RESOURCE-CONSERVING URBANISM IN SOUTH ASIA III: TWO NUCLEAR-POWERED AGRO-INDUSTRIAL COMPLEXES

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INTRODUCTION

This is the third in a series of studies that construct new approaches to the design and development of cities in South Asia. The first of these investigations was undertaken without the realization that more were to follow, and the second with the feeling that the subject might well be exhausted for a while with the completion of that enterprise. But now I have been pulled back to this line of enquiry because a new complement of technology, together with a body of calculations justifying its economic feasibility, has appeared on the scene.[1] One of the explicitly stated assumptions underlying previous proposals can now be explored in depth: the wastelands of poor countries like India could provide a large share of the staple diet needed to support the many hundreds of millions of people who would find greater opportunity if they were to move to cities. When the solar energy falling upon deserts and swamps can be put to work in the production of food, the cities can concentrate upon the production of other goods and services necessary to the elimination of poverty.

The first of the previous studies argued that Western methods of building and operating cities would no longer work in the Orient. Proposing an alternative involved a testing of the implications of a number of little-publicized developments in technology for the growth of very large cities. It was shown that no technical or economic difficulties prevented the formation of continuous polycentric megalopolitan

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[1] E. A. Mason, et al., The Nuclear-Powered Agro-Industrial Complex, Oak Ridge, Tennessee, Draft Report, June 1968. We actually worked with the preliminary drafts available in March, 1968.

urbanism on the Bay of Bengal. Also, new developments in marine technology suggested that cities such as Hong Kong (also, by implication, Singapore, Tokyo, Osaka-Kobe, and Bombay) could move part of their activities to relatively economical floating structures offshore.[2] These approaches overcame the known natural resource constraints that appeared ready to inhibit growth of cities within a few years.

The second collaboration undertook a long view of India, if India succeeds in its attempts at economic development.[3] It estimated the number of people that would move to the city and identified the most suitable locales for such settlement. It proposed methods for reducing the social costs of migration, and systems for organizing the core of the metropolis that conserved energy, water, land and capital. It concluded that if Indian population exceeded 1,500 million before coming to equilibrium, the urbanization process would experience rapidly increasing costs per person resettled.

In the company of thirty-three students, either graduates or special cases, from twelve departments of the University of California, Berkeley, and eight countries (not counting two others represented by former Peace Corps volunteers),[4] I have undertaken to analyze the

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[2] R. L. Meier, Studies on the Future of Cities in Asia, Center for Planning and Development Research, University of California, Berkeley, July 1966.

[3] R. L. Meier, Resource-Conserving Urbanism for South Asia, Department of Resource Planning and Conservation, School of Natural Resources, University of Michigan, Ann Arbor, January 1968.

[4] The group included Gary Austin, Juliet Banning, Michael Bledsoe, Craig Brown, Thomas R. Brown, Daniel Caraco, Brian Cooke, Elizabeth Costle, Coral Cottage, Tomi Curtis, Jeffery De Pasqua, Tara Dharan, Jon Dieges, Neil Eddington, Rory Fonseca, Kenneth Grobecker, Jack Hadge, Yitzhak Haissman, Thomas Higgins, Yong-Ju Hwang, Thomas Larmer, Daniel Leibsohn, John Logan, Paul Meade, Donald Neuwirth, Calvin Peck, Jessica Persoff, Amjad Rizvi, Zmarak Shalizi, Jorge Silvetti, Nader Vaziri, Terry Veeman, Ralph Wilcoxen.

potentials of the nuclear-powered agro-industrial complex on two of the possible sites. We were assisted by the availability in the University Library of a collection of publications from India obtained with P.L. 480 funds, but in the instance of the Sinai, information was scarce. We have sought out and obtained advice from a number of administrators and former residents of both areas. But in the end the major task was to sort out sets of plans that could be used to develop such a complex. I have accepted the task of synthesizing from their contributions and from independent studies what appear to be the most feasible development plans. The greatest difficulties we experienced were caused by the shortness of the term (ten weeks) and the fact that single copies of books containing crucial data were required by a dozen or more students at the same time. This means that not all of the significant implications have been extracted from the facts. Further study may still uncover some surprises.

I am indebted to the Center for Planning and Development Research of the College of Environmental Design for assistance in producing this report. Somehow they managed to find a way of getting this done without seeking a special grant. Also, the Mental Health Research Institute of the University of Michigan discovered a way of justifying this study as behavioral science, thus enabling it to be completed promptly.

Chapter One

THE QUICK TECHNOLOGICAL FIX

Alvin Weinberg captured the imagination of many listeners and readers when, in 1966, he argued that an important share of the world's ills could be eradicated by massive research and development programs.[1] He called the successful outcome of such a program a "quick technological fix." Most of the large laboratories created by the United States Government, operated in many instances by academic and industrial contractors, would have a vital role to play in such programs. The national laboratories were visualized as instigators, coordinators, and, to a great extent, researchers.

The idea of a "fix" has many connotations, most of them spectacular; therefore, it was widely discussed. Most opinions were based upon speculative reinterpretations of historical cases. What if a crash program had made an obviously useful new technology, such as malaria prevention, synthetic rubber, or hybrid corn, available a decade or more earlier than it actually arrived on the scene? How much distress would have been prevented? What would the world be like now? Logically, however, a "technological fix" can only solve critical problems already recognized by using ideas already at hand. Examples for current application were suggested, such as the intrauterine device for population control, and nuclear energy for Los Angeles water production, but subsequent assessment indicated that

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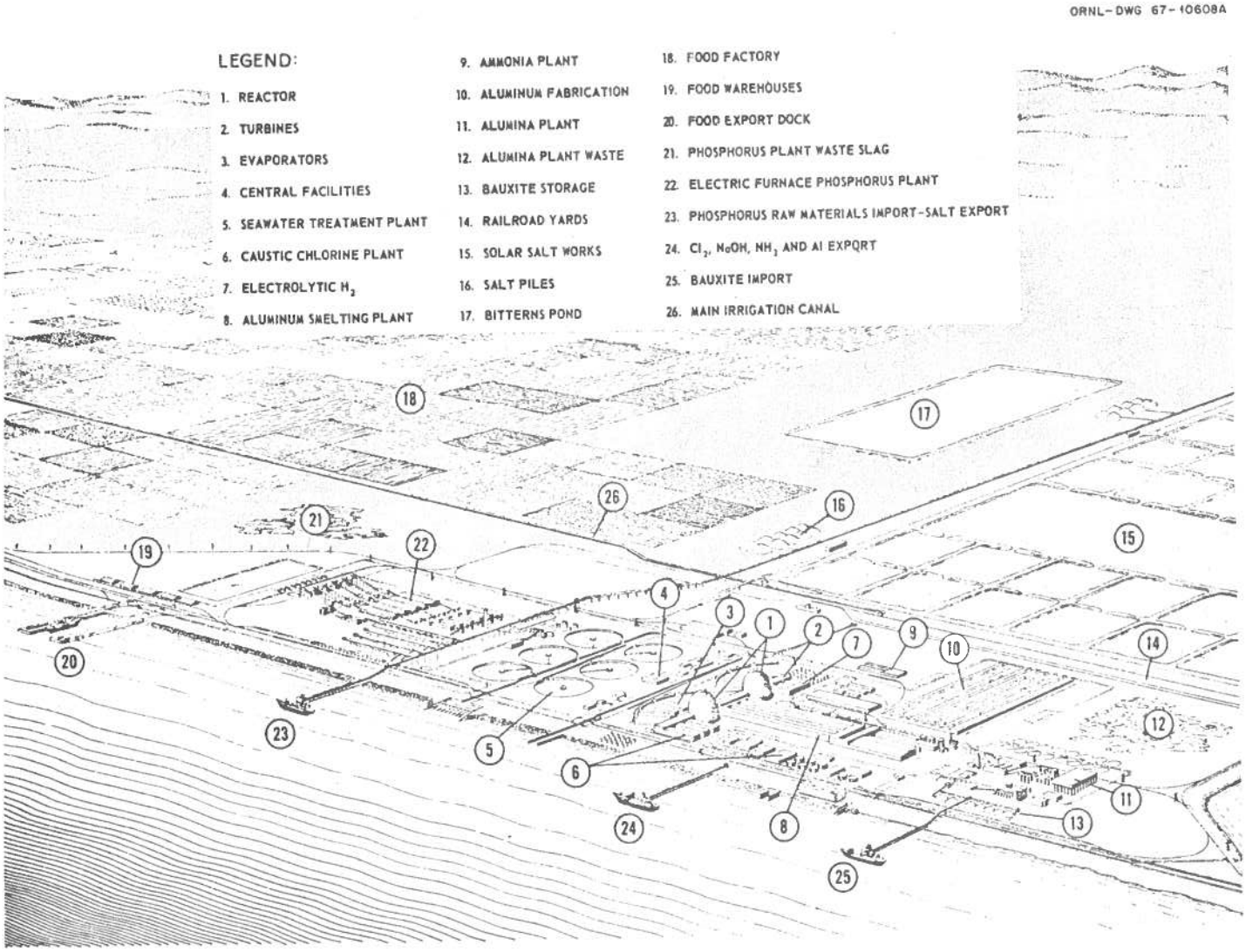
[1] Alvin Weinberg, "Can Technology Replace Social Engineering?" Bulletin of the Atomic Scientists 22, (December 1966) 4-8. This was the acceptance speech for the University of Chicago Alumni Award for 1966.

the programs for implementation were elusive--no straightforward path to the desired outcome could be found.

Shortly thereafter, the threat of great famines affecting hundreds of millions of people presented an excellent opportunity for a technological fix. A series of crop failures in the Soviet Union and in Asia resulted in imports from North America so sizable that its large surpluses were drawn down to a normal carryover supply. Simultaneously, quite independently, the nuclear power reactor industry succeeded in underbidding coal as an energy source for a large power plant at a site immediately above a good quality coal seam. As a result, a series of nuclear plants of increasing size would be built in North America. Engineers at Oak Ridge had the vision to link the world food problem with this technological success story. The connection was made by means of a novel cluster of known technologies that, when combined, could unleash a substantial expansion in food output elsewhere in the world. Their scheme could produce staple crops only slightly differentiated from foodstuffs presently consumed by the poor, and therefore quite certain to be accepted. This scheme is in contrast to repeatedly publicized proposals that would convert coal, oil, or natural gas into microbial protein, but do not explain how poor people can be induced to eat the synthetic foodstuff. Thus the stage was set for a technological fix. The Oak Ridge idea was resolved into an agro-industrial nuclear complex that produced fertilizers and desalinated water on-site and then irrigated and fertilized an adjacent coastal desert seeded to staple crops. It seemed, after brief study, to be technically feasible, economically worthwhile, socially desirable, and politically strategic.



An artist's conception of an agro-industrial complex stretching along the shore of a coastal desert. It produces and consumes 2000 Mw of electricity and 1,000,000,000 gal of fresh water per day, employing two large reactors for the energy source. It includes a 300,000-acre farm, irrigated with water from a seawater evaporator, and industrial plants to produce aluminum sheet and bar stock, electric furnace phosphorus, caustic-chlorine by brine electrolysis, and ammonia from electrolytic hydrogen. Associated facilities include a solar salt works, a railroad marshaling yard, an artificial harbor, and docks for import of raw materials and export of food and industrial products. Not shown are a town and other living quarters for about 100,000 persons.

Figure 1. Nuclear-Powered Agro-Industrial Complex

This opportunity was further explored by a summer study directed by Edward Mason, a professor of chemical engineering at the Massachusetts Institute of Technology. He was encouraged to tap technical expertise, regardless of the country or organization in which it was to be found. A converted barracks just outside the fence of the principal Oak Ridge Laboratory was turned over to the study group. The specifics of the proposal were roughed out between June and September, 1967, and a draft was shown to the press the following March (New York Times, March 10, 1968, p. 73). A sketch of the spatial arrangements of the components of the complex--as dictated by their respective sizes, links with the outside world and exchanges with each other--was also presented.

The illustration of the completed agro-industrial complex indicates the present state of the study; it outlines a bio-technical automaton that spreads out to the horizon from an empty shoreline. Not a road, office building, worker, or evidence of human settlement is to be seen. Nevertheless, the text estimates that as many as 100,000 persons may be directly connected with the project before full capacity is reached. A group of engineers and technologists engaged in feasibility testing is not expected to go any further than to make reasonable allowance in the economic calculations for the pay of workers and advances toward their housing. Their professional colleagues do not censure them for placing the human settlement problems into the ceteris paribus category.

Nevertheless, this "food factory" closely resembles scores of large-scale irrigation projects based upon big dams and hydroelectric power. The mechanization aspects are paralleled by the Groundnuts Scheme concocted by the British immediately after World War II. Virtually all of these large schemes have been dismal failures in the economic sense.

Among more than a score in Africa, for example, only the Gezira of Sudan stands out as a success. In South Asia, the returns have yet to come in on many big projects, but the majority of those that have gone into operation failed to produce food at costs low enough to compete on the market. The problems that intervened so disastrously were rarely technological in origin. Mostly they could be called "people problems", originating with settlement procedures, laws, customs, education, marketing, management, etc.

Therefore, a very high priority must be given to the feasibility testing of the human contribution to the nuclear agro-industrial complex. This is best done by fitting the "building blocks" of technology to some of the most applicable sites and then proceeding to plan as optimal a program for community development as is economic, legal, socially acceptable, and politic. This exercise should reveal a number of extra, unsuspected values inherent in the nuclear agro-industrial complex that were not envisaged by the technologists. Moreover, the proposed modifications would not be injurious to their scheme. The result should greatly increase the likelihood of success.

Project plans for a nuclear agro-industrial complex[2] must fit into the national and regional development programs. If, as is usually the case, these programs are not very explicit or effective, a means of giving them a boost should be sought. The project must also be designed to accommodate itself to the local people. Although their home territory is presently regarded as a wasteland by strangers and officials, many features are loved by the residents and the nomads

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[2]Now that the official name has been used a half-dozen times, perhaps we will be permitted to revert to the condensed term -- "nuplex" -- now used by those most familiar with it. Cf. Chemical and Engineering News 46, June 24, 1968, p. 34.

who will resent the complete transformation of their environment. Somhow the present inhabitants must be made to feel that the change is both necessary and desirable. The alternative could be bitter resistance, litigation, strikes, and even sabotage. Thus, provision must be made for plans made by and with the local communities.

One important contribution of the planning exercise is that the characteristics of the organization needed to build and manage the complex are brought into focus. Civil servants, specialized counsel, and politicians would then have a clearer idea of the enabling legislation that needs to be passed. The corporate creature that the law brings forth must be able to engage in many businesses and be accountable to many parties. Once it has taken shape, a detailed study aimed at actual design and costing could be undertaken with some confidence that a good project would result.

We have started a planning analysis of two of the six sites thought to be most promising on the basis of information assembled at Oak Ridge. These two are both in Asia, yet the social and political environments are as divergent as could be imagined. These examples are intended to illustrate what can happen to a technological fix when it is carefully integrated into the fabric of the society that badly needs it.

Many readers educated in graduate schools for technology and the sciences, whether hard or soft, will be amazed to find two fictional accounts--scenarios--included in an otherwise straightforward appraisal of the implications of this new technology. Scenarios are to the serious scholar of the future what itineraries are to the naturalist and the detailed exploratory experimental sections of scientific papers are to the laboratory investigator. However, the terms are more

understandable to the lay public because they deal with interpersonal and inter-organizational action. A technique like this is needed to overcome the paucity of information that can be injected into a statistical projection; it offers a way of searching out the non-linearities in social change so as to uncover potential catastrophes well in advance.

One feature of this form of extrapolation needs to be clearly understood: Scenarios are self-negating propositions.[3] Some of the actors in the real world will use information not yet available and resources not yet visible to improve upon the expected situation; their adversaries will concoct more elaborate ways to destroy them; neutral parties will take advantage of the shifts in power and thus change the socio-political environment that had been assumed to remain constant. Despite the fact that the future could not possibly follow the path laid out in a competent scenario, once it had become known to the actors, such an exercise has great value. It treats those phenomena that may well be relevant to decision makers but are otherwise not brought to their own attention or to their staffs. It also serves as a bench mark for the synthetic thinking of a research group at a given time. Later it is relatively easy to identify increases in sophistication or shifts in outlook and even pinpoint some of the rather subtle factors that were responsible for the advance.

It is important that the full planning analysis be undertaken by the people involved. Their society will be changed by it. Consultants in the various technologies, social and physical, should be

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[3] R. L. Meier, "Analysis of the Social Consequences of Scientific Discovery", American Journal of Physics 25 (December 1957) 602-13. The basic methodology is reviewed in this article.

available to them. Therefore what follows is merely an exploration of the range of options that this combination of technologies opens up. A large number of specific policies need to be set, and many innovations must be accepted by national and local officials. Out of this planning should come distinctive Arab and Indian solutions, quite different from those imagined on this continent. Thus far we have been able to bring a small collection of Near Eastern students to the problems whose careers over the next several decades may relate to these opportunities for making the desert bloom. A few Indians, Pakistanis, and Afghans have also helped. The majority, however, are Americans, only a few of whom have been out of the country. The quality of statistical information is perhaps as good as it will ever be, but lack of experience with the respective sites introduces a serious possibility for miscalculation.

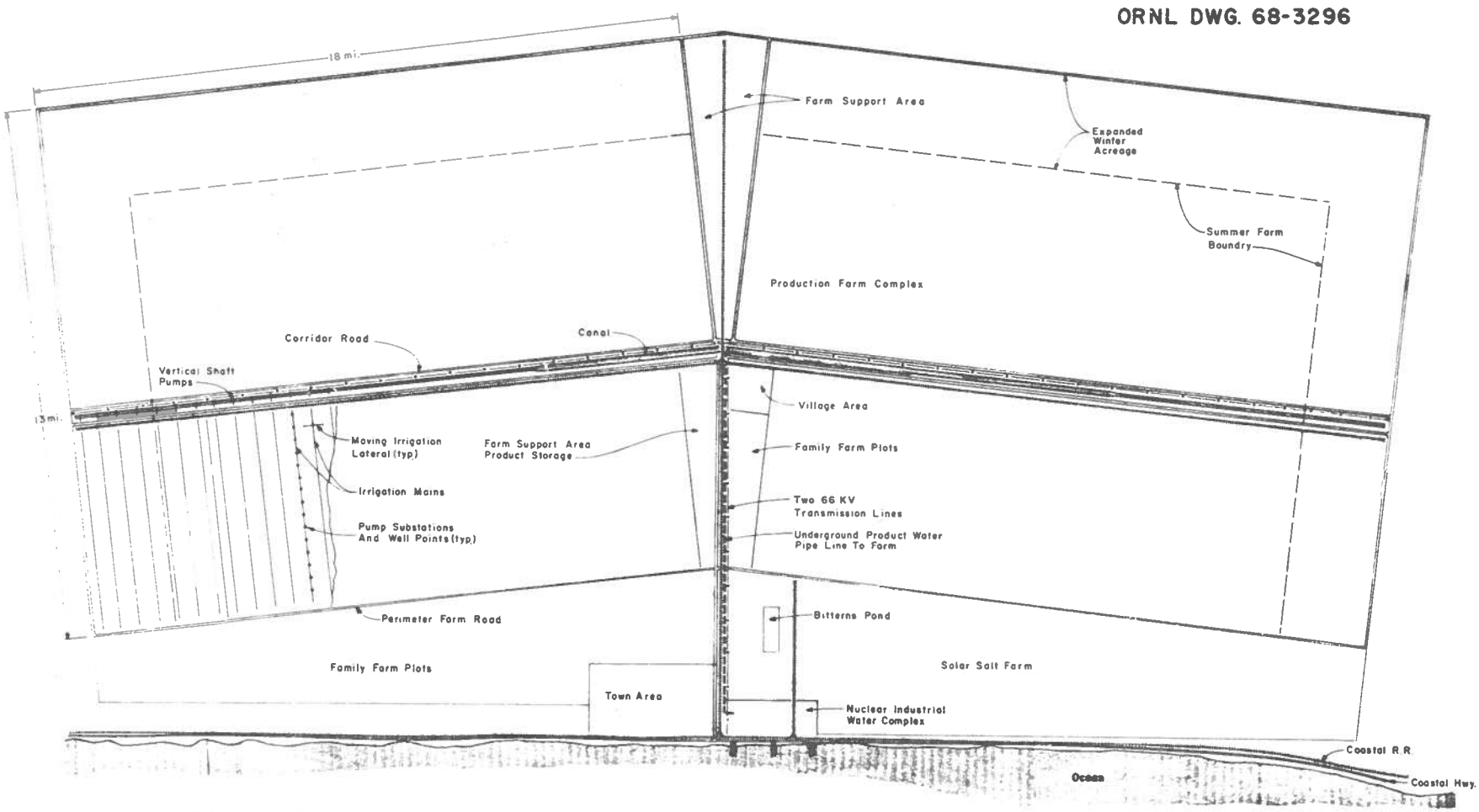

Figure 2. CONCEPTUAL PLOT PLAN FOR AGRICULTURAL-INDUSTRIAL COMPLEX

Chapter Two

THE CONCEPT AND ITS SOCIAL EXPLICATION

Technologists are forced to test their ideas within many different frameworks before they feel confident they have a workable concept. One of the first tests they consider is whether the basic structure can be represented on a map without encountering conflicting demands for the same area. This might be called the "space resource allocation" problem. What is best placed where? This representation of the proposal, forcing it to be upon a flat, homogeneous finite surface, communicates most of the facts needed by the architect and planner. Their task is then to resolve a parallel set of question: Who is best guided where? How do people fit in?

The schematic concept visualized for a simple shoreline is shown in Figure 2. From it the requirements for a "harbor city" become apparent. A labor force is needed to operate the industrial plant and handle the transportation. The organization of the agricultural "building blocks" cannot be represented on a map nearly so readily. For example, the same land can be sown to cotton one season, wheat the next, and safflower after that, with some of the stationary equipment needed to dispose of the crop being interchangeable (e.g., an oil press could process both safflower and cottonseed). The siting and sizing of the settlements that provide agricultural labor must be deduced much more from proposed operating schedules than from maps of layout.

We are conscious of the frequent mistakes made in the provision of "company towns" associated with such natural resource development projects as mines, plantations, and big dams. Repeatedly the conditions of settlement on the land have turned the workers into morose, vindictive mobs that delight in destruction. Moreover, a switch from a policy of stingy exploitation to benevolent paternalism does not bring about a desirable shift in attitudes. When decent facilities are provided by the employer, they are rarely maintained by the residents, and everything that goes wrong is blamed upon "the Company". Strikes are extremely difficult to settle in these environments and are prone to be violent. Politicians are either corrupted by the Company, or allied to the workers and their unions, so that the polarization of forces extends far beyond the resource development itself. Perhaps the greatest single risk to the continued productivity of the invested capital arises from the human conflicts engendered by such an installation. A plant that manufactures salt and inorganic chemicals from sea water in Western Gujerat with several thousand employees was reported to be suffering from strikes and expensive slowdowns as much as 30 per cent of the time. In the Gaza Strip and the Sinai the residents are daily urged on to violent action by radio and often also by some local leaders, even though there are no known resources to develop. All through South Asia the large absentee-owned plantations have generated intense xenophobia. Therefore, every effort must be made to promote and maintain cordial relations between local people, employees, neighbors, managers, staff, owners, and governments.

