the success of the International Year of the Child in the Arab world. Singled out by the United Nations for special praise were the Child and Family Welfare Association of Bahrain, the Red Crescent in Qatar, the United Arab Emirates Women's Union and the Kuwaiti Association for Rehabilitation of the Handicapped.

Arab leaders played an especially significant role. President Shaikh Zayed, for example, launched a fund-raising campaign in the United Arab Emirates with a personal donation of $1 million while Shaikh Sultan al-Qasimi, the ruler of Sharjah, donated a 250-acre site on which to build a rehabilitation center for retarded children.

Rudi de Groot

Outside the United Nations school in New York stands a nine-ton Year of the Child statue (left) sculpted by Edwina Sandys, a grand-daughter of Winston Churchill. Another, complementary, work (above) stands outside U.N. facilities in Geneva.

Behind this wholehearted response to the Year of the Child stimulus are two impulses: need and tradition – and the need is obvious. Each minute three more babies are born somewhere in the Middle East and of the Arab world's 140 million people, some 45 per cent are under the age of 15. And in some countries – such as Egypt or Morocco – more than half the population is under 20.

But the stronger impulse, probably, is the tradition that "children are the wealth of the Arab world." This, no doubt, can be said of many peoples, but in the Arab world that feeling is particularly strong, as one oft-told tale suggests.

It is a tale of a stranger who visits two houses. The first has many children, but no light, while the second house has many lamps but no children. Upon which the stranger remarks, "The house with many children was lighted, but the house with many lamps was dark".

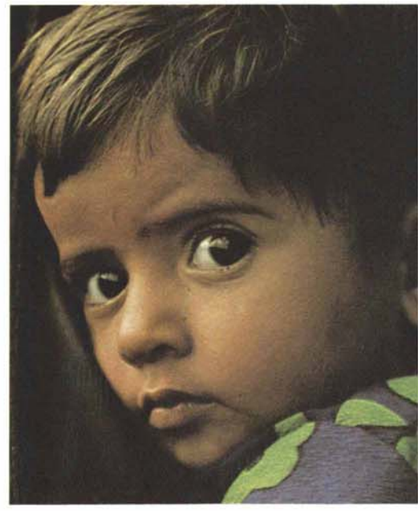
Arabs have always derived great joy from children, whom they consider a gift from God. In some areas the traditions go back a long way. Boys, for example, are particularly prized, and it is said that in certain Bedouin tribes the person who reaches a father first with news of the birth of a son may still be rewarded with a sheep, or even a camel.

Other Arab traditions, of course, spring from Islamic custom. Names, for example, are most frequently drawn from Islamic history and one writer, indeed, has said that Muhammad, the name of the Prophet, is the most popular name in the world. Other names famous in Islamic history, and therefore common in the Arab world, are 'Umar, Walid and Khalid for boys, and Khadija and Aisha for girls, although Arab attachment to nature – and poetry – also shows up in such names as Nur ("light") and Nawara ("blossom"), and cultural values are built into such names as Sharif ("honest") and Fadila ("gracious").

Some Muslims name the baby on the seventh day after birth, when the Muslim Profession of Faith is whispered in the baby's ear by the imam or by the eldest member of the family. A charming custom still observed in parts of Egypt and Saudi Arabia on the seventh day is that of showing the baby the house, when, accompanied by singing and the banging of tambourines, and surrounded by children carrying candles, the richly dressed baby is carried by a grandmother or aunt from room to room.

As a baby and toddler, the Arab child is never far from its mother. Mothers carry an infant everywhere, first in the arms and then astride the hip. Bedouin women may bind their babies into a goatskin carrier, which can be hooked over the shoulder, hung on a tent pole, or laid on the desert sand.

Later, though, it is the father who becomes the paramount figure in the life of an Arab child – when the child is about



four. But although from then on the father becomes the symbol of authority and chief disciplinarian, he is rarely cold or aloof; to the contrary, most Arab fathers are warm, affectionate and tender toward children.