Certain principles will be observed in the following discussions of the planning of the projects. They are intended to minimize

the frustrations most people encounter when dealing with new neighbors and incomprehensible bureaucracies. The permissible investment in conflict-prevention is limited; the present guess is that it should not exceed 10 to 20 per cent of the capital cost of an otherwise feasible project. One of the principal effects anticipated is that the odds placed upon eventual payout will shorten, and a number of other entrepreneurs may decide to locate in the vicinity in hope of capturing some of the spillovers.

I. The boundaries of the operation should be delimited so as to disturb the lives of the minimum number of households.

Economists will argue that these projects should be labor-intensive, which almost always means the uprooting and resettling of large numbers of people. They neglect to take into account the social and political costs of such a strategy, and the management problems that result.

II. The locale should be as intimately connected with a metropolis as if it were a satellite city, so that natural leaders can find a number of routes for upward social mobility and organization-building other than becoming engaged in fanning resentments at home.

Because the core activity is agricultural, there is a tendency to think of concentrating training upon agriculture-related subjects and promoting rural institutions. Political and social responsibility is enhanced by enriching the environment with many kinds of information -- mostly urban, but also international.

III. Every prior human claim to land and facilities must somehow be adjudicated in the process of occupation.

All coastal deserts are occupied by nomads who depend upon certain land characteristics to make their living. Compensation must be found for their loss even when they do not own the land. Both of the areas we investigated contain a number of landless peasants, for whom a similar compensation is required, and smallholders whose social status hangs upon land ownership. It is imperative that mechanisms for justice be adopted that fit into the traditional social system, regardless of the formal legal arguments normally espoused by bureaucrats.

IV. Each household must have open to it two or three options, as well as an opportunity to change its mind.

The search for the best choice liberates and modernizes this technology, and all that accompanies it, is ultramodern as compared to what presently exists. Part of the process of becoming modern is the abandonment of fatalism and acceptance of the responsibility of choice. The need to choose does not take away all of the sting of change, but it serves to sensitize attention to environmental transformation, and therefore brings about self-education. The penalty to the household for reversing the decision should be set somewhat below the going charges by moneylenders. On the other extreme, opening up too many alternatives at once causes great confusion of mind.

V. All resettlement activities, such as house building, must be organized so that a strong payoff exists for collective enterprise and for knowledge about the operations of state institutions.

The sense of participation, more than anything else, produces personal satisfaction. Therefore the socialist predilection that the

State or the Company should provide housing, utilities, medicine, recreation, and other services is rejected as dysfunctional; positive incentives should exist for people who help themselves in groups.

By now it becomes apparent that we are asserting that the best strategy for getting a nuplex into operation violates the reflex reactions of economists, educators, accountants, and bureaucrats. Their respective standard operating procedures have notable deficiencies when applied to this set of problems. The ideologies of both the capitalist and socialist camps produce serious conflicts if their operating principles were to be applied. The reason for the rejection of these standard points of view is that the success of this project requires policies that build trust from the beginning and overcome the tendency to engage in litigation. There must be instilled a willingness to learn techniques of triple cropping that have not yet been standardized, and to live in multiple-shift communities. The utmost should be done to allow the people to develop into a self-reliant, autonomous, yet cooperative, population. The empirical findings of the human organization school of investigators (Simon, Likert, Argyris, Holmberg, Kennedy, Jaques, Whyte, and numerous others) are being drawn upon to reduce the chances of failure.

Programming

One of the newer techniques utilized by both engineers and planners for prevention of mistakes in estimation and implementation is called network planning. The method identifies the independent steps or operations involved in getting from here to a completion of the project. For each of these operations a time cost is estimated, on the basis of the nearest analog in current practice. Then a critical path is found for the sequencing of these operations so that the time of completion is minimal. Our "educated guess" regarding what will be

the critical path is presented in Table One. It represents the outcome of a number of attempts to trace the steps in construction upon four different sites under different hypothetical conditions.

Once the probably critical path is known, it is possible to lay out an investment program that fits it (Figure Three). (If the critical path should change, most likely due to political interruptions or to technological innovation, the investment program is adjusted accordingly.) A financial program--the schedule of requirements for capital expenditure followed by a forecast of the value added directly created by the enterprise from which repayments can be withdrawn--can be deduced from these estimates. Long deferments of return are highly undesirable in a poor region, because they postpone the accumulation of tax increments at the local level. Such taxes pay for the equipment and facilities for which the state and local governments had already assumed responsibility, but they cannot meet their promises very readily until the funds are in hand.

The project is expected to reach a steady state in about twenty years. Then the yields of foodstuffs should approximate the maximum attainable in mass production. The equipment will have evolved to the point where each unit is fitted to the other units so that a smooth flow is maintained. The disturbance of the eco-system will have made its maximum impact and the populations of birds, rats, insects, weeds, and fungi will have worked their way into a new quasi-stable set of relationships. The valuable by-products, whether straw or green fodder, will have found a use. At that time the labor force would remain constant, although an increasing proportion would move out of agricultural labor and join the service sector. Because the age distribution of the population will drift toward middle age, a small amount of net migration is expected.

Table One

SCHEDULE OF STEPS TO FULL OPERATION

1. Surveys of project area (aerial, ecological, sub-surface, land use, economic).
2. Drainage and reclamation tests.
3. Boundary delineation and selection of key sites (industrial complex, harbor city).
4. Land acquisition.
5. Experiment sub-stations begun.
6. Initiate canal and drainage layout.
7. Diesel plant with desalination unit installed.
8. Rail and road construction begins.
9. Industrial complex site preparation begins.
10. Heliport completed.
11. Workers tent city and storage depots completed.
12. Temporary headquarters and hostel for technical staff completed; housing begins.
13. Power grid connections made.
14. Meteorological and micro-climate station completed.
15. Flash flood drains completed; canal and reservoir construction begins.
16. Seed production spurred.
17. Small-scale production begins (3000 - 10,000 acres).
18. First reactor on stream, also brine electrolysis, phosphorus, sea salt production.
19. Salt flushing from soil begun on large scale.
20. Ammonia plant on stream; fish farm starts up.
21. Harbor city plan, Stage I completed (quays, bazaars, water and sewer mains, etc.).
22. Roads, rails, canal extensions to ultimate boundary begun.
23. Begin construction silos, loading facilities, and farm factory villages.
24. Resettlement or relocation of agricultural workers and families.
25. Multiple crop production of Stage I scale (80 - 100,000 acres) under way.
26. Complete heavy transport connections and first pipelines.
27. Flushing of Stage II starts, using water between crops.
28. Major drains and pipelines completed to boundary of triple crop land.
29. Chemicals and plastics plants completed, pipemaking begun.
30. Surface the roads, settlement accelerated.
31. Stage II reactor is on the line.
32. Farm production expanded.
33. Containerized harbor completed, lighter transport system activated.
34. Railroad electrification begins.
35. Harbor city plan, Stage II, completed.
36. Convert drains and/or canal into barge waterway.

Table One (Continued)

37. Peripheral lands desalted and converted to livestock.
38. Recreational facilities open.
39. First biotechnical graduates produced and absorbed.
40. All basic systems go.

The Farm-Factory at Steady State

We have coined a distinctive phrase to represent the agricultural activity. "Farm-factory" operations, as outlined here, are distinctly more thoroughly organized than any to date, some of the most recent of which have been called "factory farming." Our term is not elegant, but it will serve to indicate that something different from the existing Western techniques must be invented by technologists and managers in the Orient.

One threat to continuous production yet to be resolved is posed by the scale of operations. It presents opportunities for monopolistic control of prices, or at least the popular suspicion that a monopolistic conspiracy is in charge. The unique technology of a large multi-crop, capital-intensive agricultural facility does not fit any of the present government farm control programs. Therefore a charter, or franchise, similar to that devised for such corporate public utilities as those supplying gas, electricity and water, must be designed. The multiple-armed creature of that charter will hereafter be called the "Corporation" so as to distinguish it from the more limited companies that have engaged in plantation agriculture in the past.

For a workable solution we have drawn upon Indian precedents as much as possible, or borrowed from the latest reformist viewpoints in India. These institutions are less advanced in Arab countries; most reform viewpoints are neither economically or administratively feasible. The best outcome seems to be that of a strong administration with built-in sensitivity to both the metropolitan market and the local labor force. Its task as a new public utility would be to produce a bargained-out number of basic rations at lowest cost and maximize profit with the remainder of the resources at hand. This program reflects the current

Table Two

FARM FACTORY OPERATIONS
(ca. 1988)

Size:	1,000	million gallons per day distilled water
	1,000	megawatts electrical power capacity
	320,000	acres of fully irrigated land
	100,000	acres marginal lands (using rain and surplus water)
	70,000	acres fisheries
Managerial Responsibility:		
	250,000 A.	Corporation - managed
	50,000	Small holders (some under contract)
	20,000	Subsistence plots, urban settlement, etc.
	170,000	Peripheral farms, cooperatives, specialists, etc.
Crops:	200,000	Cotton (1750 lbs.)
	400,000	Wheat and Millet (6000 lbs.) or Sugar
	120,000	Pulses (300 lbs.)
	60,000	Safflower (4000 lbs.)
	60,000	Potatoes, Sweet Potatoes, and Yams (45,000 lbs.)
	40,000	Fish (1800 lbs.)
	100,000	Forage Crops (hay, pasture, silage, etc.)
	120,000	Vegetables and Fruit (30,000 lbs.)

onions	beets
tomatoes	"bhutta"
"brinjals"	citrus
okra	papayas
pumpkins	bananas
cauliflower	strawberries
peppers	

thinking that it is becoming the duty of a metropolis to supply both bread and circuses, although in this part of Asia it may become flour for unleavened bread with television, and the Corporation becomes the agent the metropolis employs to plan and manage the production.

Considerations like these determined the prospective allocation of crop land shown in Table Two. The high allocation to cotton is explained in the scenario to follow as a means for obtaining indirect foreign exchange sufficient to pay off external obligations incurred in the course of construction and in operation.

Because the crop yields proposed approximate the maximum obtained continuously on well-managed farms (they are only 10 to 20 per cent below the record yields achieved by champion farmers), the greatest risk of failure lies in the use of ineffective crop production techniques, therefore the Corporation must concentrate on acquiring the information needed to achieve such results. The nuclear reactor has such high safety factors built into it, little trouble is anticipated from the quarter. The productivity of the evaporators that produce the water for the crops can be impaired by unknown factors that build up in the environment (for example, TVA water treatment facilities were shut down more frequently than designed due to the invasion of the reservoirs by molluscae that clung to iron surfaces), but research has already suggested many strategies for keeping the equipment going. Nor is land reclamation fraught with much risk. This leaves the greatest uncertainty in the stage when the particular strains of seeds and rootstock must be chosen for planting, and again when the crops must be defended against pests.

Therefore a substantial effort must be organized for plant breeding and seed production. This is an activity that has already been established on a substantial scale on the southern side of the Gulf of Kutch

and in the Negev region. However, the standard set by the Rockefeller Foundation centers in Mexico and the Philippine Republic is quite a bit in advance of the leaders in India, and those unusual examples are at least the level toward which a project like this should aim. Perhaps 10 per cent of the whole acreage would be devoted to seed, with half or more of it exported to the Indo-Gangetic plain, particularly Bihar, or the sub-Sahara areas where equivalent growing conditions exist. Conscientious removal of diseased stock, weeds, and the treatment of the seed itself results in a labor-intensive operation. Logically it would build up around the original agricultural experiment sub-stations and along the connecting roads to the locale through which all improvements in yield and almost all new crop types must pass.

But what about the organization of the remaining 90 percent of the acreage? The best proposal to date is to divide the territory into about twenty equal parts. Each of these would be run from a carefully located village. The quota for the production of the rations that had been contracted for well in advance could be divided among them in roughly equal parts. The remainder of their land and water could be allocated to more of the same, or else committed to the crops that seemed likely to produce the greatest profit. The annual bonus tradition for industrial employees is generally based upon profit-sharing formulae, so visibility of profits is very strong and it influences much of the behavior around the village shops and the meeting place of the panchayat. I imagine a two-man team, one a Corporation appointee, the other elected by the workers, acting as the strategists in the game against Nature, and directing the use of powered equipment (much of it drawn from a few central pools) and of scarce manpower. It is important that the villages engage in friendly competition against each other

because then they become far more willing to accept innovations. The planning and programming of transport, storage, and marketing are left to the headquarters group in the Corporation, part of it in the harbor city but much of it in Bombay or Cairo where top quality people can be hired. They would be checking upon the actual performance of the 12-15,000 acre subsidiary blocks and recommending alternative strategies for future cropping. The key index for a project like this, with relatively expensive water but cheap land, is the market value of output per unit of water consumed. Because most purchases are low value raw materials, and labor is quite cheap, even if the standard 30-40 per cent premium for urban wage standards is paid, the greatest social return appears to lie very close to the maximal level of this ratio.

Operating Conditions for Labor

Existing reports on irrigation agriculture at this latitude are geared to double-cropping techniques. The standard approaches for using a new water supply would require perhaps 50 per cent more investment in leaching the soil, installing pipelines, and extending canals than is implied here. More water would be lost by evaporation and somewhat more fertilizer would percolate away during the fallow periods than in farm-factory procedures adapted to the new, very highly productive strains of crop plants. Journey-to-work costs would be significantly greater. The principal saving involved in double-cropping would be registered in the smaller inventory of machinery needed. Because the land remains inactive as much as two months per year in a double-cropping program, the machinery can be used more steadily at a single task, such as plowing, and breakdowns in equipment can be repaired in time to meet crop planting schedules. In triple-cropping programs the completion of the harvest, turning over the stubble, working the soil,

and seeding must occur on a round-the-clock schedule. Shifts in the weather have previously resulted in the piling up of field work, but with better weather prediction such occasions can usually be spotted in advance, and they can be resolved by keeping some extra equipment at hand. Altogether, it appears that Sundays and holidays must become routine working days for the employees, just as they are for transport workers and public service employees in electric power plants.

One of the gravest problems facing a resource use facility, such as a large mine, a major paper mill, or a farm-factory as planned here, is the build-up of insularity in the community. Too often only the top managers and engineers are rotated through the ongoing enterprise. This practice builds up an "us and them" split between the workers and their union against the Corporation. Everything that goes wrong in the community can be blamed on the lack of interest, or poor planning by the Corporation and its representatives, because the Corporation appears to be all-powerful. Much of this insularity can be prevented by providing a variety of paths for upward and outward mobility of ambitious workers. Inside the firm workers may move to the Bombay or Cairo operations, usually after acquiring some specialized training. As marketing becomes increasingly important over time, it is possible to foresee a steady drift from the farm-factory households to the metropolis. It would be good policy to encourage the movement out, and replace the workers with new families from the region, because groups of new workers can be taught new work procedures with little resistance, thus allowing greater flexibility for technological change.

At steady state the only employees being added will be replacements for those who are quitting. It would not be at all surprising if the turnover were to be 20 per cent per year. Many of the newcomers

will discover that they will not be able to accept the discipline, but quite a few will have learned so much that they are encouraged to set up some ancillary enterprise of their own. Gujeratis have a reputation all over India for their pertinacity as small businessmen, and they have specialized in particular in the processing of agricultural products all over Africa and South Asia. Palestinian Arabs have also demonstrated a capacity for small business elsewhere in the world.

Thus an open system must be designed that adds value to people even more than the soil resources, the energy inputs, or the information. The Corporation can be viewed as a gigantic human resources development program, and not merely a mechanism for human maintenance, as indicated by its contract to produce rations. It is this people-building characteristic more than any other that promises the community tranquility and labor peace necessary to productive operation.

Population Forecasts

The number of people for whom to plan could not be estimated until as clear an image of the future as possible had been formulated. Now we can proceed with the estimation process.

One mode of argument starts from the experience accumulated with the analog that most closely approximates the planned conditions. The Central Valley of California offered very similar agricultural challenges when it was being committed to the crops tentatively assigned to this project. In 1946, when field labor was earning two or three times the amount assumed for India and the Sinai, the peak labor requirement for cotton in Tulare County was one worker for every six acres. For citrus in the coastal desert valleys, the ratio was one such worker for every eight to thirteen acres. For dry beans, however, it was one for every eighty

acres.[1] Further research would have uncovered more data of this sort, but the degree of relevance for projected conditions in the 1980's is not too great. With labor requirements as great as this, it is important that the seasonal work force find employment in crops with different peak requirements. Control of pests was still quite primitive at that time (an operation that might well be labor-intensive in the farm-factory, if maximum yields are to be obtained), but mechanization, including sprinkler irrigation, is likely to trim the effort spent upon tillage.

A parallel basis for projection is to identify one of the best-managed contemporary operations in an underdeveloped country. However, here we find that even some of the most recent publications from those countries record information that is equally dubious. For example, an assessment of labor requirements for cotton-wheat production in the sandy soils of the Punjab in 1956-7 by the Ulra Joint Farming Society, Ltd. showed that 21 permanent laborers, and the equivalent of three others in casual labor, were required to operate 141 acres when using both tractors and animals.[2] This works out to six acres per man with a double-cropping cycle.

A third approach involves an unraveling of the technological calculations compiled by Oak Ridge for the general case. The technological inputs, as incorporated in standard comparative studies, are really

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[1]State of California, California Senate: Special and Complete Report of the Joint Legislative Committee on Agriculture and Livestock Problems, 56th Session (1946), pp. 108-26.

[2]H. Laxminarayan and Kissen Kanungo, Cooperative Farming in India, (New York: Asia Publishing House, 1967), p. 54.

an outgrowth of the cost accountant's analyses of relationships internal to the production process. Labor cost ratios, in order to be comparable, must include the maintenance labor for the machinery and equipment involved in this approach to food production. No direct estimate of total labor cost is given in the Oak Ridge report, but various means of estimation converge upon $35 per acre per crop, or about $105 per year. In America this would mean that two men would have to farm 200 acres in order to earn $10,000 apiece per year. This sounds reasonable as compared to present performance. In Asia many of the services these men would purchase in town would have to be provided by the Corporation to itself. The local wage scale presently varies from 5 to 40 per cent, of the American level. The method we have employed is to set aside 20 to 25 per cent of this figure as a profit-sharing bonus and to pay the rest in the form of the going wage at that time, as is common in the semi-developed areas of the world, such as Japan, southern Europe, and the urban parts of Latin America. Then a hierarchy of pay scales can be constructed (Table Three) with the number of workers at each level, with the differences in pay between levels reflecting conditions anticipated a decade or more hence.

Table Three

Wage and Salary Scale for Farm-Factory Production[1]

Category	Average Annual Wage[2]	Number	Contracted Cost
Semi-skilled and Unskilled	Rs. 2000	50,000	Rs. 10 crore
Skilled	3000	15,000	4.5
Supervisory	4500	5,000	2.25
Technical and Professional	7000	2,500	1.75
Managerial	7000	2,500	1.75
Executive and Top Staff	10000	500	0.50
		75,500	Rs. 20.75 crore

[1]Add about 30 per cent for annual profit-sharing bonus if the project achieves the designed level of profitability (say 15 per cent on investment).

[2]This level is about 50 per cent greater than would be needed at present in rural India, and roughly comparable to metropolitan wage scales.

It will be noticed that this allocation to labor results in a ratio, acres farmed to top labor force requirement, of about 4.3, instead of the 6-8 range found historically. A careful analysis of the data would point out that this seems quite reasonable, since we expect to be triple-cropping. However, the trouble involved in managing the transfer of such large numbers to the site suggests that, if at all possible, the work should be organized so that many fewer people, if necessary with higher educational attainments, should be employed. Thus, the employment figure obtained in this exercise in estimation is viewed as a maximum; it is approximately what would happen if the enterprise came into equilibrium with wages in Bombay or Cairo and their environs.

It may mean, for example, that a much smaller permanent population would be planned for, and the peak labor requirements are met by hiring

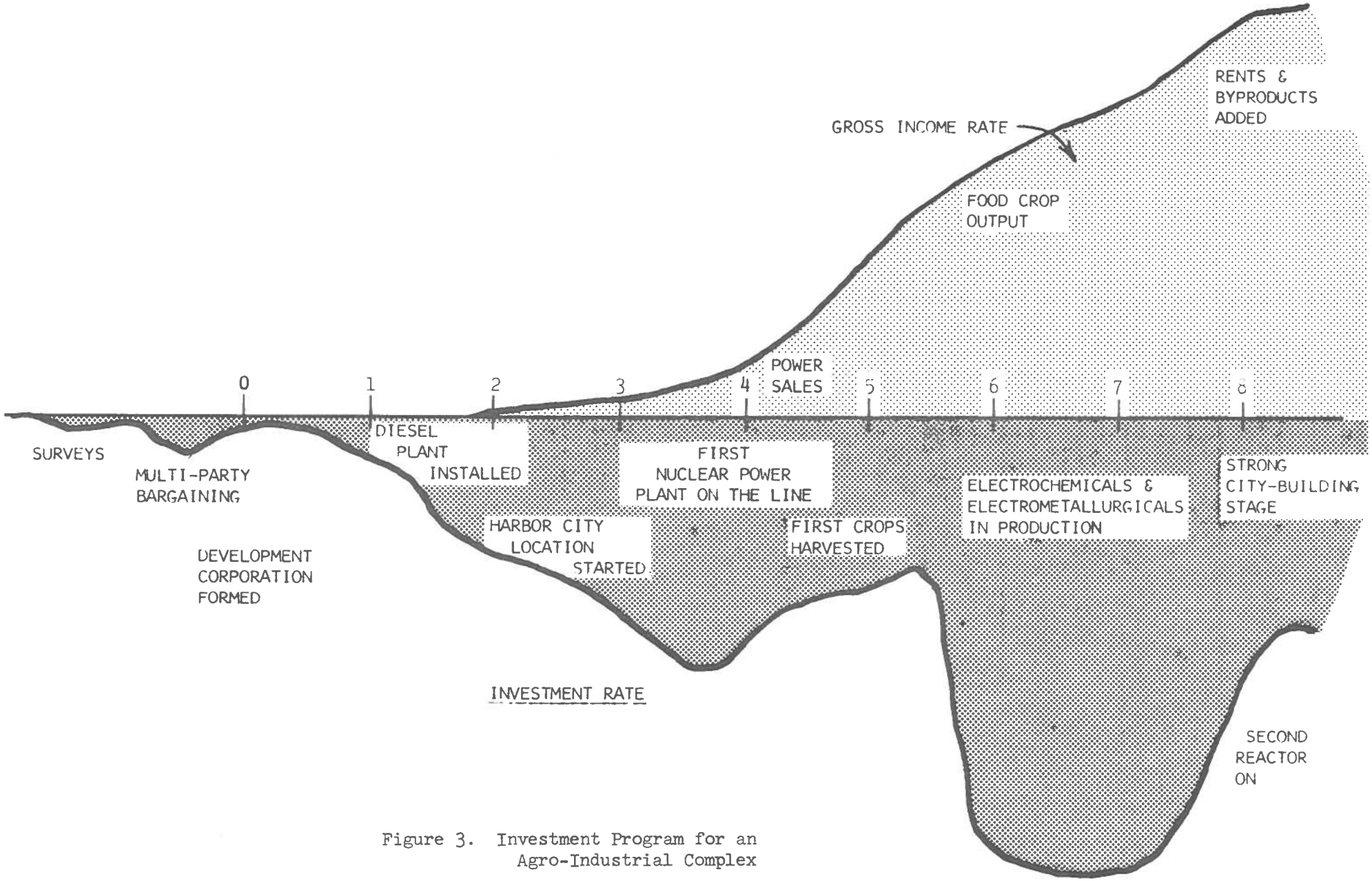

Figure 3. Investment Program for an Agro-Industrial Complex

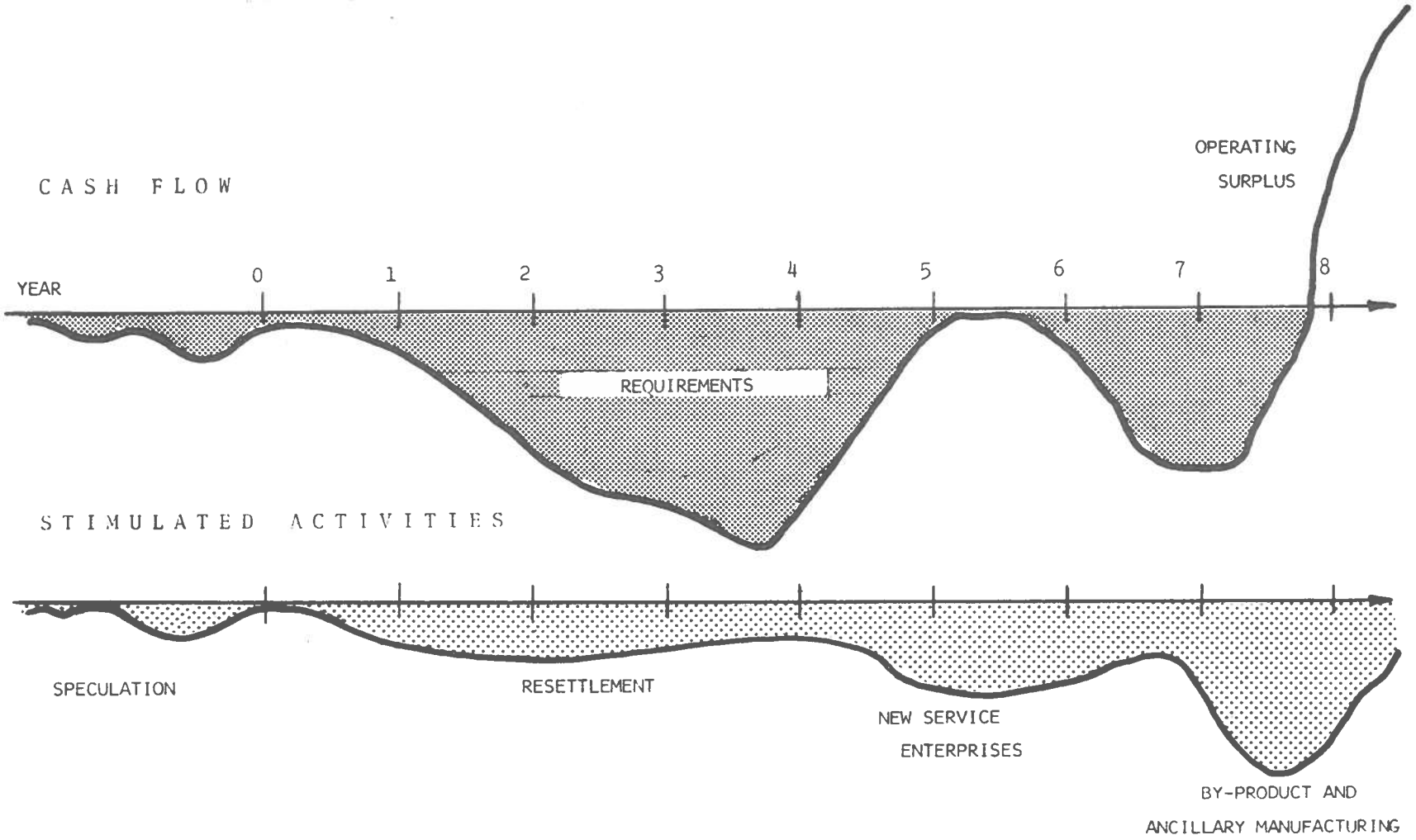

FIGURE 4. NET CASH FLOW FOR THE STANDARD COMPLEX AND THE STIMULATED ACTIVITIES

day labor from the households, if necessary, from the surrounding areas. The latter would live in camps or barracks and take their cash back to their villages. Many factories in developing countries, e.g., the jute mills of Hooglyside in West Bengal, operate on this basis already. Nominees for the "permanent" working staff are then drawn from the temporary labor force or from the children of permanent employees.

In addition to the rural workers, a considerable number will be employed in the nuclear power plant, the desalination plant, the fertilizer plants, the electrochemicals and electrometallurgical facilities. With this equipment it does not pay to have excess labor on hand. The demands of the unions should be resisted by using arguments of safety, since the task of finding jobs for surplus people in virtually automatic facilities introduces extra chances for error. In these plants labor cost makes up a minor (usually less than 10 per cent) share of the cost of production in all of the alternatives for deploying manpower, so any saving in labor cost is trivial. Without elaborate justification, since the existing plants in developing countries offer no direct basis for estimation, we assign 5,000 employees to the industrial facilities in the complex. Most of these will be shift workers who acquire multiple skills over time.

Service workers constitute a large addition to the labor force. Quite a few of them will be in transportation, even more in commerce, a large and unpredictable number in personal service, and another quite unpredictable quantity in government services. The principal reason the government services are unpredictable for a new urbanization is that many of the key facilities serving this population already exist in centers on its periphery and have prior claims upon the resources available for

expansion. Construction workers form a separate category that is often left out of planning for steady state operations. Actually they should find employment in the business and housing sectors at the time that the main industrial and resource-oriented construction has passed its peak (Figure 4).

The overall employment picture to be planned for takes on the dimensions shown in Table Four. This is far larger than was originally anticipated in the Oak Ridge report. The principal reason for earlier underestimation is the more careful assessment of primary, secondary, and tertiary effects. Originally, for example, it was assumed that the surplus water would be applied on peripheral farms on a single-crop basis, without reckoning that it would add to the number of persons whose principal source of income would depend upon the water, thus making them almost the equivalent of employees. Personal service will be large in India, where the whole social system is geared to it, but had been omitted altogether in prior considerations.

A major urban center will claim a good share of this imported population. The families of employees in heavy manufacturing, transport, government, and much of commerce will expect to live in relatively cosmopolitan areas at high density, mainly because the services are then convenient. A portion of these will prefer to live in more specialized communities organized along self-help lines as urban villages,[3] alongside employees in construction, personal service, fisheries, and nearby farm-factory agriculture. Such urban villages would be in easy commuting distance of

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[3]See the preceding monographs in this series for the prototype urban village proposal as it might evolve in the vicinity of a growing metropolis. The more modest version applicable here will be discussed later.

Table Four

EMPLOYMENT BY CATEGORY IN A NUCLEAR-POWERED AGRO-INDUSTRIAL PROJECT (Steady state)

	Workers	Total Members of Households[1]
Agricultural (farm-factory operations, including smallholders and independents)		
Regular employees	50,000	150,000
Temporary employees	5,000 - 25,000	5,000 - 40,000
Peripheral, single-crop farms	5,000 - 15,000	25,000 - 60,000
Fisheries	5,000 - 10,000	15,000 - 30,000
Industrial		
Heavy industry	5,000	20,000
Light industries (byproduct use)	2,000 - 10,000	6,000 - 30,000
Services		
Transportation (independent services)	3,000 - 10,000	5,000 - 30,000
Commerce	5,000 - 15,000	10,000 - 45,000
Government	1,000 - 5,000	5,000 - 15,000
Personal Service	2,000 - 20,000	5,000 - 30,000
Construction	2,000 - 5,000	6,000 - 10,000
	85,000 - 170,000	252,000 - 410,000
Normal expectation	120,000	330,000

[1]The multipliers, which indicate the numbers of persons supported by workers, according to the nature of their employment, is based upon norms in India. Many workers in personal services, construction, or temporary employment would maintain their families in their home villages. No equivalent experience exists for Arab society. We have also incorporated significant reductions from the present, based upon an assumed acceptance of birth control by all but the poorest families.

the harbor city and so should be regarded as part of it. The overall population expectation would be 62,000 (25 per cent of the total) at the minimum population expectations, and 200,000 (or 48 per cent) at the other extreme, based upon category-by-category assessment of the implications of the technology and the development program (Figure 5). These estimates incorporate effects directly traceable to the project and do not include the consequences of opportunities opened up for development, the impact of which cannot be foreseen. Most of the extra opportunities will bring about further growth of the harbor city and not affect the interior or the periphery.

The remaining settlements are towns or villages, a number of them with some long-standing history but now completely transformed by the new fertility of the soil. The village centers used to coordinate the field work and serve as primary shipping centers are not likely to exceed 10,000 persons, even when fully developed. Peripheral villages, on such as those engaged in livestock raising, primarily dairy, and cottage industries, are expected to range in size from 500 to 5,000 persons. An important proportion of them would be designed to enable the more permanent settlement of the seminomads who formerly criss-crossed these coastal deserts with their flocks. A small population may live on independent farmsteads outside the villages, but living among one's own fields is a pattern that is exceedingly rare in Asia, though common for analogous types of agriculture in the Americas.

The Farm-Factory Villages

The technology of a nuclear agro-industrial complex imposes a number of unique conditions upon the settlement of farm workers. They could very well combine to make living conditions almost intolerable,

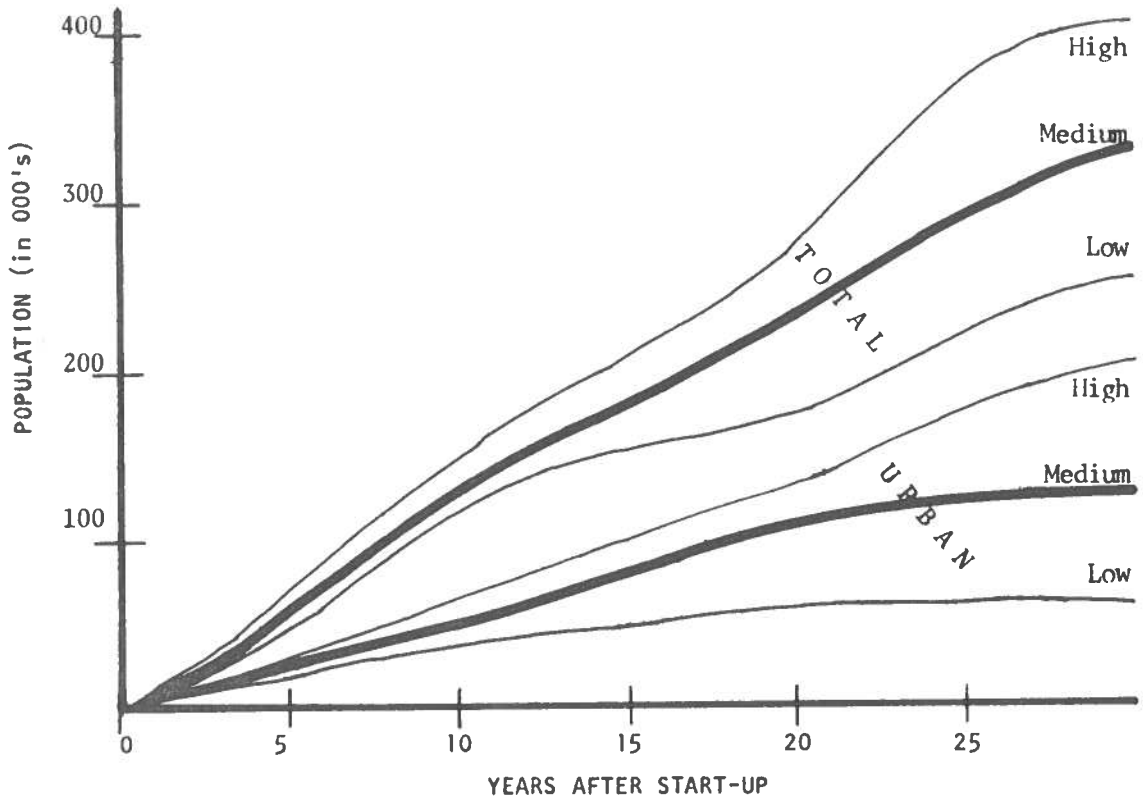

FIGURE 5. POPULATION SUPPORTED BY FULL PROJECT

so that petty irritations build up resentments against the many-armed Corporation. Normally, they would be released by periodic public disturbances. This friction greatly hinders the learning process so necessary for the effective utilization of expensive capital equipment. As we inspect the experience of earlier irrigation schemes, we see that one of the most common sources of failure has been the lack of attention given to community formation processes.

We start with a variation of the proposition enunciated from the beginning: The community must plan for itself and organize the construction of its own facilities. However, the alternative available to it can be very restricted if the Corporation is arbitrary and inconsiderate in the arrangement of its own facilities. Therefore some careful preliminary planning is required to assure a wide range of desirable alternatives. Very likely a planning assistant will be needed later to provide liaison between the community and the company over the principal construction period (up to ten years). We have explored this preliminary planning process in order to discover the principal constraints upon community building.

Probably the most striking physical element in such a community is the tall grain elevator. Allocating two out of the three crops to grain, with dry beans or oilseeds in between, will create a huge storage problem. If part of the acreage is used instead for cotton, potatoes, citrus, small fruits, and vegetables, the bulk of the facilities is likely to increase even further but the distribution of shapes and forms will be varied. Much of the temporary storage and preliminary processing must be located at the first collection point. For reasons of access and convenience the community must also be built at this point.

Analysis of the alternative locales proposed for the overall scheme suggested that such communities may range from being camps with changing shifts of workers (e.g., in the Little Rann of Kutch) to small settlements containing around 1000 people or to railroad-based towns containing 10,000 or so persons and a number of small industries. The people may have already been living on the site, or they may have been moved in from nearby sites when the farm-factory was created, or they may have immigrated from a distance. Each of these groups will have a distinctly different collective preference for the layout of the village and its neighborhoods.

Let us take up the respective scales of a settlement that eventually accumulates about 1000 workers for the farm-factory, including administration. This will enable it to operate about 20 square miles of irrigated farm land, plus some extra that might produce a single crop by dry farming techniques. The overall population supported by these basic 1000 jobs is expected to range from 4000-7000 persons. Perhaps 500-1000 non-agricultural jobs, quite a few of them for women, would be created within the community. Many of these workers would be engaged in processing by-products, but a substantial proportion would be providing services to the farm-factory village population. As with most colonizations and "company towns", we would expect a gradual buildup of population as families are completed, reaching a peak perhaps fifteen years after the major influx, followed by a plateau and then an accelerating decline in population. Subsequent developments may interrupt the decline but they are not foreseeable at the present time and must be introduced on their own merits when those opportunities appear.

Such a community is expected to have 100-200 elevators, silos, granaries, packing sheds, and refrigerated storage structures, a number

of them reaching as much as 100 feet into the sky. The volume of storage reaches the same magnitude as the volume of construction needed for domestic purposes. It must also have repair facilities and parking areas for as many as 1000 vehicles, some of them of the "behemoth" scale. The vehicle park might well take up three acres of land. This is to be compared with twenty to fifty acres for the human settlement. (People prefer to pack themselves together quite tightly in coastal desert areas.)

The provision of several options for people displaced by the agro-industrial project is expected to result in several types of residents in these villages. Landless farmers and day laborers are expected to opt for the "subsistence guarantee" garden plots, but the landed agriculturists would become smallholders, operating tracts of one to twenty acres and contracting with the Corporation to dispose of their output. They may also form cooperatives for marketing specialized crops. Thus a village of these dimensions might require about 1000 to 2000 acres in its immediate vicinity for gardens and small holdings. From that center the thousand employees should be able to operate as much as 15,000 acres on a farm-factory basis.

The social structure that arises in such a community is foreseeable in part. At the top is the resident farm manager and a handful of leading citizens -- perhaps including a politician, union leader, business man, doctor (or professional plant pathologist), and an engineer. In the upper middle rank would be the active smallholders, businessmen, school teachers, top technicians and local managerial staff of the Corporation. In the lower middle rank would be the remainder of the small holders, the semi-skilled and skilled personnel working

for the Corporation, while near the bottom are the unsuccessful farmers and the sojourners from outside who seek permanent employment. This society more nearly resembles what is found in small industrial cities than in agrarian villages.

It is important that the personal assessment of social status by the heads of households and their wives would suggest that 80-90 per cent of the population had advanced in life as a consequence of the establishment of the farm-factory and the exceptions would not be able to argue persuasively that the Corporation or the Government were responsible for their losses. The image of having achieved something must be a strong consideration, for example, in planning the arrangement of physical facilities, and should remain a primary component of the managerial policy thereafter.

Comfort and convenience of the village-dweller must be assigned the highest priority in the village plan. Thus the cool summer shadow of the elevators and silos will be valued, but not the dust produced while transporting the grain. The sea-breeze is very much enjoyed in all coastal deserts, so it cannot be blocked off by the Corporation. The landmark elements of the village ought to be under partial village control. This might include the color of the paint, the establishment of a daytime and night-time image, and the provision of services. (For example, both in India and in the Sinai it will occur to the local people that the walls of elevators and silos are large enough to serve as outdoor cinema screens. Indeed it is physically possible to maintain a simultaneous double feature. However then the houses would probably need to be arrayed very much like the parking places in a drive-in theatre! Nevertheless, if one or two villages opted for

spectaculars, others are expected to elect a different physical treatment of their collective environment and would watch television at night instead.)

Village design for the Sinai and in the Kutch seems to encounter the same kinds of problems. Decisions locally arrived at seem likely to converge on similar solutions despite the disparity of Arab and Gujarat cultures. We present, in Figures Six and Seven, a few of the alternate proposals for village construction that fit within the funds likely to be available.

Chapter Three

A SCENARIO FOR INDIANS

In April, 1968, the concept of a nuclear-powered agro-industrial complex became the official concern of the Indian Government. The draft report from the Oak Ridge National Laboratory arrived in India in March, 1968, with M.P.S. Ramani, a chemical engineer of the Atomic Energy Commission of India, listed as co-contributor. Several agencies were assigned the tasks of preliminary evaluation. Because the initiator of the project -- the Atomic Energy Commission -- was a high-prestige, high-competence agency to which many of the most difficult technological design tasks were assigned, the scheme was given careful scrutiny. The formidability of the task dismayed several young I.A.S. officers, so they found themselves reduced to nit-picking. However, the engineers and economists trained in the United States and experienced in its technical jargon were able to raise a number of important questions.

Why not use coal instead of nuclear energy? A comparison of the two approaches, using current figures for services and transport (but neglecting economies of scale and prospective supply shortages), suggested that the fertilizer costs in the nuclear-powered complex offered no advantage. The concept of a complex, with its byproduct utilization potential and recapture of external economies, is a relatively new concept in India, and one which is especially difficult to convey to superiors. These battles to displace cost projections based upon historical trends alone had to be fought in America in the 1930's, in Western Europe in the late 1940's, in Japan and Southern Europe in the 1950's; now it is India's turn. Integrated industrial complexes go unquestioned in oil refining and chemicals

production, but elsewhere in the economy a new kind of accounting that measures marginal costs and returns must be installed before the increased productivity of capital becomes visible. These sophisticated ideas are already used in New Delhi by the national planners, but they have yet to be adopted by many of the groups engaged in industrial process design.

More damaging criticisms were also transmitted. Where, for example, was the market for all that aluminum? (The answer to that argument was to retreat and argue that for a site on or adjacent to the Kutch there was likely to be sufficient power demand building within the Gujarat electrical grid, so that a smaller aluminum plant utilizing nearby bauxite appeared to be the proper solution.) Similarly, why not invest in the double-cropping of the Indo-Gangetic plain where capital per unit of output would appear to be less? (The answer to that was that coal might suit the Indo-Gangetic plain better, at least initially, but a nuclear power complex deserves careful simultaneous study.) Most telling of all was a political question: Why put all these new plants into one package when they could be distributed over ten, or even fifteen, states of India and thereby generate some new support for the Government? Stable government can be worth a great deal to India, because it prevents waste arising from destructive conflict. But how is its value to be measured and compared?

A few of the commentaries were complete misunderstandings; the authors appeared to be discussing quite another proposal. Some of the criticisms were stated bluntly, but more often they were framed in delicate circumlocutions, so that only the most alert civil servants could gauge their intent. One of the latter raised an issue that later became fundamental: It argued that (1) the long-term development of the West Coast of India, and Bombay in particular, was constrained by access to food

since not enough could be produced locally, (2) the harbors had increasingly limited capacity to meet the food deficit by imports, therefore (3) much of the buffer stocks of foodstuffs now being accumulated should be stored in the West, but (4) if this is not acceded to, then Bombay and the other Western metropolises should seek a supply which was proof against monsoon failure. Indeed, the most careful economic evaluation of the ideas imbedded in the agro-industrial complex was based upon the full appraisal of costs for withstanding two successive failures of the monsoon with internally assembled buffer stocks.

Thereafter a Special Technical Committee was convened to decide what should be done next with this idea. At its first meeting, early in 1969, a memorandum reviewing the tentative findings of the follow-up studies at Oak Ridge and Berkeley regarding a Gujarat site was submitted.