In the life of the Arab child, however, fathers and mothers are not the sole source of love and affection. Uncles, older cousins and grandparents also play an important part in bringing up the Arab child. Arab culture is a kinship culture in which the "nuclear family" – parents and children – exists within the framework of an extended circle of relatives and friends, whose interdependence in life is very strong.

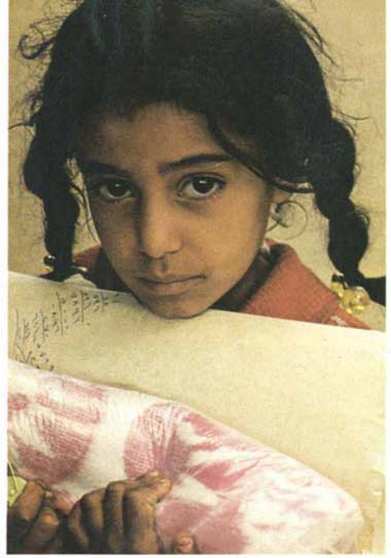
Because of this, says Audrey Shabbas, co-founder of Arab World Consultants, an educational consulting firm, the Arab child has many more avenues of guidance, help and friendship than the average Western child.

"Pampered and spoiled by a family of many adults, the Arab child is the object of a great deal of physical contact," says Shabbas, adding that childhood in urban areas "lasts long and is a time of carefree games and amusements within a large circle of cousins, relatives and neighborhood friends".

Nevertheless the Arab child, later, seems neither as free nor as carefree as his Western counterpart. When among adults Arab children behave like adults, usually not speaking but sitting quietly at the side of the grown-ups. Amazingly, the children rarely squirm or fidget, moving only to offer candy to guests. In the villages and fields, children assume adult responsibilities at an early age, tending goats, collecting firewood and doing household chores.

As elsewhere, education of children is of great importance in the Arab world, particularly today as the current drive to modernize and expand education in the Arab states reaches its peak.

This drive, a reaction perhaps against the years when education declined, is particularly noteworthy in Saudi Arabia, possibly the most rapidly developing country in the Arab world and one of the most conscious of the need to educate and train its young people. Almost from the day that 'Abd al-'Aziz ibn Sa'ud united most of the Arabian Peninsula, education has been high on the list of priorities. It was not until 1954, however, that establishment of a kingdom-wide, modern system of education really got underway.



In that year 50,000 students were enrolled in 469 schools, whereas, now, there are some 5,832 government schools with more than 700,000 pupils of all ages and some 39,000 teachers.

Education services, says Shabbas, co-author of *The Arab World: A Handbook for Teachers,* vary from one Arab country to the next. Many are compulsory, some have separate facilities for girls. All are free, some including university and other schooling abroad. Some receive as much as 20 per cent of their country's annual budget, and a few have as desirable a student-teacher ratio as 12 to 1.

Education to an Arab family, however, means much more than what takes place in the formal school setting. "Although the school meets the academic requirements, it is the family," says Shabbas, "which instills in the Arab child a value system, social conscience, and the very rules which govern daily life and a complex system of social interaction".

A system of etiquette, called *adab* in Arabic, teaches the well-behaved child, who is termed *muddab,* to obey parents, respect elders and be generous, co-operative and helpful to all. Proverbs, used to accentuate everyday conversation, teach the Arab child to be honest and hard working, and reproach those who gossip, quarrel or lie – such as the popular saying that a "fresh and happy face" together with fresh water and fresh green are the three things in the world that give most joy.

In socializing the Arab child, the emphasis is on raising him to be a member of the group. On asking a teenager in Amman, of mixed Jordanian and American parentage, how Arab children differ from Americans, he answered that Arab children are friendlier and help one another more. At a very early age, for instance, Arab children instinctively look after young visitors without regard to age, and with the same attention that parents give to adult guests.

Thus psychologically prepared, says Shabbas, and with access to greatly improved medical care and the necessary education, the Arab child is well equipped to take advantage of the opportunities of the future – opportunities that this international year has highlighted and – at least in the Arab world – has advanced significantly.

John Lawton is the Editor of a new international English-language daily newspaper soon to appear in London.