Skilled administrators were dismayed by the implications. In their experience a major project always required close collaboration between Union and State bureaucracies, but the cooperation between the proponents of this project and the large public enterprises would have to be truly intimate, to say the least. However, it was a heroic mission, and one that could not be dropped without scandal. The international interests in the scheme made it a tricky diplomatic task as well. Indeed, it was the set of international ramifications that suggested the "solution." A Minister Plenipotentiary was appointed to discuss the project with countries and companies. A new, industrial member of the Atomic Energy Commission was handed the task of assembling a Study Group, which was to prepare a plan within fifteen months; it would incorporate the results of a feeling out of the availability of credit for the hard currency component. Actually, on advice tendered to the Prime Minister in an interim

report, a joint industry-government team was formed to promote an international consortium. The structure of such a consortium was traced back to the idea of a quasi-public corporation proposed in May 1968 by Senator Javits, leading a bipartisan group of Senators, for the establishment of a "Peace by Investment Corporation" which sold debentures in small denominations to the American public, allowing participation in pooled investment projects overseas. Thus, within six months of the time the Outline Plan was announced, the Great Western Atomics and Foodstuffs, Ltd., (GWAF) became a reality. Although much of the initial stock was held by government corporations, GWAF was a corporation intended to make a profit.

The London Economist probed deeply to find the formula around which the deal was built. Their reporters discovered that the American Government had quietly expanded the import quota of Indian cottons produced according to the style of the Gujarat mills, and this near guarantee of foreign exchange was increased in value by a contract to provide the proper grades of cotton from the reclaimed land, thus replacing imported cotton. The enhanced foreign exchange was committed to a guarantee of repayment to General Electric for equipment that could not be made in India, but it was hoped that General Electric, seeing several more such contracts in the offing, would retain its equity in GWAF. Some of the ammonia was contracted to Ceylon for sterling credits to be applied to setting up aluminum production. And so it went. Three-cornered deals fell through at the last moment, and were replaced a few months later by a four-cornered deal. Many of the less-sophisticated contracts still out of the reach of Indian fabricators were bid for on easy terms by Japanese firms intent upon acquiring the breadth of knowhow needed for coping with the agricultural revolution that was imminent in Japan.

Meanwhile, in the Kutch, rumors were flying. The only positive

action taken was the decision to expand the activities of the experimental agricultural substation in the Little Rann of Kutch and to establish two other substations where small amounts of water were immediately available and the constitution of the soils was somewhat different. The quoted prices on land in Kandla, Mandvi, and principal stations on the railroad suddenly multiplied by two or three. Traditionalists, mainly speakers, agitated against the introduction of a nuclear reactor. Gujarati chambers of commerce indicated their backing of the project. The M.L.A.'s (Members of the Gujarat State Legislative Assembly) sought clarification to resolve the wildest stories, most of them generated by the unexplained appearance of surveyors in various parts of the District. The ebullience of the talk forced the emigrant families in Bombay and Africa to reestablish their claims to inherited property and to hold family discussions about strategy. Thus, tourism doubled, and business improved noticeably.

The first stage of the project concentrated upon acquiring the specific data on costs and yields needed to produce cotton for Ahmedabad and Baroda and rations for Bombay. Most of this information could be obtained for very similar soils and climates elsewhere, but the tight programming required for eventual triple-cropping raised a number of critical questions about suitable strains of crops and the kind of equipment required for quick changes from one crop to the next. A Diesel generator-desalination plant, bought second hand from an Arabian refinery, was established at the mouth of the Little Rann and a farm of two hundred acres was started up in 1971. It revealed that the return on investment, based upon open market prices in India, was highly variable, but the long-term contracts should stabilize the return on the investment at around 12 per cent per annum before taxes at the 300 MW nuclear reactor stage and perhaps

15 per cent with the lower costs in prospect when operating at the full 1,000 MW or greater scale. Considering the risk involved in agricultural enterprises, this is no more than an ordinary return. More than that, it threatened to commit to a single project a very large share of the advanced talent with knowledge about advanced electro-technology. Interest in the project began to lag, and a "go slow" recommendation seemed certain.

Then support appeared from a totally unexpected source. A "social entrepreneur" in the postal system developed an idea that arose in part from using the postmen as distributors of contraceptives, a program introduced in 1968. He proposed selling stock in GWAF to those people who would otherwise invest their surplus funds in agricultural land and inflate its price. Normally they would elect to receive their dividends in cash, but they could choose to take it in produce. The Postal Service would undertake to deliver standard packages. Due to the drought-proof characteristic of this facility, investors would have greater assurance of obtaining food in an emergency than they would functioning as non-resident landlords. In India, the postal delivery service is more dependable than any other distribution system and the postal savings are trusted more than any other institution, so a new outlet for savings available there could be given a head start by its reputation. A share costing Rs 1000 was to be accompanied by a guarantee of 30 daily basic rations per year. A "pilferproof" package of ten rations, weighing twelve to fourteen pounds, and coming in several formulations to suit the various tastes for food in the country, was designed. Buffer stocks were created in the interim so as to be able to meet the guarantee. Thereafter, it was "full speed ahead" on a project that was four times as expensive as an integrated steel complex, such as India has created several times already, but perhaps ten times more complicated.

Politics were always a problem. Because the joint interests of Gujarat and Maharashtra were paramount, other states did not participate, and the Union Government in Delhi was constrained to take a back seat. Civil Service pay standards and procedures were rejected, and closer attention was paid to the labor market as it existed around Kutch. This still left the task of setting criteria for the employment of 50,000 workers, primarily men, for the second stage of the farm-factory and process industries. The policy undertaken was to draw upon Bombay for industrial workers, paying Bombay wages for all semi-skilled and skilled labor. Unskilled labor was hired from the adjoining territory around the project. Extensive on-the-job training was provided in both cases. Continued expansion of all communities and work groups, combined with an extraordinarily elaborate formula for humanizing the production system, prevented cut-throat competition among the politically-directed labor union confederations for the loyalty of the workers, as had occurred in the steel towns and the heavy industries of Bombay. The rapidly rising size of the potential annual bonus, paid out just prior to the holidays, shortened the length of the "quickie" strikes that were often called in protest of the actions of managers.

The Indian Army provided a considerable share of the management, technical manpower, and skilled labor for the second stage of the development on the Little Rann of Kutch. A large number of high quality officers and volunteers came up for retirement in the early 1980's due to the mobilization during the Chinese attack of 1962. A strong infusion of talented, idealistic manpower entered military careers at that time who would otherwise have gone into the Civil Service, the universities, and the professions. Continuous threats from Pakistan and China during the 1960's assured larger

budgets for modern equipment, especially telecommunications and vehicles, than was available elsewhere in the Indian economy. Thus the highest standards of motor maintenance and the deployment of organized activity over space were to be found in the military services. GWAF offered an extraordinary appropriate career opportunity for the retired serviceman, so it had the pick of the lot. Military men had previously familiarized themselves with the Kutch region because so many of their maneuvers were carried out there.

The satyagraha[1] of 1981 caused great damage in the Harbor City, in Ahmedabad, and even in parts of Bombay. Ostensibly it arose out of the language issue, as had so many before it. Multi-lingual individuals, such as those arriving from the armed forces, had repeatedly been preferred over those with a 100% Gujarati education. The latter had long before organized an association to defend their "rights." However subsequent investigation revealed that this outbreak of violence was so much greater in intensity than its predecessors because of some extra elements that had been added. One other group abused by the rise of GWAF was that of the Eunuchs, a transvestite cult (also called Hijadas) that has one of its major concentrations in Western Gujarat. One of their headquarter towns, Tikār, was in the path of the broad-gauge railroad extension, and their akhada, the ghetto of the Eunuchs, was demolished.

The Eunuchs worship Bahucharā mātā with secret rites. The population at large believes they practice magic and so is generally willing

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[1]A holy war marked by demonstrations, including well-publicized fasts to the death by respected leaders, intended to affect decisions of authorities by reminding them of their moral duties. Although Gandhi insisted upon non-violence, the satyagraha has increasingly triggered mob outbursts.

to contribute the customary "half rupee and three paise" for the performance of precautionary rituals at all important events, such as marriages, celebrations of the birth of the first son, and installments in office. They seek recruits among men who appear to be sexually impotent and hope to become important in their next incarnation. Also male orphans from poor families are adopted. As with many marginal groups in India and elsewhere, they maintain a special communications system of their own, with a number of members serving as couriers between akhadas carrying messages in their private code.[2]

Once this group was gravely affected, it responded by instigating a number of disturbances at the annual festivals held in towns and villages around the Gulf of Kutch while agitating for preservation of old ways. Police repression triggered off full-scale riots on several occasions. The Eunuchs retreated to the countryside and built up suspicions among villagers. The police attributed a number of assassinations of community political leaders to activist groups collaborating with the Eunuchs. The least educated villagers, the cattle-raising Maldharie communities on the periphery of the farm-factory lands, were the most inflamed, despite their rapidly improving circumstances. Thus the most violent outburst was triggered when the Maldharies were in the city for a festival associated with the marketing of cattle.

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[2] A. M. Shah, "...the Hijadas of Gujarat," American Anthropologist, 63, No. 6, Dec. 1961, 1325-30. This historically sensitive note is a critical review and summary of a number of observations made by Western-trained investigators over the previous century.

MILESTONES IN THE GROWTH OF GWAF

1975	First reactor goes critical
1977	Broad-gauge railroad to Kandla completed
1979	Canals for the full 500 square mile tract are completed
1980	Second reactor goes critical
1981	The acetylene and polyvinyl chloride plants go on stream
1982	Aluminum plant starts operating
1983	Triple-cropping program begins; fisheries go into full production
1984	Parallel facility for western Kutch (Abdasa District) authorized
1985	Expansion into remainder of Little Rann authorized
1987	The Mahanagar (megalopolis) of Bombay organized to promote orderly settlement
1990	Technical assistance contracts to Sudan and Somalia signed which provide for installing equivalent facilities
1991	Large scale breeder reactor project launched jointly with Pakistan to exploit the full possibilities of the Rann of Kutch

What Does Organized Speculation Teach?

Was anything learned from this attempt to construct a plausible sequence of events stretching from the present to a successful utilization of this technology? Scenarios written for the future are necessarily anchored in the period that provided the stimulus for drafting them, therefore they are limited to the kinds of events that already have precedents or have been foreshadowed by "near misses." Such projection is obviously only one of many alternative futures, and, because it is optimistic in outlook, not among the most likely of the lot. What does one have to be alert to and work for in order to have good things happen that might otherwise be overlooked?

The first problem was that of finding an organization that can build and manage a project on this scale. The predecessors miss by more than a factor of ten. Most have failed to be profitable. It must obviously be one of a new breed that has been adapted to the transfer of advanced technologies. This project goes at least one step beyond the industrial complex based upon petroleum refining and petrochemicals. Other people, primarily around New York, have been struggling with the general problem of organizing large ventures, and thus far their image of the future coincides with the resolution of the difficulty reached here.

The second problem was that of financing, both inside and outside of India. Some very ingenious arrangements have recently been publicized which attempt to apply the funds obtained from several extra shiploads of grain originating in the United States to the financing of the infrastructure of Calcutta. This deal is still so unusual that it, or a near-equivalent, would hardly be believed. Therefore the "deal" for foreign

exchange was concocted on a considerably cruder level. In any case it can be claimed that the sophistication is sufficiently advanced that a number of adequate solutions are possible. The idea of financing through buffer stocks and postal deliveries seems to be a natural next step, once Indians begin to think seriously about insurance appropriate to local risks and the institutions needed to provide security for families when their financial resources are adequate. What is proposed is nothing more than a long term "futures" market in mixed commodities set up for the ordinary well-off consumer instead of the hedger and speculator.

A third problem arose regarding the appropriateness of the site. The foregoing sequence of events accepted the location that appeared to be preferable both for economic and administrative reasons. A physical development program for the area was laid out according to procedures likely to be employed by cooperating public corporations, such as the railroads and the nationalized shipping company, and then a search was undertaken for complicating factors. In this manner the presence of the Eunuchs and the Maldharies was uncovered and their possible reactions woven into the scenario. However, the choice of the site itself represents a salient branching stage in the chain of future events. Therefore we shall shortly explore the implications of choosing sites other than the Little Rann of Kutch.

It became apparent in the course of preparing the scenario that the assumed schedule of investment (Fig. 3) required all kinds of foreshortening of the ordinary political processes. There will be a tendency to delay and reconsider on the part of many Indians, because this project reshapes the relationships between States to an unpredictable extent, and these painful adjustments could well cause financial failure. If unsympathetic politicians engineered such a delay it seems likely that the first

nuclear agro-industrial complex to come into production would then be a joint enterprise between the Australians and the Japanese in Western Australia. There the chief difficulty would be the scarcity of agricultural labor. Given the prospective grave shortage of such workers both in Japan and in Australia, an English-speaking Indian contingent of contract labor might be welcomed. Historically, the Gujarat has been a principal supplier of hands for overseas agricultural development.[3] The commodities produced, however, would be destined for Tokyo and Osaka. Experience of this sort might well allow the Indian counterpart to override opposition and put it back on the road to implementation.

Finally, when applying the principles of comprehensive developmental planning[4], we are forced to look for sources of future political trouble. They might arise from old feuds or belief systems incompatible with rapid, mechanized progress. A well-organized preservationist clique can cause a huge amount of damage if it is not checked early in a controversy. The best planning introduces preventive effort at early stages so that the groups prone to violence do not come into contact, or, if they should, the reactions will be damped down rather than inflamed. In many instances this approach would be called "public relations" in India, where the term has not yet become a euphemism for the lobbying activity of a

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[3]Chandra Jayawarena, "Migration and Social Change: A Survey of Indian Communities Overseas," Geographical Review, 58, July 1968, 426-49.

[4]R. L. Meier, Developmental Planning, (New York: McGraw-Hill, 1965) Chapters 1-4.

narrow-minded interest group. The recent history of India suggests that it is headed for an intense political crisis in the cities where the dissonances between the educated language communities and the availability of economic opportunity will be at issue and the management of each new project will be forced to make controversial decisions.

Lakhpat

The farthest northwest settled territory of India is called the Taluka (sub-district) of Lakhpat. At present it is relatively primitive, with only one track that is called a road, no seaports or airports or towns of significance, and it has no future. Its western margins shade off into a mangrove marsh and elsewhere there are very shallow beaches, as might be expected of an estuary that lost its principal channel. Since the overall area is 890 square miles, it is relatively easy to fit a 500 square mile project within it.

The proposed location requires the use of the only firm land that seems to be available on Kori Creek and, it is presumed, the most easily dredged channel through the creek to the coast. The harbor city for the project would best be placed upon this high point, even if it were to be dominated temporarily by existing communities. On the basis of the 1961 census, 11,000 persons were occupying the area encompassed by the proposed farm-factory. This is trivial as compared to the numbers that are needed as the project goes into production, so a minimum of public resistance is anticipated.

The Taluka of Lakhpat possessed, according to the census estimates, a remarkable amount of subsistence farming, cattle-raising, and marginal settlement. The literacy rate ran about 15% in 1961 and is expected to

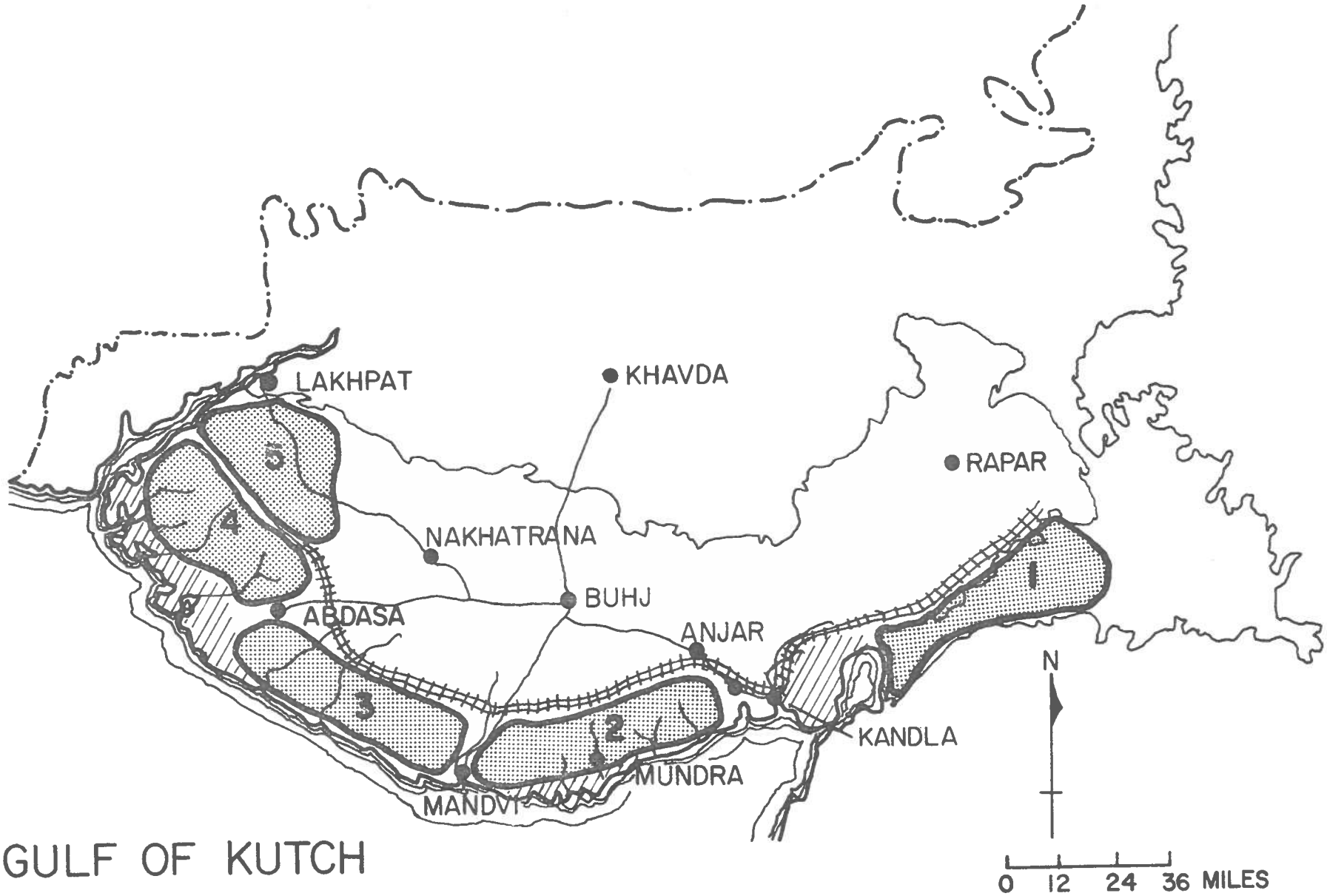

Figure 6. Sites for a Nuplex in the Kutch District

remain behind the rest of Gujarat unless something constructive happens in this territory. The soil is deltaic, overlying a thick layer of limestone, so drainage and erosion are expected to be problematic. The soils are probably not the best available in the Kutch and they may have a composition that prevents the achievement of top crop yields. The weather is variable, with crop failures more common than elsewhere in India (one every three years).

This site is likely to be used in the expectation that the Rann of Kutch itself would be developed eventually in a joint Indian and Pakistani enterprise. When leached, the Rann's deltaic soils are expected to be superior, so Lakhpat, when fully developed, is likely to become more specialized than is indicated in the expected output described in Chapter Two. Many more legumes are likely to be produced.

An illustration of the way the project might be placed upon the land is shown in Figure 6. The marginal land between the units controlled by an agroville is most often single-cropped and would allow gradual social change, without uprooting, in most of the existing villages (say 75 per cent of the expected population).

Mandvi

Of all the areas in the District of Kutch, the coastal belt on both sides of Mandvi appears to be the most likely to have a variety of good soils. Its harbor is sizable enough to allow a quick start on construction. Its schools and medical services are substantial enough to sustain the demands put by the people arriving on the scene over the first year to two -- an extremely critical period in recruiting for personnel needed for later stages of organizational growth, but who may be dismayed by frontier-

like conditions that would otherwise exist.

Mandvi is an old town with a recorded history going back to 1581 A.D. It has a number of buildings that go back to the period of the Muslim builders of the seventeenth and eighteenth century. One of the natural consequences of this long history is that it retains the major festivals and fairs that have grown up in the interim. It is also one of the centers of the dhow trade in roof tile and related commodities, and shipyards for the building of small ships have long been established there. The long-established contacts with Africa and the Arabian states have resulted in a net efflux from the Mandvi area, many more males than females. The most common immigrants in those parts of the world are the Gujeratis, many of which first made the trip to become pedlars and small traders.

At Mandvi the planners are forced to make a choice. If it is believed that quite a few projects of this kind will need to be built as integral units, then the alternatives outlined on Figure appear to be a reasonable selection. They also minimize the displacement of the existing population in the course of reorganizing the countryside. However, if the aim was to create for this area the most promising single agro-industrial complex, it is probably best to set the project down on both sides of Mandvi (comprising about half of zones two and three) and thereby minimize the cost of infra-structure.

A deviation from a circular form is adopted for the exploitation of the potentials inherent in the farm-factory, moving generally to a sausage shape extending from just behind the coast line to the 200 foot contour, a level that is reached 11 to 15 miles inland. For an optimal design, the industrial complex would be sited a few miles to the west of

Mandvi and a railroad line extended from Kandla through the farmed area to the industrial estate. Many of the farm-factory villages would naturally be organized around stations on the railroad extension.

The gravest single difficulty in using the Mandvi area is that far more people, about 120,000 altogether, would be displaced or would lose control of their environment during the period of construction. It would take a great deal of the most valuable farm-factory land to meet the 25,000 or so family choices as to whether to become a home owner, an urban village member, an independent smallholder, or a stockholder free to leave the area but participate in the fruits of the enterprise.

Little Rann of Kutch

The census records no permanent population in the Little Rann of Kutch, primarily because the monsoon turns it into a sea of mud for several months of the year. Its high points, mostly arrayed down the center, have cattle-drivers' camps and salt-resistant brush. In the dry season it is quite firm, with the appearance of cracked, dried mud.

Reclamation of this area for agriculture involves the design of some sophisticated drainage systems followed by the introduction of the desalinated water and fertilizer. The final system would be constructed very much like the body of a vertebrate, with fresh water flowing from a principal "vein" into capillaries and then into the actively used soil. Most of the water is lost through transpiration from the surface of plants, but it also evaporates in the course of application, and some must also percolate past the roots and dissolve the saline constituents before it is added to the water table. Water-logging can be prevented by collecting this seepage in a system of "arteries." Local pumping stations can maintain a fine control over the flow-through rate in any part of the project. This

system must be able to use rain, whenever it falls in normal amounts, and withstand the periodic floods caused by cloudbursts. Therefore, the drainage system must have a capacity perhaps thirty times the normal requirements. However, considerable savings can be made in the future designs, as compared to the past, by drawing upon the new, much more accurate satellite-based weather forecasts, which allow damage prevention action to be taken immediately in advance of the challenge.

After comparing the advantages and disadvantages of dozens of alternative reclamation strategies, the following appeared optimal:

1. The drainage canals be dug close to both boundaries of the Little Rann, which appear to be lower by a foot or two of elevation. The northern one is used to sweep out the Kandla ship channel, reducing the dredging, and the southern links brought around the end of the Bay an extra 10 to 15 miles.

2. A causeway be constructed to close off the Bay and make of it a "lake" devoted to increasingly intensive fisheries. Its contents will have increasingly reduced salinity over time.

3. The fresh water canal or pipeline go up the "spine" of the Little Rann, together with a road and an extension of the broad gauge railroad paralleling it.

4. The reactors be placed on a monor peninsula so that the salt water intake comes from the Gulf or from the shallow Bays to the south, and the effluent saline water can go to coastal swamps transformed into salt pans.

5. A causeway be constructed at the narrow point (ca. 3 miles, but flood control may require 20 miles of raised embankment) for both a road and railroad to Kandle.

6. The harbor city be constructed between the reactor and the existing

rail terminal of Navlakhi to the east facing a fresh water reservoir to the north.

7. All farm-factory villages be located on the spine as stations on the road-rail-canal mainline.

8. The semi-nomadic Maldhapie communities (vandhs) be established at the drainage canals, which could then be used for barging forage to growing dairy herds and transporting milk products.

9. Urban villages (two to four) be set up on the mainline between the harbor city and Navlakhi for the immigrants with other languages or religions.

In this scheme it is evident that some of the industry and employment would be diverted from the harbor city to Kandla and Navlakhi and the settlement would spread as far as Gandhidam, the Townsite for the Port of Kandla. The harbor of the harbor city would operate in a way that was complementary to the existing quayside equipment. For example, we were impressed with the suitability of the new container ships for supplying the smaller harbors of India. The LASH system carries 73 lighter barges, each with about 500 Ton capacity, and loads while standing at sea (Business Week, May 18, 1968, pp. 160-4). Although originally designed for the export of paper and wood products, it appears to be ideal for agricultural commodities and chemicals.

Chapter Four

FOOD-PRODUCING COMMUNITIES FOR WESTERN INDIA

Whenever the monsoon fails, as it does once every three to ten years in most of India, two kinds of communities are severely affected. Villagers in the drought zone, who do not have irrigation accompanied by reservoirs large enough to tide them over the following season, must be supported at subsistence. The metropolitan regions that trade for the village surpluses are caught short and must either draw upon buffer stocks created for such exigencies or else go into the world market. As long as the buffers remain small, the cost of food rations in a city might double or treble; the funds scheduled to go into industrialization and infra-structure development are diverted into relief measures for the poor. Growth of the modern economy has been limited most by this periodic scarcity of food, and only secondarily by the lack of capital and specialized skills.

As long as this condition lasts in India, and deliveries of staple commodities to the city are uncertain, each new structure and every new institution must be calculated in terms of food requirements. Thus in Calcutta during 1965-66, a twenty-story office block or apartment building required 100 to 300 tons of black market rice to build with a bit of sugar and ghee on the side before it could be started. An administration was forced to recognize that a technical school with 1,000 students brought in from the countryside would require that about 300 to 400 tons more of grain and pulses must be collected

from the producers and redistributed with equity. It was the opportunity to produce extra food, independent of the variations of the monsoon, that induced us to concentrate upon the Kutch. Moreover, the dependable production of food for the most dynamic industrial region of India, thus removing the dominant constraint, yields a much greater contribution to development than is indicated by the economic return using world market, or even internal market prices.

We have therefore focused upon the provision of rations for the Bombay region (including Baroda and Surat), with a guarantee of cotton for Ahmedabad in order to overcome difficulties with foreign exchange. All of the subsequent exercises in design are intended to expedite the fuction of a food-producing metropolitan satellite settlement and to exploit every local opportunity in achieving this aim. Very likely the difference between a marginally feasible project and a highly profitable one will depend upon seizing these minor opportunities. Bombay would also become the principal user of the electrochemicals and electrometallurgicals produced by the industrial complex.

Still more explicitly, we shall concentrate our attention upon the most likely site, as well as it can be judged from this side of the world. Then Kandla can be used as an immediately serviceable stockbuilding center for the materials of heavy construction. The harbor city for the farm-factory and the industrial complex could then grow at a more orderly pace on the south shore of the Gulf of Kutch. The metre-gauge railway will serve adequately in the initial stages, particularly when it is extended along a causeway at the head of the Gulf of Kutch to connect the two existing terminals of Kandla and Navlakhi. This causeway should allow the progressive desalination of the Little Rann of Kutch through drainage canals that deliver

leached-out salt, much of it dissolved by runoff water, around the lake that is created to the Gulf beyond. The harbor city can probably be located upon this lake and part of the lake itself divided off to be used as a reservoir for holding the inventory of manufactured fresh water reservoir. The nuclear reactors and the chemical process facilities would have to be sited on reclaimed land adjacent to the expanded harbor. Since, in any case, they must be supported by deeply-driven piles, the shortage of solid land imposes no liability. The site that utilizes the soils of the Little Rann -- if they can be economically desalinated -- seems to be the simplest to get started, gives little difficulty in the moving of people prior to construction, and yields many secondary extras before the development levels off.

The Little Rann, like the more famous Rann to the north and west, is a unique phenomenon. At one time, perhaps four thousand years ago, it must have supported lush vegetation, but the shift of the main channel of the Indus River that connected it with a major supply of melted snow from the Himalayas allowed a seasonal invasion of salt water. The high ratios of evaporation in that locale led to a crystallization of salt at root level -- a highly toxic condition guaranteed to create a desert. The soils themselves are grey-black silts containing some calcium carbonate and gypsum. The average rainfall is close to 40 cm. (16 inches) per year, but it falls over the period of a few months. Variability of annual rainfall totals is extreme, since an average of two years out of ten records a deficiency in excess of 60 per cent, yet cloudbursts of five to ten inches are not at all uncommon. The Gujarat Economic Survey indicates that an agricultural station has been established to study methods for reclaiming the soils of the Little Rann and

adapting them to the most promising crops. Since they do not appear to differ significantly from the deltaic soils of the Nile and Ganga (West Bengal and East Pakistan), the chances of success seem very good.

The Development Sequence

In order to provide sufficient background to test proposed solutions to the "people problems" associated with the occupation of the Little Rann, we have undertaken a brief textbook type exercise in the reclamation of the land.

The reclamation process seems likely to involve a sequence very similar to that invented by the Dutch for their polders, since the techniques were discovered to be applicable to land suffering from salt water intrusion in West Bengal under conditions quite analogous to those occurring here. This means that islands or blocks were enclosed by sea walls and the channels between them were pumped out several feet below sea level. Then the rain and other water poured on the top soil will percolate through, dissolving salt, and eventually diffuse into the canals. Soil quality improves as it is used in conjunction with fertilizers. Brackish water drains down to the Kandla ship channel or the causeway, whereupon it is pumped up several feet to get over the barrier into the Gulf.

The principle that capital investment should be postponed as long as possible caused us to choose a part of the Little Rann for very early reclamation that was (a) close to the principal drainage ditch that would have to be built and also (b) near to the railroad stations. This saves on the building of roads and canals. Some of the urban villages that supply workers and students to the harbor city, as well as farm workers for the fields, could be established in this

area. Thus the first programs of self-help housing and community building should be initiated at points from three to eight miles from the barracks and bazaars of the harbor city. Some high-density housing, say 30 to 100 units to the acre, would be constructed in the harbor city for the urban workers able to pay substantial rents, but these are not expected to compete with the opportunity to occupy a parcel of one's own land -- and build one's own house -- in or around the urban villages and on the fringes of the harbor city.

The formula for granting plots of land for house and garden to a household, so as to maximize participation and satisfaction, has yet to be worked out in detail. Undoubtedly it will change markedly in India according to the subculture. A recipe that has worked elsewhere would assign the plot for a lifetime and then, if it was not to be occupied by a more junior member of the household, the land would revert to the community, whereupon it can be assigned to a hardship case among the new immigrants. Further subdivision is not permitted.

Journeys to the fields are much longer in this approach to the development of the Little Rann than on other sites. It might even be necessary to set up labor camps for full-time employees as well as the temporary workers. There a man could work as many as ten shifts per week and accumulate enough credits to take a week off. Miscellaneous holidays for the respective ethnic communities make this kind of industrial calendar preferable to working regular shifts.

At first it was thought that the fresh water canal carrying distillate from the desalinization plant up through the center of the Rann would be big enough and deep enough to serve also as a barge canal. However, calculations show that the canal would then have to

start 10 to 20 feet above grade at the nuclear reactors in order to come out at grade 50 miles up the Little Rann. No matter what is done, whether it is intermediate locks, or a transfer of goods up the sides of the canal at the terminal, some problems of congestion develop that may not be economical to solve. The best solution seemed to be that of pumping the water up the slight incline presented by the Little Rann; and the aquaduct, broad-gauge railroad, and highway would point inland side by side. Most of the farm-factory villages would be strung along this spine, probably ending up more like a town than a village in its organization.

New Housing Opportunities

Housing policy presents the strongest conflict between the new development thinking and the dogma of state socialism borrowed by India from the West over the past two generations. The issues come to focus when we are presented with the need to create a specialized new town or city. The typical Indian town planner's proposal will be vastly different from what would be suggested after a review of successful and unsuccessful projects. The principal basis for the difference does not lie in the provision for schools, clinics, roads or sewers, but in the prescriptions for the supply of housing.

What does the Indian town planner accomplish today, hedged in as he is by a number of financial restrictions and demands from the engineering contractors responsible for getting the facility into operation? First, he is forced to accept recently acquired land, from which the previous residents have been bought out and evicted. Often they set up squatter housing just outside the fence and take jobs in the construction gangs. Then he is forced to recapitulate the formal corporate hierarchy in his housing and land use plan. A carefully

graduated set of perquisites, measured in terms of floor space, size of lot, access to specific modes of transportation and amenity and landscaping, is assigned to each salary class in the hierarchy. A house must be "laid on" for each full-time regular employee at standards to suit his rank. Nominal rents are charged, and extra costs (usually much larger than the rents) must be met by the enterprise.

Architectural differentiations in the houses follow a rationale developed by a group that rarely uses the planning information, but seeks a "harmony" of its own. The architects do pay an increasing amount of attention to environmental controls (affecting comfort, lighting, drainage, pests, etc.) and to materials of construction that must be available in large quantities during the construction season. Thus almost all of the houses are likely to remain habitable for twenty years or more.

However, it is already evident that, in all new towns constructed to date and reported to us, the occupants are rarely the kinds of family units for which they were planned. Construction delays, the last-minute reworking of the technology upon which the community is based, produced a number of crises and emergency adjustments. Many more sojourners were present than was anticipated. Also, the complusion to spread out the units on the land (a density standard borrowed from the British and only slightly modified) has greatly hindered community organization. Finally, most occupants of government housing have different ideas about maintenance than those of the architects; therefore an Indian new town gives the appearance of almost universal neglect and decay within a few years after it is built. Houses exhibit many makeshifts in and around them, sewers are burst, weeds grow in the side-streets, shops go out of buisness in the bazaar, with no replacements

willing to move in, and waiting for the bus seems interminable. Bustle, gaiety and confusion have been replaced by a mid-Victorian propriety.

These early attempts must be regarded as steps in a learning process. As compared to what was being done earlier by the administration of a rajah, the achievements are remarkable, but they still fall far short of Indian expectations. The government can do some things reasonably well, particularly the equitable distribution of scarce goods to the general population. The marketplace is an efficient institution for assessing the relative value of goods available for exchange -- it is now regulated well enough to prevent routine corruption and reduce adulteration -- but the land market remains subject to monopolistic forces that often raise the price of land to a level that accounts for more than half of the residential rent. Cooperatives and other forms of self-help for house-building seem to work well when aided by local politicians, but cannot readily be sustained when the leadership changes. A new housing policy must take advantage of the strengths of these institutions and overcome their weaknesses as much as possible.

The principal aims in the design of the new communities associated with a nuclear agro-industrial complex are (a) to provide manpower of steadily improving quality, and (b) to minimize the likelihood of conflict, either between the people and the Corporation or between subgroups of residents. The choices of materials, house design, and community form are made within these constraints. The plan is then no longer a blueprint of the community to be constructed by a contractor, but is instead a program for collective effort in which most of the details are left for later determination. The overall effect is one of continuous development at the individual, household, neighborhood and town scales, at least until the total output reaches a plateau.

Settlers who come into such communities should be encouraged to find their own solutions to their housing problems. The following procedure illustrates the new thinking:

1. A campground (serai) can be set up for migratory peoples and for emergency housing needs, for which a daily or weekly rent is charged;

2. A place in the guest-house or barracks should be made available for specialized personnel, many of whom are connected with construction of industrial facilities;

3. A small private parcel of land should be allocated at request to any immigrant head of family for "homesteading";

4. A supply store for materials of construction and prefabricated elements should be maintained;

5. Settlers should learn how to build their own houses by working with craftsmen on public buildings or with cooperatives that assist each other when building houses;

6. Credit for materials should be made available to anyone with a parcel of land, but it should be doled out in stages upon evidence of satisfactory completion of the prior stage (a provision that prevents embezzlement);

7. The parcel (about 800 square feet seems adequate for India) is developed for immediate shelter and the remainder of the structure is added either as the owner's savings accumulate, or in response to the growth of his household;

8. The appearance of small contractors, willing to build a house quickly to the client's specifications, should be encouraged, because most families recognize that investment of their assets in property is a better hedge against the uncertainties by the future than investing in jewelry;

9. Private sources of funds should be encouraged to invest in rental housing at higher densities, perhaps paying land rents to the corporation proportionate to rental payments by residents and small shop owners.

The gravest handicap to past self-help programs that used brick, concrete, stabilized earth, and stucco for raw materials is that the value of self-help labor applied to housing was only about a third of what would be paid as wages. This low efficiency also tended to extend the completion time. Much of that labor was expended in carrying heavy materials, including water for the cement and straw for the kiln. The nearby production of food crops, fertilizer, electrochemicals can change this picture considerably by producing cheap fiberboard, aluminum sheet, plastic film, foam plastic, or perlite. Electric power would be relatively cheap. These local advantages suggest an approach to assembling a self-help house very different from the early experiences.

One promising material is a polyurethane foam sandwich. The polyurethane is produced principally from locally produced products and sealed to a board. A number of variations are possible, but the houses remain very light in weight. The polyurethane resin can be used as an outdoor paint in many climates, while its foam has excellent heat insulation properties. Paraskevopoulos and co-workers[1] have shown that satisfactory beams can be made with a folded plate design, so a second story is feasible. Polyurethane is cheap wherever the regional demand is large, thus it is well suited to a quick buildup of housing. Perhaps

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[1] S.C.A. Paraskevopoulos et al., Structural Potential of Foam Plastics for Housing in Underdeveloped Areas, University of Michigan, Ann Arbor, 1965.

by the time it is needed, the more sophisticated stressed skin, filament-wound version would be preferred for multi-story tracts since the shells would cost only two to three dollars per square foot.[2]

Experiments in the Central Valley of California directed to providing housing for agricultural laborers in communities devoted to irrigation agriculture have opened up a number of new possibilities (Hirshen and Van der Ryn, Berkeley, 1968). A brown kraft paper liner board can be scored, folded, and anchored to a concrete slab or earthen floor, and then sprayed with a perlite-concrete mixture to provide weather resistance, insulation and surface coating simultaneously. The surface coating operation is a craftsman's job, the remainder self-help with the aid of precut panels. This approach is fitted to a local building rate of 200 units or more per year, of which perhaps half would use the method as the most economical source of relatively permanent housing.

Other interesting structures adapted to hot-dry areas (as found in the interior) can be developed to support a metal dome with a hole in the top. An aluminum roof would weigh very little and have high salvage value. Adaptions made to the boxes used for containers at the harbor could lead to higher density megastructure possibilities.

Brick, hollow tile, cement block, and poured cement are already used in Gujerat, particularly by persons who have acquired experience working with these materials. Housing forms based upon these almost traditional materials should be very little different from the presently constructed types.

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[2] S.C.A. Paraskevopoulos et al., Research on the Potential of Advanced Technology for Housing, University of Michigan, Ann Arbor, 1968.

Chapter Five

REGIONAL INTEGRATION

An agro-industrial complex can only serve India if it is closely interconnected with the society as a whole. Since coastal deserts have in the past been extremely isolated, this means that the region containing the complex must be replanned so as to fit into the new view of its future.

How is the region defined? Politically, the preferred location in the Little Rann would immediately affect land in the districts of Kutch, Jamnagar, Rajkot, and Surrendranagar, in that order. The capital of Gujarat State, Ahmedabad, being also the largest metropolis in the vicinty, will be given a considerable stimulus. The bulk of the output would be marketed in Greater Bombay, the core of Maharashtra State. The remainder of the output is expected to go to the Indo-Gangetic Plain to the northeast. Nevertheless, perhaps 90 per cent of the social, economic, and political impact is expected to be found in a contiguous two-state area. This will be designated as "the Region" for the purposes of this study. The "locale" within the Region will be all those places whose future is predominantly determined by this project.

The economic success of the complex depends to a considerable extent upon the sale of electric power within a radius of 300 miles or more, so the grid required for its collection must be reinforced somewhat earlier by connectors. Even greater investments are required for the bulk transportation networks, because farm produce puts a heavy load on such systems. The movement of people to new locations, the

provision of jobs away from the residences, and enhanced tourism, together set up a demand for passenger transportation that may diverge markedly from the routes by which the produce moves. Construction and management of this vast food, power, and chemicals enterprise creates a huge demand for quick transfer of information, so the telecommunications networks must be introduced very early in the course of the development. Training and skill development will be at a premium, so the state educational systems must also be reorganized.

Electrical Power

Over the decade 1950-60 the installed capacity for power production in Gujarat was growing about 10 per cent per year, which is a bit slower than it was for India as a whole. The total projected demand for 1975, which is the earliest the first of our reactors could be put on the line, is 1385 MW.[1] Thus a plant with 300 MW capacity equals the increase in demand over a period of 2.2 years, which is quite reasonable for a single increment in supply.

The power grid developing in Gujarat is based strongly on the movement of energy from hydroelectric plants in the southern part of the State through Surat and Baroda to Ahmedabad and its northern satellites. The Saurashtra Peninsula, which juts out into the Arabian Gulf just below the Kutch, is just recovering from the previous division into a number of petty princely states that were engaged in feuds with each other, so its grid is still in the making. Since the project inputs include 75 MW from a nuclear power plant

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[1]National Council of Applied Economic Research. Techno-Economic Survey of Gujarat, New Delhi, 1963.

this decade, and a number of hydroelectric plants in the east, a power plant site between Kandla (which has a steam plant), and Navlakhi (on the projected extension of the principal grid) appears to be strategically located at the center of gravity for demand. A site at Mandvi is already peripheral, and at Lakhpat would introduce the possibility of a deal with Pakistan to supply part of the power requirements of Karachi, where the load center is much closer.

The subsequent 700 MW reactor would definitely cause imbalance to the grid. It would also require three years of growth to use the total capacity. Thus a concentration of electrochemical industries on site is definitely advantageous. An aluminum plant using nearby bauxite and clay, and locally produced caustic soda, would fit in very tidily. The rationalization of transport required for the farm-factory would make this the logical site not only for aluminum, but also for magnesium and calcium carbide.

To conclude, the dimensions of the power production economically associated with the complex are great enough to challenge the electrical power industry of Gujarat but not large enough to embarrass it with large amounts of surplus capacity, such as very often occurs with hydroelectric projects. The site on the Little Rann is strongly preferred by the power industry.

Transportation

Capacity for the movement of goods and people to a large extent determines how a region organizes itself. The four most common modes of transport -- road, rail, water and air -- will control the course of development by their ability to accept or need to deny new kinds of quantities of inputs and outputs. We have had to investigate these capacities,

as far as they are presented by published materials, in some detail in order to discover how far, speaking in spatial terms, the secondary and tertiary effects of this project would be significant.

The highways of India, by American standards, hardly exist. The National Roads form a sub-continental network conceived to satisfy local interest groups that do not have ready access to a railroad station. They are paved only a small part of the time (there seems to be no up-to-date guide equivalent to those that cover the European road network), and only one lane has been laid down even then, except in the most densely settled territories. The highway system as presently planned will not help develop this project, even if the Little Rann is found to have suitable soils. The roads that follow the old caravan trails are now increasingly used by elaborately decorated five-ton trucks that carry highly valued produce between the cities and the market towns. However the roads are also increasingly used by cyclists, ox carts and perhaps the coolies who move products on their heads, although in the future, when more families are trying to move to the city, the country buses will become extremely important. They afford an opportunity for the voluntary exchange of personnel between addresses within the region.

The state and federal highway systems will increasingly serve to carry the high-status professionals and businessmen on their holiday trips to the out-of-the-way hill stations and other centers for tourism accessible by bus. These roads are not at all geared, however, to serving the commuter.

The Indian inventor-designer who is backing the new approaches is constrained by the limits upon movement of a railway-bus line. He will probably retreat to his quarters to await his next reincarnation

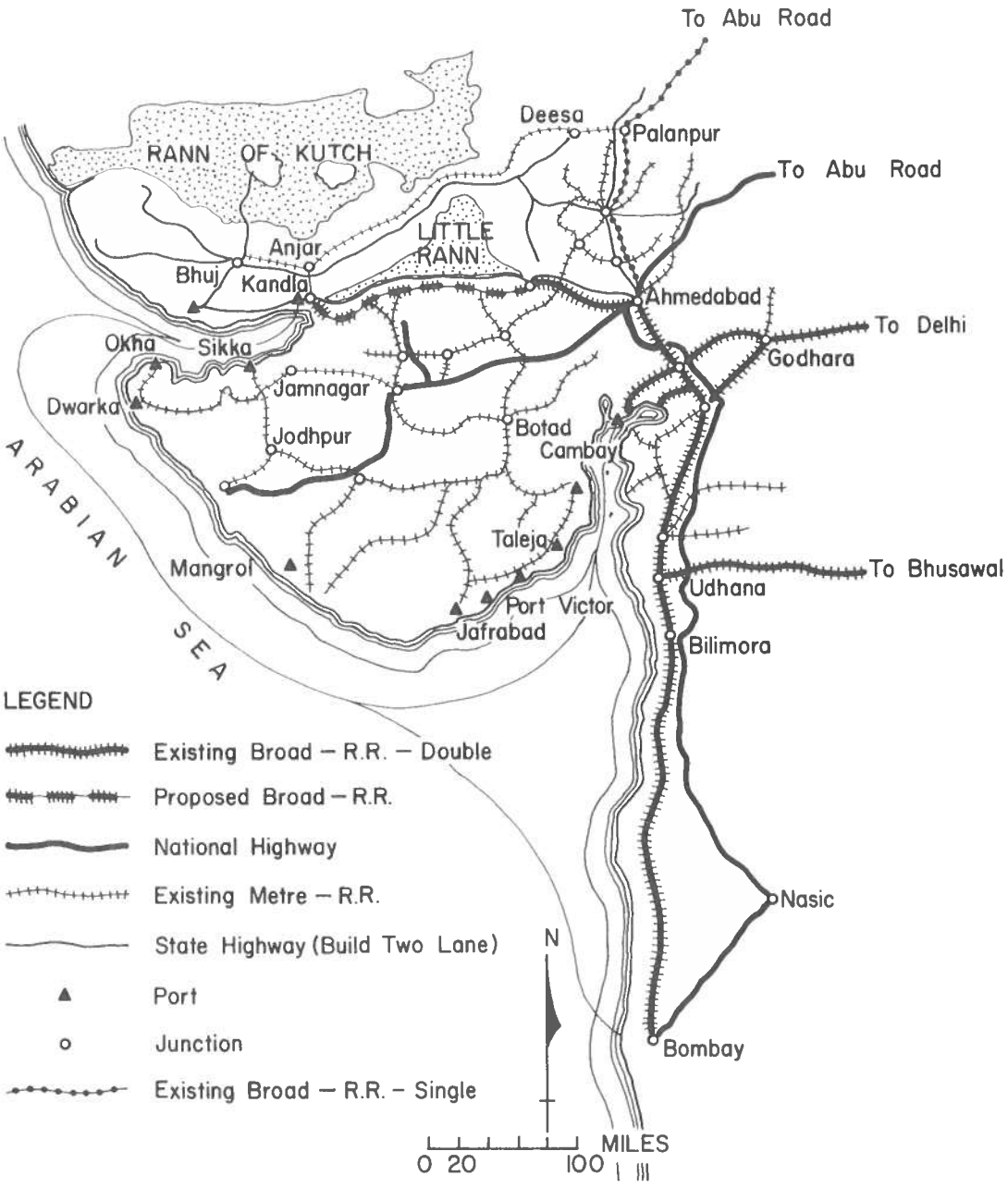

FIGURE 7. TRANSPORT NETWORK FOR NUPLEX IN THE LITTLE RANN OF KUTCH

or engage in campaigns to change official attitudes regarding higher volume use of the roads, but the roads themselves will almost certainly still remain poor until some strong, truly economic use emerges. The non-network roads inside the farm-factory will be used to deploy equipment to the fields that need it, so that roads within the triple-cropping area and adjacent to the harbor will have a justification for being asphalted.

The air lanes are even less developed. Kandla has an airport that serves the whole peninsula of Kutch. During the period of future project construction Kandla may develop traffic up to three planes per day, to move the key people in and out. Its function is much more interregional coordination than regional integration. Besides passengers, these planes will be needed to keep the pieces of advanced equipment in operating condition. There is very little we can imagine now that is worth more than the $3.00 per pound value that is minimally necessary to justify the costs of flying it to market, so the airport has no direct export effects.

Rail transportation is likely to remain the principal hauler of both passengers and high tariff freight. The Indian railways are the most efficient billion-dollar corporations in the whole society and hope to remain so despite the traumatic experiences of the past few years. The first operating losses in their history were experienced by the railways in 1967, but they were exacerbated by adjustments to findings of the management scientists who discovered that the procedure for making up trains was out of date. The revised length of trains and programming of the rail yards led to a cancellation of more than half of all the backlog of orders for the railway stock.

The greatest problem encountered in adjusting the rail networks to an agro-industrial complex is the difference in railroad

gauges. We are forced to cope with all three. The heavy-duty, broad-gauge lines are double-tracked from Bombay to Ahmedabad, and single-tracked to Delhi in the North. However, the high price of salt inland (and the tax on it) was responsible for a spur line being built from Ahmedabad to the edge of the Little Rann, where extensive salt pans were operated. The remainder of the rail network in Gujarat is single-track, meter-gauge, with the exception of a narrow-gauge line in the Kutch that connects its capital, Bhuj, to the rest of the network. The difficulty stems from the uncertain, but ordinarily high, cost of transferring freight from one gauge to another.

An assessment of the capacity of the existing line out of Kandla to the main line leading to the Indo-Gangetic Plain suggests that it is limited at about 3,000,000 tons per year (based upon parallel experiences in South Korea) with multi-shift operation and 30 per cent of the capacity assigned to passenger movement. At present it is carrying, we believe, only about 1,000,000 tons, but this may grow in the interim. Even if centralized traffic control (CTC) is installed, capacity is likely to be extended only to about four million tons.

The demand for freight is estimated in Table Five. It shows that we will probably need much more capacity. The harbors should be designed to put the remainder aboard containerized lighters and cargo ships. However, the strong need for heavy duty transport carrying the crops away from the farm-factory villages suggests that the broad-gauge line be extended to approach Kandla from the South. (The map is schematic; it has already been suggested that the line jog so as to proceed down the spine of the Little Rann.) With some excess transport capacity and several modes of transport on hand, the delivery of the food to the consumers can be carried out despite labor troubles. The cost of the

Table Five

TRANSPORT REQUIREMENTS FOR A NUPLEX AND THE RECLAMATION OF THE LITTLE RANN

A. IMPORTS		Tons/yr. (000's)
Phosphate Rock		1,650
Silica		500
Bauxite		400
Salt (local)	650	
Petroleum Coke		60
Coke		160
Cement		100
Aggregate (local)	300	
General Cargo	100	200
Totals	1,050	3,070
B. EXPORTS		
Ammonia		400
Phosphorus		150
Mixed Fertilizers		150
Aluminum		80
Chlorine Products		200
Caustic Soda		50
Plastics		150
Sub-Total		1,180
Cotton		240
Wheat, Millet, and Sugar		1,000
Fish (Iced or Tanked)	50	300
Forage (Straw and Alfalfa)		100
Safflower		40
Pulses		100
Potatoes	100	1,100
Vegetables and Fruits	200	1,200
Dairy and Livestock	100	500
Sub-Total	450	4,480
Total Exports		5,660

extension from the salt pans. The cost is estimated at Rs. 2,000,000 ($270,000) per mile for about 110 miles; the rolling stock and the stations will add another 40 per cent to this. Therefore the rail extension will add seriously to the investment in the complex (about $42 millions).

With prospective transport demand at the 10 million ton level, the capacity should be installed at perhaps a 30 per cent higher level. This allows for surges in flow, inventory buildup, etc. Fortunately, production is continuous and not seasonal, but the monsoon can hold down the practical capacity for a period of as much as two months. On the whole, this project would nevertheless use the transport facilities as efficiently as the best in India. The public corporations in the transport services are enthusiastic about taking on business like this.

The solution to the heavy transport requirements appears to be as follows:

		Added Capacity
1.	Put the meter-gauge line on CTC	1,000,000 tons/year
2.	Build 110 miles of broad gauge	4,000,000
3.	Expand and reorganize Kandla Port	2,000,000
4.	Harbor city port	6,000,000
	Total	13,000,000

This arrangement will allow the Gujarat government to take advantage of industrial opportunities that are as yet unforeseen without straining the facilities. If more heavy industry is installed, or if much more salt is exported, the possibility of electrifying the railroad remains open. India plans to electrify all the lines subject to heavy traffic in the 1970's and the 1980's and the low cost of electricity here would make this one of the most advantageous routes. An alternative would be to create a pipeline to the north which could move liquid ammonia and chemicals as well as petroleum products across the Rajasthan desert.

Either a heavily-used railroad or a pipeline would by itself justify the introduction of microwave relay contacts with key cities in the region. The region would also become well connected with the remainder of South Asia through the communications satellite that is due to be in place in 1972. We can say quite safely that the telecommunications network is more easily installed than any of the others. The planning for it has already been done.

Chapter Six

AN INSTALLATION FOR THE SINAI AREA

The original Oak Ridge report identified a number of coastal deserts as promising sites for the nuplex. For each of these potential sites we must consider the effects of nearby resources and activities upon the structure of the complex that would be economic in that locale. Due to special types of local opportunities, some of the "building block" industries may yield greater returns than were calculated on the basis of world prices. For the Arabs presently in the Gaza Strip and Sinai area, several of the most important opportunities lie completely outside the realm of normal business accounts. Therefore, considerations for the design of such facilities must be broader in scope than those with which engineers, or even economists, have been known to work.

Note first that a project of this type requires several hundred million dollars worth of foreign exchange. However, the American foreign exchange difficulties will last for some time to come; therefore, foreign aid largesse no longer supplies a solution. Much of the investment may mobilize a supply of dollars drawn from the banking centers of Europe, but these sources demand a higher return to recompense for every added element of risk. Fortunately, the interest rate on the capital for the complex could be 10 per cent per annum without rendering the project uneconomical. The investment cannot be safe and productive at all, however, if <u>peace</u> is not more likely than at present.

The obvious approach is to design the project so that it contributes to peacekeeping between the Israelis and the Arabs. Complete assurance is not necessary, nor expected; merely tipping the scale toward continuing peace would excite the interest of those who possess land and capital in the region. Indeed, the sums required for bringing about a change in the possibility of peace by means of such projects are insignificant compared to the scale of existing investments at stake in the Near East. As much as anything else, our task must be that of finding ways of using the project and its outputs as levers for pacification instead of stimulants for further conflict.

Part of the solution lies in the formulation of a corporation to create and manage the operation. It must almost certainly be thought of as an international consortium, and the territory upon which it holds a franchise must be a demilitarized zone. The members of the Consortium must be dominated by neutral nationalities, such as Scandinavians, Japanese, and Latin Americans. A number of firms, including the large equipment suppliers, should undertake part of the risk. In addition, a number of the Near Eastern sources of investment capital, such as the foundation incorporated by the Kuwaitis, the banks in Beirut, and some nations expecting to make a direct financial profit, should acquire significant blocks of stock and be represented on the policy-making body.

Such a formulation would appear to be "exploitation", unless the Consortium offered the workers and local residents first chance at all subsequent issues of stock. Thus, within a generation or so, the way should be clear for the local people to acquire a controlling interest.

Staff working for the Consortium at policy levels would need to have international origins and commitments, so that they could overcome marketing problems as well as feel free to leave for more responsible jobs. Much of the managerial staff could well be Arab, because the level of education is increasing rapidly in this part of the world, but the technical staff must be hired on the basis of skill and experience in process industries and modern agriculture. Over the first decade, the majority will therefore almost certainly have international origins.

The constitutional form of the parent organization should be modeled after the overseas versions of the TVA, so that self-help and self-governing procedures are built into its framework. Actually, the officials of the World Bank and cooperating institutions are aware of a number of relevant administrative procedures that have been tested in one or more developing countries; these procedures need merely to be assembled and packaged on this site.[1]

The possibility of large gas deposits distinguishes the Sinai from most other coastal deserts and can significantly affect the industrial structure and scale of the economically viable complex. Any discovery of large quantities of natural gas (equivalent in magnitude to discoveries in Iraq, Libya, Algeria, or Nigeria) would make it possible to achieve low enough unit costs for water and fertilizer at a much smaller scale of operations than envisaged in the Oak Ridge report. Gas-powered turbogenerators and gas-based hydrogen production for fertilizer are less capital-intensive. Then, if the nuclear reactor is to be added, it would energize the later stages of expansion. The chances of such a discovery are greater than elsewhere, but still less than fifty-fifty.

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[1] A. Waterston, Development Planning, (New York: McGraw-Hill, 1965).

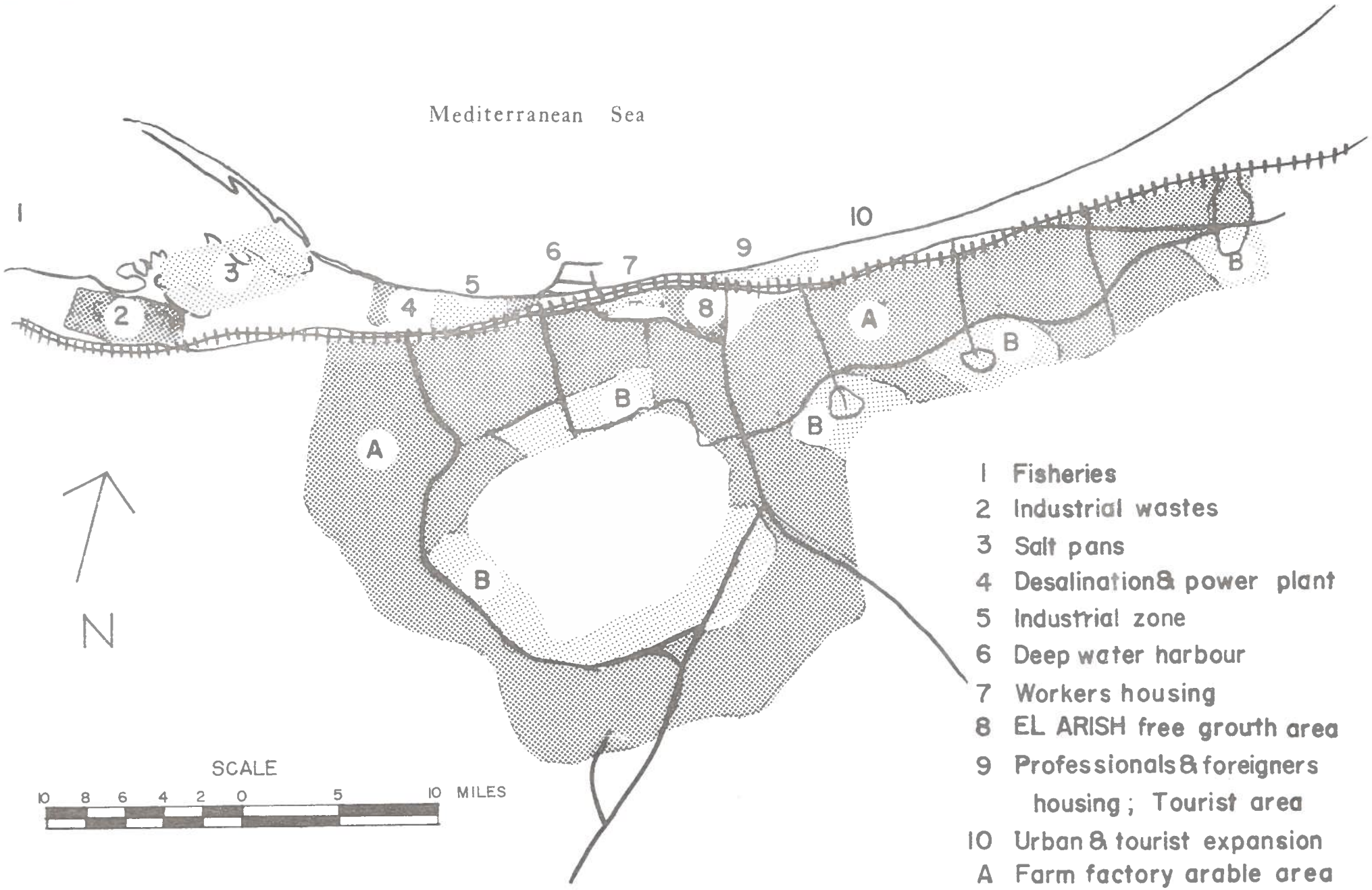
They suggest a very flexible plan for developing the complex, perhaps postponing the electrometallurgical plants altogether.

The primary market for the foodstuffs so produced is the urban population in Cairo and along the Nile. The population there is growing by three to five per cent per year, due both to a high urban birth rate and to strong migration from overpopulated rural precincts. Parallel growth in Egyptian food production, already very intensive, probably cannot be maintained. Therefore, as many as 10,000,000 people may need to be supported with imported grain, oil, and sugar by the early 1980's.

The fertilizer market in the Near East is due for a huge expansion. The industrial estate at the Aswan Dam may be able to provide most of Egypt's fertilizer requirements at that time, but we expect that all the other nearby countries should find this agro-industrial complex to be the lowest cost producer. Jordan, Syria, Lebanon, and even Israel could draw upon the output, and some could go to Cyprus, Greece, and the Balkan countries.

The electric power outlets are limited to 500 miles or so, for a heavy user, so that the continent-based metropolitan areas would gain some extra industrial prospects due to reduced costs of electric power. Egypt, again, is the largest potential consumer. Most of these countries could also use the vinyl plastics and chlorinated solvents produced as byproducts.

Such arguments, together with topography and present settlement patterns, lead us to choose a site immediately to the west of El Arish for the industrial reservation. The sea-salt evaporation ponds and the fish farm are then immediately to the west, the airport only eight to ten kilometers away, and a railroad connects with the inadequately used port of Ashdod, so that construction of facilities does not have to await harbor development at the plant site.



FARM FACTORY DEVELOPMENT IN THE SINAI

Human Resource Development Opportunities

As a consequence of the hostilities of 1956, hundreds of thousands of peasant Palestinian Arabs were pressed into the Gaza Strip and left without significant sources of livelihood. The loss of their land demoralized them. Undoubtedly they would have perished but for the refugee assistance organized primarily through the United Nations. Most families have lived for years in tents and other temporary quarters grouped into camps of various sizes. At present more than 250,000 people live there and in the Sinai. This population has a natural growth rate of almost three per cent per year, so that by 1980 we must expect that almost 400,000 will be on hand.

The condition of the people in the refugee camps is deplorable. The better educated members of the population emigrated and have since diffused throughout the urban Arab world and the Western European metropolises. They serve as teachers, technicians, mechanics, construction hands, restaurateurs, hotelmen, etc. This leaves a less adaptable residue waiting in anticipation of the time when they will reoccupy the family property. The Gaza Strip population is reported to be poorly organized and apathetic as compared to similar camps formed in Jordan and Syria during the same period. Under these depressing circumstances, an Arab youth is forced to make his own way, independent of the direction taken by his parents. His choice could lead to guerilla warfare at one extreme and the creation of new, modern communities on the other. The primary need is for a purpose in life -- a constructive future for individuals with predominantly peasant backgrounds.

It is proposed here to design a nuplex offering the maximum variety of options. The local people may stay where they are; they may

learn a trade that is expected to be in worldwide demand. They may obtain industrial jobs for the men and a tiny plot nearby on which to grow vegetables. They can raise animals, or they can move to a cosmopolitan, urban center and accept the responsibilities of petty bureaucrats or small businessmen. Tens of thousands of new places could be created. Of these perhaps the most useful both for the Arabs and for the world at large are the specialized trades.

A relatively new set of biotechnical trades seems likely to evolve with the agro-industrial complex. They follow from the need to find the optimum combination of distilled water, fertilizer, seed and soil in order to obtain yields close to the biological maximum in year-round cultivation. The threats of rats, locusts, grasshoppers, rust, and viruses are far more serious under these intensive growing conditions. Therefore, a continuing success depends upon early detection and intervention. More than a "green thumb" is required; rather, skills in adjusting fertilizer to water and weather and skills in applying pesticides for at least a dozen different crops, must be accumulated. This art can only be acquired through experience while working in concert with agricultural scientists. As the new intensive agriculture spreads through the semi-tropical and tropical zones of the work, these technicians will be in very great demand. Since we envisage this Sinai installation as one of the first to be brought into production, and quite likely the first to be operated by a Muslim society, these Palestinian Arabs would be in demand in territories ranging from Borneo to Mauretania, and perhaps even in Latin America.

These observations upon the skills required to make an agro-industrial complex work effectively are exceedingly important because

they indicate that the first stage of development -- the biological experiment station dependent upon a diesel-powered distillation plant -- must be at least as concerned with the training of personnel as it is with the selection of strains of crop plants and the production of seeds. The opportunities and hazards presented by the various soils -- especially the active dunes and the hollows with alkali deposits -- must be fitted to the alternative fertilizer mixes to discover the most economic combination. The results of such experiments need to be transmitted to the least educated workers so that they themselves can profit and also demonstrate the superiority of the new knowledge to their fellow villagers. Only then would a suitable multiplier for the original training effort be achieved.

The next stage in the Sinai is expected to occupy 60,000 to 100,000 acres of land. The industrial facilities would include, as a bare minimum: (1) production of sea salt, (2) electrolysis of brine, (3) electric power production, (4) treatment of seawater intake to prevent sealing, (5) production of lime and carbon dioxide as a by-product, (6) hydrogen production (7) liquefaction of air, (8) ammonia synthesis, (9) phosphate treatment by electric furnace, (10) fertilizer mixing, (11) miscellaneous byproduct uses of chlorine and oxygen, mainly plastics production, and (12) distillation of the seawater coolant for irrigation, domestic, and industrial purposes. Power would be put onto the grid to serve nearby cities and to energize the pumps that move as much as 500,000 acre-feet of water inland per year.

Many of the trainees will elect to settle on a plot of land of their own, employing to their own advantage the skills they have learned. We have called these settlers "smallholders", because they would operate

varying amounts of land, while living on a farmstead or in a village. In general, they would draw upon the labor available in the household and use machinery cooperatively. The marketing of the produce would be contracted to the corporation or else, particularly for specialty crops, handled by a grower's cooperative. It is both economically and politically advantageous for the Corporation to lend money for the development of smallholdings and assist in the organization of the co-ops. In most plantation and irrigation district developments in the past, the smallholders have been the low-cost producers, because it is politically difficult for a corporation to reduce the wages of labor when the prices of the commodities drop, while smallholders can retreat to a subsistence basis and still meet the water charges from their sales. Thus, thousands of families may be encouraged to become smallholders with one to twenty acres of land under their management.

Another group will be needed to operate tractors, spray equipment, and irrigation on Corporation lands according to "food factory" techniques. As hired hands, they should be encouraged to settle on a garden plot of their own (payments over twenty years or so) so that the household can be reasonably independent of the employer. (Then the bargaining can be between equals, since the workers need not starve even if they should disagree with the Corporation.) Some of the workers living on these small plots will have semi-skilled jobs in the multiple-shift industrial units of the industrial estate. The plots may be grouped into hamlets which support an elementary school and one or two shops, with excellent access to the new city or to a market town. The size of the plots is likely to vary between two to four acres (0.5 to 1.0 acres), since that amount of land will keep an Arab household of four to eight persons alive

and could leave something over for obtaining cash, if a sufficiency of water exists.

A third group of Arab workers would live in the city itself, but be granted a parcel of land upon which they could build houses of their own. Since Arabs prefer to live compactly, these plots are likely to be mostly 80 square meters apiece (800 square feet), but some may be larger. Water facilities would be communal, at least initially, as would television, encouraging these settlements to be more open for interaction than is common in established urban Arab communities. These provisions are intended to keep squatting on open land under control. The availability of such neighborhoods makes it possible to use police power humanely when people are living at subsistence. People can either go to the campground or to an urban village under development. Public order can be maintained in a developing city as long as even the poorest individuals are offered alternative places to live.

Initially about a thousand households are expected to opt for the cosmopolitan center. It would serve the international experts, the luxury tourists, and a number of Arab counterparts being trained to take over the most responsible jobs. Quite a few independent professional and business personnel would be included within these urbane circles. Their capabilities and numbers are likely to grow the most rapidly over time, because services of all kinds become more important as the variety and specialization of the export commodities increases. Thus, a new city would be born adjacent to El Arish that would grow rapidly to a population of as many as 100,000 persons, a considerable fraction of them living off European winter tourism. Due to the low cost of electric power, it would very likely be the first designed for completely air-conditioned interiors.

Altogether, four different kinds of settlement are proposed here, two of them minimal at the start but still allowing for a lifetime of adaptation and improvement. The two others permit unlimited variety, according to the energies and interests of the individuals and their families. Perhaps more than anything else, however, these are environments that are open, connected with world cultures, modern technology, and the most progressive Muslim societies. The adventurous individuals can move out into the world to take advantage of such opportunities and leave positions open for others to take their places. Institutions for human resources development -- the communities, schools, offices, and cultural organizations -- need to reflect the openness. There are possibilities of expansion beyond the first 500 square mile farm factory, but success will depend upon the development of specialized products and the buildup of marketing skills.

A Scenario for the Sinai

In our projection the action begins in 1969. Then it is announced that a $5,000,000 grant has been given to C.A.R.E. and the International Co-operative Alliance to create an experimental station to acquire specific knowledge applicable to the taming of the deserts of Arabia and North Africa, more specifically, the Sinai itself. Full co-operation has been promised by the Rockefeller Foundation units in Mexico and the Philippines. Both Pakistan and India have promised seeds and technical assistance. The Japanese have offered instruments and technicians. The cash grant comes from a group of foundations, and the aim is to bring in a team of world famous agricultural scientists to acquire the data needed to design food factories based upon desalinated water.

In the same year a Scandinavian banking syndicate, working with the Swiss and the Kuwaiti government representatives, announces that it is seeking an option on all unsettled land in a 3,000 square kilometer (1,200 square mile) area of the Sinai. Simultaneously, the long-standing program of the Israelis to finance their additional agricultural water program with desalination plants based upon foreign aid and low-interest loans faded from the picture (Science, 160, 1968, 1093). Economic realism dictated that Israeli farmers produce for export without subsidy in order to put the national economy on a firm footing.

Within a year a demountable desalinated water plant and a small diesel electric power generator are transferred from Kuwait (they were replaced by more economical units ten times larger in size). A hundred pre-fab houses have been set up, and Arab workers have been brought in to work the gardens, handle the construction, and create a community of their own. A hundred acres of four basically different soil types have been converted to sprinkler irrigation and planted with fifty strains of a dozen crop species. Careful studies of crop pests were initiated, and a variety of pesticides imported to permit the study of their effectiveness. Many models of modern construction machinery and farm equipment have arrived at el Arish. Planning offices have been set up on the site and in Beirut.

The high level negotiations involving the structure of the corporation, and the financial Consortium that was brought together to back it, were completed in 1971. It was preceded by a major deal between the Japanese and the Australians to develop a similar area north of Perth for a facility that would produce wheat and dry rice for the cities of Japan. Exchange of experience agreements have been arranged. The

preliminary plans for displacement of food imported to feed the refugees were immediately activated as a group of subcontracts. Bidding was opened on the first nuclear reactor. The winner in this competition was a Canadian-backed international group; a Russian industrial combine was low bidder but it could not guarantee quick delivery. A number of Arab teams were brought together in El Arish to plan the new city and lay the foundations for the rural communities. Schools were formed for every level of expertise required, each of them organized to train extra staff so they could spin off new units every two or three years. This year is the true launching date of the project -- the "zero point" for the investment program depicted in Figure 3.

The public relations vice-president decided to cash in on the publicity and erect a "temporary" tourist airport-hotel-beach complex featuring hydroponics-based flower gardens. The plan is for 300,000 tourist-days by 1974, mainly in the winter season.

Survey research had discovered a "spillover market"among the tourists from Germany and Great Britain. This group was most interested in getting some sun in the winter and early spring and hardly bothered with publicized tourist attractions. Most of them came by air on closely budgeted tours. The more adventurous of them have followed the opening of new resort areas, such as the South of Spain (promoted just prior to 1960), Sardinia (1965), Tunisia (1969), and Crete (1971). After that series, what is more logical than the Sinai? Of course, in order to do better than break even, the promoters had to find a way to attract the summer vacationers as well. The solution was to make this site an air-conditioned, flower-bedecked jumping-off place for those who wished to get around to other places in the Near East.

The original tourist quarter at El Arish provided jobs, part time or full time, for almost 2,000 Arabs. Those who were not attracted to biotechnology or the maintenance of machinery were encouraged to go into the hotel trades via a Swiss-operated school associated with a 600-room, multifunctional hotel. Later a series of tracts about a quarter mile apart up the coast toward Gaza were leased to developers, each of them installing slightly different combinations of attractions. By this time all the dunes had been blanketed with vegetation close to the shore and the string of date palms behind the beaches was backed by thickets of shrubs.

The growth of the agricultural activity took on a peculiar shape due to significance of the tourist potential. The first stage developed an area approximately 150 square miles to the south of the railroad up to the 90-foot contour. It was formed from El Arish and the urban village-type settlements on its outskirts. The second nuclear reactor provided enough water to enable the cropland to be extended inland twenty-two miles and along the coastal strip for forty-five miles. The hilly area in the center (about 25,000 acres) was assigned to grazing, cattle-feeding, and other animal-oriented activities. The farm-factory villages, with their small, intensive workers' gardens, tended to cluster around this gentle hill or on the pipeline extending to north-east. The sedentarization of the nomads was carried out in small hamlets on the periphery.

What was learned from this attempt to construct a scenario? The primary lesson was the inability to speculate at all on most of the relevant social and cultural developments in the absence of a political solution to the Arab-Israeli confrontation. Whereas in India one could pick out certain critical issues stemming from language, religion, and revivalism that would probably come to a head in next decade or so, in the Gaza Strip and the Sinai it seems that almost any local or personal issue could well become a determining force. In addition, decisions in any of a half dozen surrounding Arab countries could easily set the course of events onto a new path. This doubt about the future indicates that whatever happens over the next generation will be extremely sensitive to the decisions made over the 1968-1970 period. History counts hardly at all in determining the future despite the frequent reference to the past in the inflammatory speeches. Thus the importance of this project, conceived as an exercise in human resource development, is emphasized. More specifically, according to the information obtained so far, the Arabs are relatively homogeneous in their characteristics, and there are no odd and unusual groups which must find an accommodation with the demanding discipline required for triple-cropping a coastal desert.

Similarly, the steps to self-government -- including the evolution of experiences at the local level -- cannot be worked out at the moment. This affects our thinking about the means to implement the establishment of self-help communities in the Harbor City area and in the countryside. When decisions have been reached, however, the progress can be much more rapid than in India, because the level of education runs about twice that of the Gujeratis of Kutch, based upon years of schooling per capita. (There are no concrete data at hand;

this statement sums up a multiplicity of clues we have encountered.) As a result, it should take fewer Palestinian Arabs to operate the full agro-industrial complex -- perhaps only 250,000. This is still the majority of those likely to be residing in the Gaza Strip area. Indeed, if this project is really successful and opens a variety of world-spanning careers to the Palestinian Arabs, their replacements may have to be drawn from Jordan and Syria, where the morale has been somewhat higher but the animosities seemed also to be correspondingly greater.

The nuclear reactors, we have assumed, will remain under the close inspection and control of the International Atomic Energy Authority of Vienna, who could shut them down on a moment's notice, and the high level of radioactivity would prevent the use of nuclear weapons in terrorist activities. Given an assurance that the worst outcome can be prevented, the investment still looks promising.

Chapter Seven

THE EVOLUTION OF NEW LIFE STYLES

The quality of life of the people most intimately involved with the project cannot be neglected. Is there some way of gauging it? Might there be some critical opportunity in the course of the development that might lead to a higher plane of life? Every planner worries about missing the best chance when a spurt of growth occurs. His colleagues, with their hindsight, accuse him of lacking foresight. Therefore, efforts must be made quite early that are aimed at minimizing regret. Everyone recognizes that project planners on the scene will be overburdened with detailed implementation and the construction of makeshifts to get over some emergency, so they cannot be expected to make a push for the best. Improvements in the quality of life are the responsibility of long-range planners.

It is already evident that the nuplex must, if it is to be operationally feasible, dominate Nature within a sub-region in a manner never before experienced outside of the central portions of the metropolis itself. Its ecology is totally man-made, because even the parks, open spaces, and roadsides would be affected by the desalination of the soils, the introduction of fresh water via sprinklers, and the massive infusion of fertilizer. The tempo is set by the round-the-clock characteristic of the process industries and the triple-crop agriculture. Action must be programmed to proceed at high speed with a minimum of error, but there must also be enough slack on hand to meet foreseeable emergencies. The slack, in the form of extra equip-

ment, inventories, and training routines, will in many instances be more visible to the outsider than the action. The organized strategy in playing the game against Nature, as represented by weather, pests, and markets, is changed by the kinds of stakes involved. No longer is mortgage foreclosure the imminent threat, but only a loss in the amount of bonus that would be paid out of profits.

The culture the immigrants brought with them would have to be reorganized. It must admit a great many traits first observed elsewhere in the nation or in territories overseas. This borrowing will be identified most readily in the vocabulary, images, and styles exhibited in public activities. Thus many parochialisms and regionalisms are discarded, with only a few occasionally restored as sentimental museum-pieces or anniversary celebrations. Inevitably the religion, or systems of belief about ultimate values, will be changed to reflect what people feel is important about the social environment. If the Corporation and the government find a formula for orderly management with an increasing range of options for the population at large, the new doctrine would teach how to build a good life (or a higher reincarnation) out of duty to the job, achievement of goals of stewardship, the acquisition of knowledge, and tolerance for different viewpoints.

Every subculture can be represented as a fabric made up of life styles. In each life style a few roles will determine the color and texture of the strand. A few of those unusual for Asia, yet essential to efficiency in a farm-factory subregion, can be described:

agriculturist -- a man dedicated to maintaining the health of a standing crop, picking up clues of disease or malnutrition as quickly

as they arise and then exerting his utmost to root out both the illness and the cause. In his non-working life he may grow pedigree vegetables or flowers that challenge his skill.

livestock raiser and fish breeder -- they exhibit the same responsibilities to the dairy animals and the fish population.

master mechanic -- a man who has a feel for machines and the way mechanical parts synchronize. He is a member of a team with differentiated skills that has the responsibility of keeping a fleet of vehicles in good working condition. Most likely he will be tinkering with motorcycles, watches, or toys on his time off.

process industries operator -- a man who understands the flow of fluids through pipes and the instruments that record its passage, reacting quickly to stabilize any perturbation. He might well find an avocation in all of the specialties already named, or he may study engineering, especially refrigeration.

organizer -- because so many new opportunities are created when strangers assemble to settle, a number of individuals at every educational level will discover they have a capacity for inducing people to cooperate. In their spare time organizers find themselves organizing, but it may be a sports team or a social club instead of a housing cooperative or a private firm.

It will be noted that all of these life styles emphasize interests in organization -- animate, inanimate, and human. Therefore, they are comparatively stimulating and satisfying, especially if the subregion progresses toward higher output and increased proliferation of social organization. The implications of this self-organization must be traced out as far as it is possible to do so.

Designs for Households

We have not made the common error of planners of new towns that households will be of normal sizes. In all of our projections in this study we have recognized the dynamics of migration resulting from "pull" type forces. For that case we find ourselves dealing with pioneer individuals from a household who establish themselves, as in Figure 2 of the second monograph in this series,[1] later bringing their families and providing a beachhead for relatives. Thus initially the households will be constituted as nuclear families, but over time and with increasing prosperity, some will be reconstituted as extended families. In addition, we must postulate an effective family planning program because the forces of conservatism and the demands for social security are greatly reduced. Therefore, we must assume that the average size of household will be in range of 3 to 4 persons instead of the present 5 to 6 persons. The maximum sizes will be almost as common, but many more one-person and two-person households would be maintained, very much as in Western countries.

Studies of present housing both in the Gujerat and on the Gaza Strip indicate that people are living in buildings not suited to the climate. Why should this be? We know that sometimes the most highly evolved vernacular (i.e. artisan-produced) solutions for houses, neighborhoods, and parochial buildings have become obsolete without the people themselves recognizing the changed conditions. When that occurs, investments in traditional styles do not pay because, as people become more educated, they learn enough to reject them for "something better."

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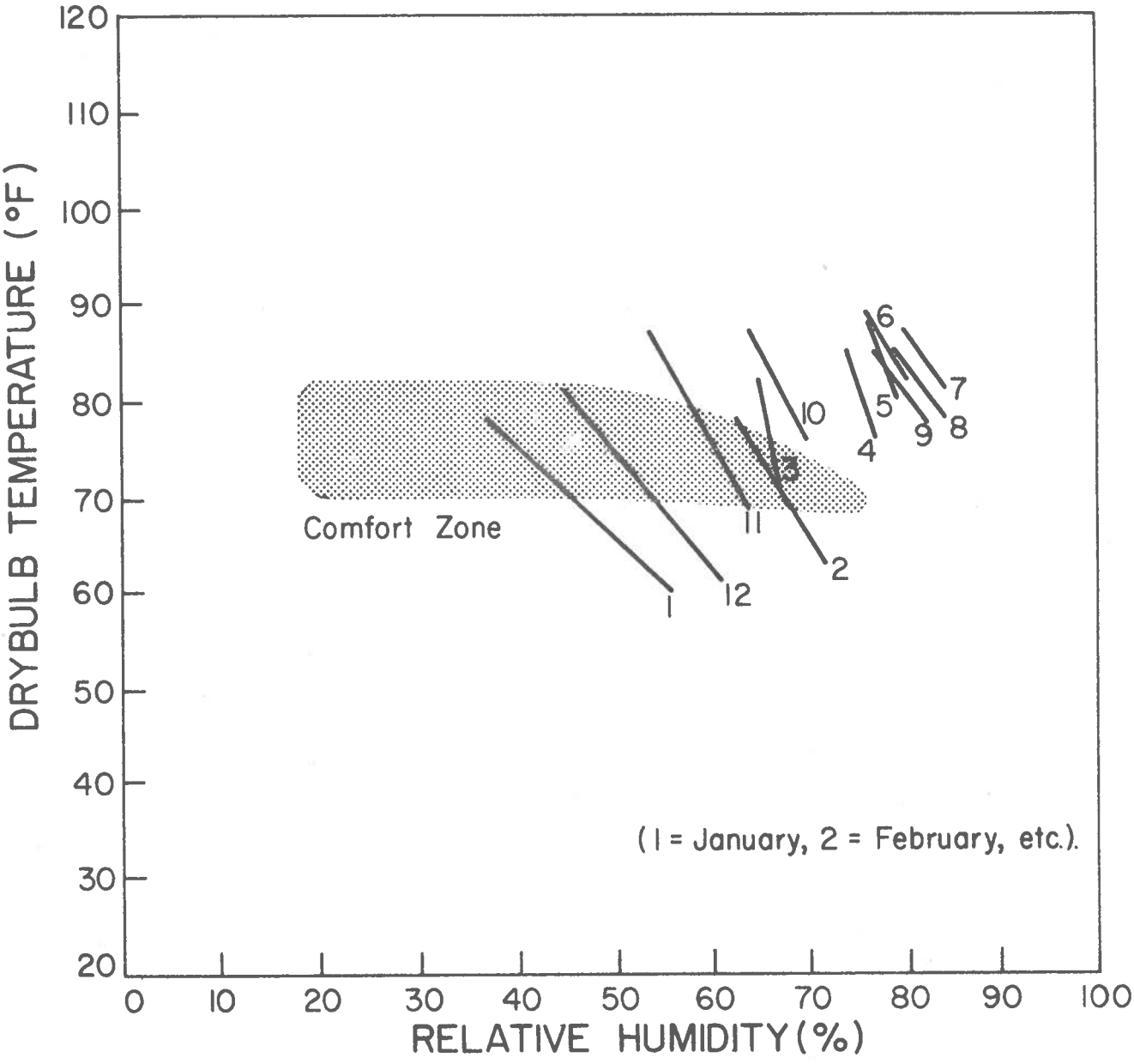
[1] R. L. Meier, Resource-Conserving Urbanism for South Asia, pp. 40-46.

The phenomenon of premature obsolescence of houses and related structures, such as shops and schools, can cause the decay of neighborhoods and housing tracts with the consequent formation of slums. This sounds ridiculous to persons who obtained most of their experience in areas where housing is extremely scarce, but a personal review of recent trends in Japan and South Asia indicate that typical instances of ecological succession are already under way. Good design should be able to prevent such waste with very little, or any, extra cost.

In Western India houses are made of brick, fieldstone, and tile. These massive materials assure that the inside will remain uncomfortably warm many months of the year. A minority of the population finds a way to sleep on the roof during the hot, humid season so as to radiate body heat out to space, but most sweat out the night on low beds of loosely woven cord or net that allow some contact with the cooler air flowing along the ground.

One explanation for infilling walls with masonry and for roofing with tile is that the Gujeratis originally came from a hot, dry climate in the North (five centuries ago they were concentrated in what is now the Punjab and Rajasthan) and they brought their artisans with them to Kutch and Saurashtra. The tightly closed structures probably also served as a partial defense against malaria that was endemic in the swamps. These choices were reinforced by a recognition of the fire hazard created by the thatched roofs and wattled walls of the indigenous tribes.

In the Sinai area people have had enough of tents and other temporary structures. They are seeking something permanent that can be put upon land of their own. The image of the casbah, with each house



ASSUMPTION: MINIMUM DAILY TEMPERATURE IS PLOTTED WITH RELATIVE HUMIDITY READING FOR 0800

MAXIMUM DAILY TEMPERATURE IS PLOTTED WITH RELATIVE HUMIDITY READING FOR 1600

COMPARE THIS TO CHARTS IN VICTOR OLGYAY, DESIGN WITH CLIMATE: BIOCLIMATIC APPROACH TO ARCHITECTURAL REGIONALISM, (PRINCETON, PRINCETON UNIV. PRESS, 1963).

Figure 8. Climatic Stress on the Gulf of Kutch: Dwarka

walled in from the street, seems still to be retained as an ideal to a large degree. For reasons of comfort, however, the materials ought to have low heat capacities, thus radiating very little of the heat of the desert into the home, while they must at the same time possess high insulating value. The color, of course, should be white, with titanium dioxide pigment preferred over lime whitewash. Once families have compared the old with the new prescription, the difference is significant enough to impel families to choose homes with engineered comfort.

It is the job of the architect to discover what values are held unchanged from the previous generation and which of them are being modified. The new life styles generated by the farm-factory communities will be the primary source of the modifications. The architect must synthesize a cheap, convenient, intellectually exciting way for these households to build themselves a new house, preferably using new materials produced in the industrial complex. What follows is not an indication of what should be done, but the form that a solution could take if the new opportunities were to be grasped.

Climate in the Gujerat comes close to that of southern Florida, having very similar temperature and humidity but more seasonal rain and much less of it.[2] Subdivision of the land, landscaping and house design must be integrated to expedite ventilation. The steady sea-breeze, averaging 13 to 14 miles per hour, or its reverse, should set the alignment of the streets. Fast growing shade trees keep the

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[2]Excellent climatic data exist for sites close to the Little Rann of Kutch, particularly Dwarka. Cf. U. K. Meteorological Office, Air Ministry, The Makran Coast from Gwadar to Karachi and the West Coast of India to Latitude 20°N (London: His Majesty's Stationery Office, 1944, pp. 14-17, 64); also Central Building Research Institute, Roorkee, Climatological and Solar Data for India (to Design Buildings for Thermal Comfort).

ground cool, so they should be grown in courtyards, along principal walkways and canals. (Note: The experiment station must start a tree nursery as soon as the project gets a "go-ahead" signal.) Boundary walls, if any, should be of open tile.

For the houses themselves, the roof line should be low and the walls should be light. The roof ought to be double, and preferably corrugated aluminum, whitened on the top surface, since it offers maximum efficiency in withstanding sun and weather. It also happens to be more economical than anything except palm thatch, the supply of which is exceedingly limited in this area. If houses are done improperly, condensation will collect in the early morning, leading to a mildewing of cotton garments. Very likely insects will be under control, so unscreened jalousies could serve as windows.

Two kinds of solutions can be suggested, and both may be used simultaneously. Air-entrained concrete can be formed as beams and shells light enough to float. Since much cement will be needed by the project, these shapes would represent a minor adjunct industry. Polyurethane resin will be produced at that time in the Bombay area. It could be foamed into standard panels with an outer skin of anodized aluminum foil which does not require paint, and an inner surface either of resin itself, paper, or cloth. Roof panels with supports would also be prefabricated. Flooring could be packed earth, concrete slab, tile, reed mats, or synthetic fiber rugs. Thus there can be adequate housing solutions for every price level, and an opportunity to expand and elaborate to fit changes in family size and income.

For the Sinai it can be said that the design and construction experience appropriate to the locale already exists. The huge housing

program in Israel over the past dozen years, particularly for Yemenite immigrants, has supplied a number of successes and failures for analysis.[3]

Very likely prefabricated blocks, beams, and shells of air-entrained concrete would be the most popular. Much housing would need to be protected against blowing sand for the first few years after construction, so windows will need to be small and tightly sealed. The higher latitude (32°N) brings with it a chilly and sometimes damp winter that will require some electrical radiant heating as soon as the family can afford it.

Any of these materials and designs enable a man to build around a garden, or a workshop, or a study. They are portable, flexible, and have about the right durability. The aspect of the street or court in the Indian community would be extremely varied, while for the Arab community the interiors of the blocks would develop some differentiation that would be reflected by the shops facing out to the road.

Designs for Neighborhoods

In India life style is strongly determined by religion, caste, language, and ethnicity. If one is a Sikh, he is likely to be found driving a taxi, truck, or tractor; if Marwari from Rajasthan, he keeps shop in the Bazaar; or if Madrassi, he is expected to be a bureaucrat. Of course not all of them are, but the biases are strong in those directions. Neighborhoods in cities also reflect such groupings, but in the future it must be anticipated that Indians will seek a neighborhood with educational level compatible to their own. European

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[3]Joan Ash, "Planning and Housing for Immigrants in Israel", Town Planning Review, July 1962, pp. 120-121.

cultures, as well as the Japanese; i.e. societies that invested heavily in education ahead of India, have noted such a trend. The new social roles described earlier are likely to crystallize as life styles without concentration into specially designated neighborhoods, but the third or fourth change of address within the project area could well reinforce certain nuclei, so that, for instance, the mechanically inclined families would concentrate around some private repair shops, metal working firms, and parts distributors. Thus variety in neighborhoods should be enhanced, being represented by some of the present urban pattern, some of the characteristics of the villages from which the residents came, and some differentiation according to education and specialty.

In the Sinai the Arabs are expected to aggregate in a neighborhood according to community or province of origin. However, if they have acquired high school diplomas, they may instead choose neighborhoods that fit their income and education, as in Cairo and Alexandria.

Growing these neighborhoods in a convenient, orderly, and economic fashion requires forethought and planning. Architects in this study criticized all the earlier versions of a neighborhood or block unit, particularly as depicted in Studies on the Future of Cities in South Asia, although the later were the consensus of two experienced Indian architects. The concept presented there did not allow for different household needs of the initial settlers. Closely related families have been living side by side in the villages and are likely to reconstitute this arrangement, if at all possible, when they migrate;[4]

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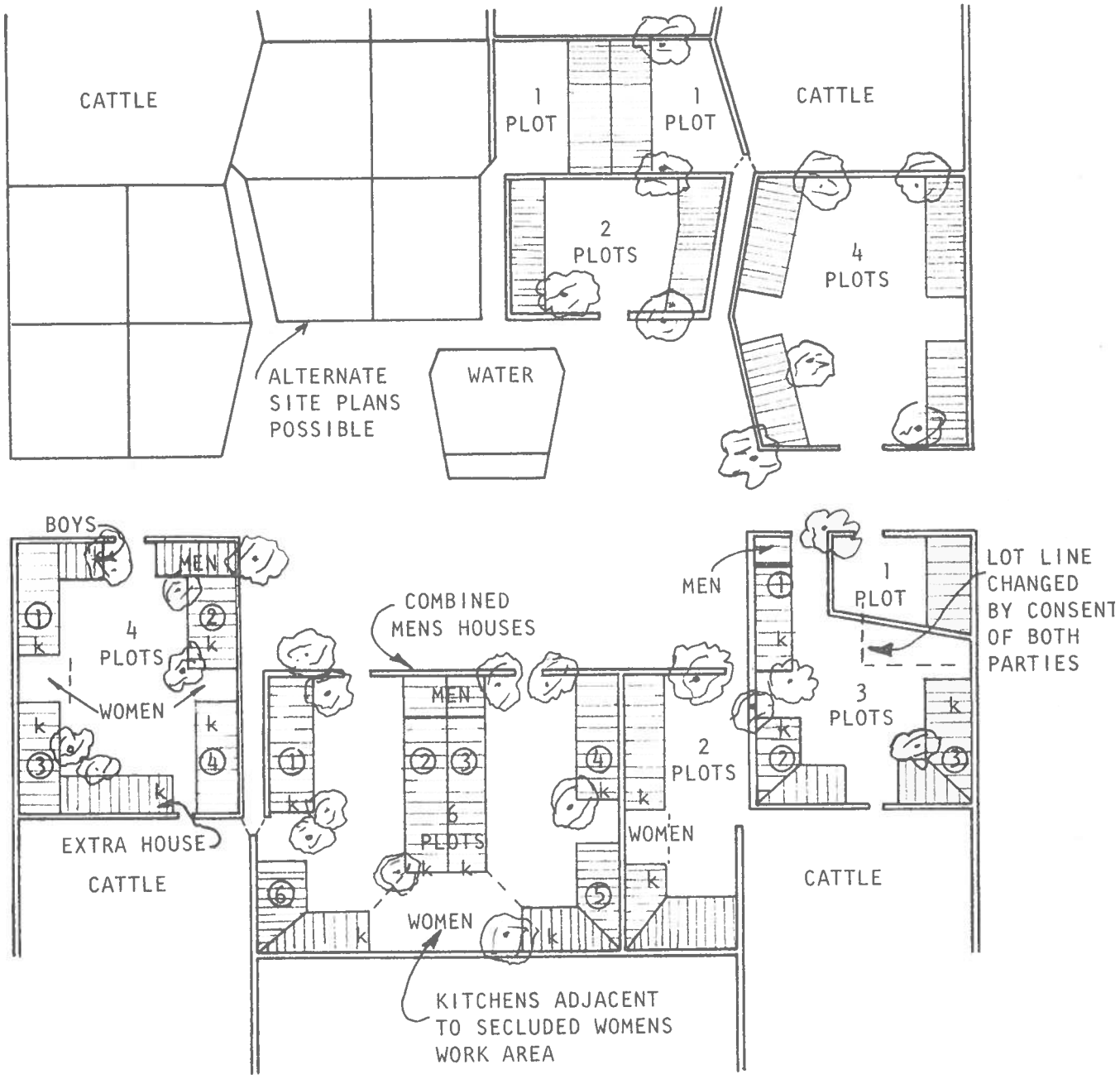
[4] Oakley, D., "The Village Society," in K. R. Unni, Ed., The Rural Habitat, Occasional Papers, Department of Housing, Rural Housing Wing, School of Planning and Architecture, New Delhi, 1965, pp. 7.



URBAN VILLAGE

ALTERNATE CLUSTER LAYOUTS

SCALE 0 20 40 60 80 100

Figure 9.

so combinations of two to six households may group themselves around a common area that leads out into a larger courtyard containing water facilities, toilets, public television, and public work space.

This design was analyzed again by an anthropologist. One defect implied, but not actually drawn into the plan, is the long and narrow street that runs by the side of this strip of neighborhood units. It is easily rectified, however, by making every other street broad enough for the holiday processions and burials. These roads would support small shops at places of maximum foot traffic. This brings up a question regarding the "burning ghats" or cremation area. The wider roads would need to lead to such a place adjacent to the drainage canal, into which the ashes of the dead would be tipped or scattered. Street lamps are not shown, and usually do not exist in Indian communities except in commercial places, but the multi-shift nature of this subculture will place a high premium on street lamps strong enough to assist cyclists. The problem of getting effective street lighting, trees, and ventilation simultaneously has not been solved, but the conflict was recognized only a few days before this exploratory study had to be terminated. A satisfactory solution may well exist. Simultaneously it was recognized that a school, a medical clinic, an open air cinema, and a small dramatic stage, along with one or two small temples or mosques would need to be interspersed among a grouping of ten to twenty neighborhood units.[5]

A somewhat less intensive exercise aimed at growing neighborhoods in rapid succession was undertaken for the Sinai. The locale

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[5]M. N. Srinivas, Social Change in Modern India, (Berkeley University of California Press, 1966).

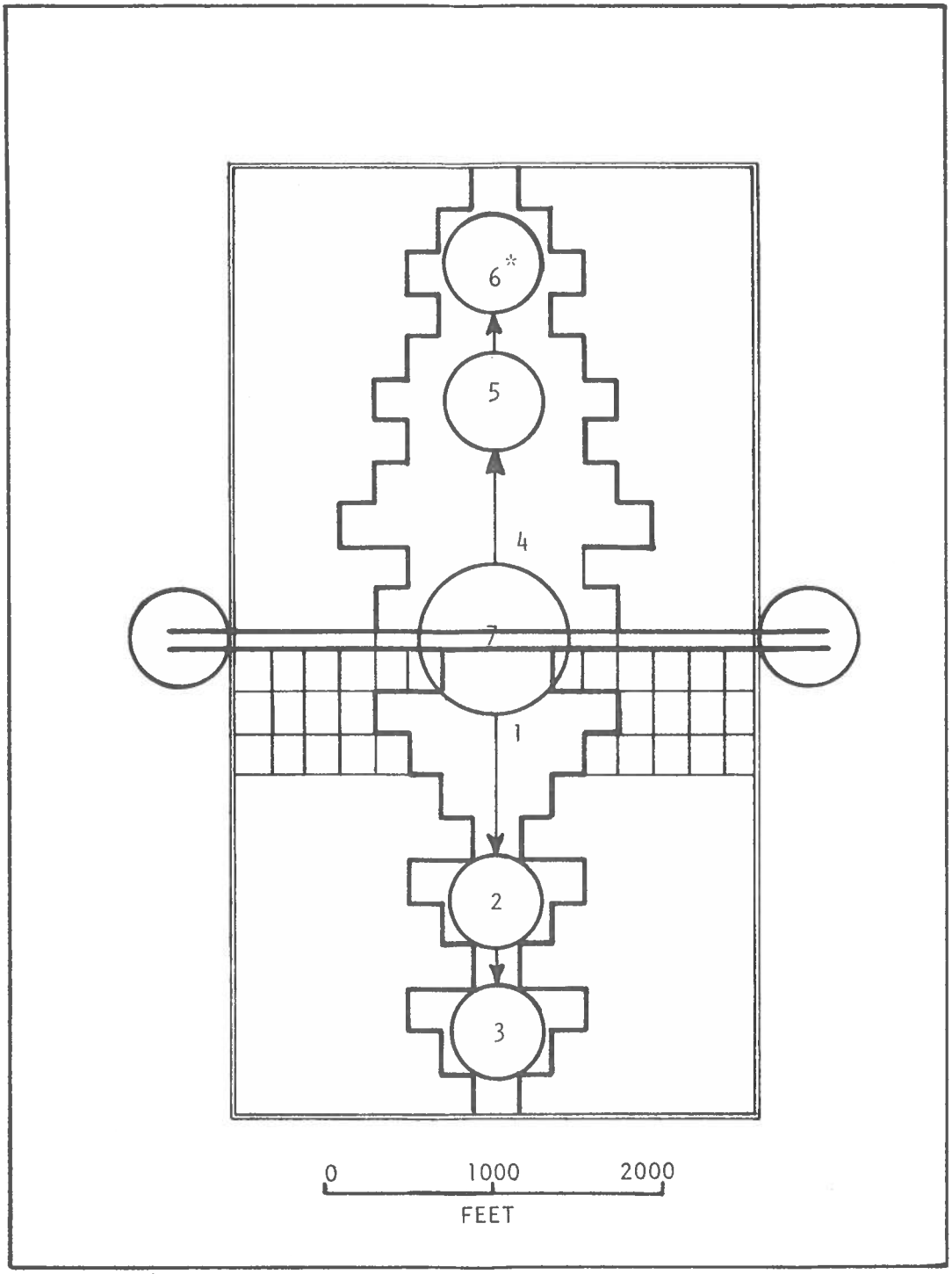

Figure 10.

SCHEMATIC PLAN OF LINEAR DEVELOPMENT OF COMMERCIAL AND CULTURAL FACILITIES FROM NODES ALONG TRANSPORTATION LINE INTO LOCAL POPULATION SECTORS.

TOTAL: 4000 FAMILIES.

KEY:

○ LOCAL COMMERCIAL AND CULTURAL FACILITIES

◯ REGIONAL COMMERCIAL AND CULTURAL FACILITIES

* Numbers indicate sequence of settlement.

alongside and back of El Arish will be marked by the presence of a wide, heavily trafficked coastal highway serving industry, tourists, and migrants and a circular road that rings a hilly patch. Arab communities started there, whether urban villages adjacent to the harbor city or farm factory villages in the field, are expected to be relatively geometric clusters of houses. In Figure 10 we see a growth away from both sides of the road, allowing one side to be brought to a state suitable for settlement a year or two prior to the other side. This strategy would allow a few hundred to a few thousand families to be served with almost equal efficiency.

It seems to be easier to design for the relatively homogeneous Palestinian Arabs than for the diverse Indians. We discovered that each community in the Little Rann would very likely require a notably different strategy, despite the lack of distinguishing characteristics on the terrain itself, so the complaint of travelers that "all Grain Belt communities look alike" should not fit India -- twins or triplets, yes, but not a full series fitted to a single template as is logical for the Sinai.

We must conclude that the geographical and geometrical exercises in the allocation of spaces have revealed that no excessive bottlenecks affecting comfort, social organization, capital investment, or human resource development have been encountered. To an important extent that is so because we chose from the outset to investigate the settlement of land with a minimum of claims upon it. Although a number of interesting points were identified which planners will need to resolve very early in the planning process, the program of developing the complex as proposed by the Oak Ridge engineers still appeared eminently feasible. What is

perhaps more important is that the project appears to offer from the outset a wide range of alternatives to the new settlers, no one of them being very much more expensive than the others. Therefore it is feasible for the people to conduct most of their planning and development independent of the Corporation.

Chapter Eight

HOW IS THE OUTLOOK CHANGED?

Does this brief social, economic, cultural, and political analysis of the feasibility of nuplexes on geographical sites cause us to reconsider any aspect of the technological and economic evaluation? Perhaps the critical question is whether the cost-saving justifications for localizing the units into an integrated cluster remain as strong as they were before.

What was found was that the full implications of triple-crop agriculture on empty land have not yet been thought through systematically. Our attempts have revealed the following novel points:

1. A sizable domestic fishery is indicated for several of the sites studied. Any contractual connection between the farm-factory and a metropolis for the delivery of staple foodstuffs should reduce the transport costs of fish to prime markets to a minimum, almost eliminating losses due to spoilage. What is the yield of fertilizer converted into algae and thence into fish food and fish? What is the contribution of agricultural wastes? of sewage?

2. Similarly, a sizable dairy can be developed on the periphery of the fully irrigated area. What agricultural wastes can be utilized? What is the economic value of pasture irrigation and fodder production? Given the hot climate, in what form should the milk be shipped?

3. The short, husky straw from the high yield Mexican wheat must be assayed from a paper-making point of view. Is the cost of water a problem for the manufacturing stage? Possibly it would also pay to grow

pulpwood with marginal water. The yield of dry matter is exceedingly high when trees are adequately fertilized, and the cost of harvest on slightly sloping land is very low. The pulpwood supply could be chosen to balance out the shorter fiber length of the straw. Several hundred thousand tons of straw per year would be available at quite low cost due to the mechanized harvest.

4. An integrated transport and storage system needs to be designed to cope with the high yields. How much grain and oilseed should be processed on site? This milling operation is often linked with chicken raising in batteries, but the latter activity can be carried out economically at some distance.

5. The production of high-valued vegetable and fruit crops requires a supply of containers, with traditional basket making materials, wooden lugs, etc., seldom available in coastal deserts. The demand for vinyl film and polyurethane foam could easily reach 100,000,000 lbs., per year for export of produce and local housing needs alone. These are large plants by underdeveloped area standards, and very respectable for Western Europe.

6. Tourism pressure will be strong, regardless of location. Some of it will be generated by the immigration directly, when potential smallholders or technicians visit to "look over the situation," more will come as a direct consequence of the promotion of the sale of securites, and others will appear merely because the airline and sea transport connections are good. With a base like this it is relatively easy to install a swimming pool of distilled water, gardens, and other man-made attractions to build up a sizable business for the hotels that will have to be put there in any case. This potential was considered in greatest detail for the Sinai case.

For each of these technologies it is evident that "building block" evaluations need to be prepared, parallel to those for the separate crops and industries in the first Oak Ridge study. However, preliminary assessments suggest that at least some of the by-products should find a use on a competitive basis. They would add value to the complex, operated as an integrated unit. Since we have discovered no undesirable by-products not previously accounted for (e. g., radioactive waste), the net effect is to find further justification for an agro-industrial complex.

These findings balance out to a great extent the recognition that the large aluminum plant embodied in the complex as a "power sink" would be difficult to justify for most sites, due to inadequate market. The presence of bauxite in Gujerat would help tie aluminum reduction to a Gujerat complex, but the Sinai prospects are very poor. Fortunately, the rate of growth of power consumption within the radius of economical power transmission could be very high if peace prevails, so that regional demand could take up the electricity that would be produced in the Sinai complex.

The most serious readjustment in the scale and complexity of the effort came about from the more comprehensive population estimates. Earlier underestimates can be ascribed to the attention paid to <u>average</u> labor requirements of the basic agricultural crops and not enough to the peaks or to the ancillary activities suggested by specific sites. In part it stems from rather callous attitudes toward seasonal labor in irrigated agriculture in the United States and elsewhere, so that the statistics regarding non-residents are very poor. The more accurate estimate is 2 1/2 to 4 times larger (i.e., 250,000 - 400,000 people) than the early estimate and still does not include any of the effects of opportunities unrelated to the

agro-industrial complex, except that they are created as a consequence of superior organization, of the accumulation of talent, or of location within a national economy. Thus, if the project is at all successful, the unspecified potentials are most likely to raise the population of a 600 - 800 square mile project with 500 square miles of intensively irrigated land somewhat higher than the estimates arrived at here. Most, if not all, of the additional population would accumulate in the harbor city, but for some sites these third-order developmental effects may concentrate in a nearby city just outside the boundary of the project. This forecast suggests that regional planning will be a much more complicated task than originally envisaged. People's requirements are much more demanding of attention -- even when they are poor and expect little -- than those of process equipment.

How Shall They Be Launched?

The project proposed for the Sinai must cope with the most intense political forces. Virtually any public move by any party in the Near East will be interpreted as a threat to one's own nation and to Arab unity in many, but not all, capitals and in centers of political thinking, such as universities. Much the same kinds of suspicions are likely to be voiced by extremist elements in Israel. Therefore, resistance to a proposal, regardless of the sponsors or the language they employ, is expected to be strong and vitriolic. Statements supporting the proposal will seem rather restrained in comparison. Can this controversy be turned into an asset that aids in the initiation of the project? Perhaps to some extent it can.

The recent decision to construct a pipeline across Israel that

short-circuits the Suez Canal and accommodates tankers at the ends much larger than the Canal can carry removes Israel from the picture with respect to a nuclear-powered complex. Israelis will then be able to get fossil fuel at wholesale or by-product prices at both ends of the pipeline and use it for medium-size desalination plants that produce water where it has the highest value, i.e., in the neighborhood of the termini. The equivalent pipeline for Egypt is planned to lead from the southern end of the Suez Canal to a point near Alexandria, so it will not affect the Sinai desert. The oilports themselves should become small boomtowns willing to pay an excellent price for water, while surrounding orchards and vegetable farms producing both for local consumption and export would be able to afford at least a good price for irrigation water.

The issue then becomes one of finding the most suitable location for the project that would maximize Arab welfare over the long run simultaneously fitting into peace-bringing efforts of the United Nations and neutral nations. This means the initiative must come from those countries which have taken on the aid-giving role in the Near East -- the USSR, Kuwait, and Libya, in that order. The USSR may not be able to assemble the full range of technologies described in this complex, particularly those having to do with food production in the sub-tropics, therefore the list of sponsors would have to be enlarged by those neutral nations whose interest is in selling equipment or services.

The proposal can then be posed in such a way that it will be seen that rejection would lead to the deprivation of needy Arabs. Some of these would be residents of Cairo, Alexandria, and Amman in the late 1970's and the 1980's when food is expected to be scarce due to population growth. Others would be the Palestinian Arabs themselves, who are deprived of oppor-

tunity more than anything else. Although the maneuverers in the United Nations and elsewhere before the proposal is announced must be alert to the nuances of contemporary politics, the design of the project itself must be based upon hard economic and technological principles applied to long term investment. The American role might be that of finding sources of credit for equipment purchased in America and making available technological information and technological experts upon request. Scientific knowledge is the property of the whole world, and food technology information should at least be purchasable by anyone in the world, regardless of their politics, but most of it is also free. An interesting point emerged in the course of surveying labor requirements in the Sinai. It is quite possible that the project would run out of Arabs from the Gaza Strip and Sinai willing to move (it needs well over half of the total population in 1980) so all the water produced by a 1000 MW facility might not be used efficiently. One solution would be that of pumping water toward the midpoint in the Israeli pipeline and selling the water to existing and new settlements in the Negev Desert. A number of Israeli proposals using desalinated water for the settlement of the Negev have been prepared but have now been abandoned because the return on the investment was too low. Very few new water sources remain to be developed in Israel after 1975, so the nation would be forced into a program of more efficient utilization or purchase. Straightforward sale appears to be the highest value to which the water could be put. Such settlements might easily be started by buying sufficient electric power to set up small "reverse osmosis" water purification plants. A project that saves capital investment in one form or another for all neighbors is somewhat more likely to stay in business

throughout the political crises everyone expects, but the risk nevertheless remains high.

The launching process in India is not simple either, due to the jealousy that exists between the States in the Indian Union. State politicians have not been adverse to destroying millions of dollars worth of the property of all-India public corporations so as to coerce the Union government into assigning it a steel mill in the new Plan, or to hounding incorruptible civil servants out of the State. This project requires close cooperation on the part of both the States and the Union on subject matter that has already been a battleground, so the utmost in technological diplomacy will be required. One of the hottest of these issues that would have to be faced at the start is shared to a large degree by a Project in the Sinai but has not been broached in this study -- land tenure law.

Legal Prerequisites

One of the great advantages of starting with empty land is that all the existing claims can be bought up or exchanged so as to start over again with some new and more appropriate subdivision of the parcels, ownership and responsibility. Land law must be a basic part of the charter. Land tenure has been emphasized as one of the principal incentives for self-improvement and cooperation. Different degrees of land control are envisaged for (1) peripheral grazing lands and drainage basins, (2) corporate lands farmed intensively, (3) smallholder's land farmed under contract, (4) smallholder's farms linked with a producer's cooperative, (5) subsistence plots, (6) household plots, (7) community land in (a) peripheral, stock-raising villages, (b) farm-factory villages, (c) urban villages, and (d) the harbor city. Sometimes an enclave may be formed around an existing city, as with

El Arish and Kandla. Entrepreneurs of privately owned enterprises, such as factories or tourist hotels, will wish to obtain control over land for at least the maximum life of the investment placed upon it.

The greatest menace is that of speculation, which is liable to withdraw land from use due to an unrealistic value being placed upon it. Fragmentation into uneconomically small units would not become serious in the first generation but it is so common throughout India that a strong effort should be made to prevent a repetition. The right to fresh water must be attached to specific tracts of land, and since the value of the land is primarily attributable to access to both water and people, it depends also upon the price of water and the transport tariffs. One proposal worth investigating is that of guaranteeing water equivalent to the amount required for standard double-cropping and then auctioning off the remainder. If no bid higher than the standard contract price is received, as might well occur when the area has had a good rain, the production from the desalination unit would go into a reservoir. Otherwise the marginal water would go to the efficient producers.

One of the best means of producing an incentive for moving in and settling would be modifications of the "homestead" acts that various countries have devised. A man would receive title upon demonstrating that a "home" had been constructed on the premises, even if it was only minimum shelter. Similarly, a subsistence plot could be obtained by the head of a family when he was able to show that it was completely under cultivation. Such parcels would then be salable as a unit but the price is not likely to rise too steeply if new families also have the option of homesteading. Thus windfall profits from real estate should remain free from scandal.

If village and city commercial land is held for both lease and ownership, with entrepreneur owners possessing no more than half of any land classification category at the time of initial settlement, the chances of destructive "holdouts" should be very small. Leases can be granted on a proportion-of-receipts basis in urban areas. The land classification category must be spelled out either in zoning regulations or at least in a land use plan.

Very likely the same charter would have to specify job rights and responsibilities, stockholder categories, and the limits upon the participation of outsiders, because the local law is hardly likely to be explicit enough. However, human relationships must remain more negotiable, so that they can be re-evaluated continuously as education, bonds to the community, and private investment accumulate. Allowing for less leeway for human rights and duties should help prevent the worst threat of all for a capital-intensive facility -- polarization of sentiments in the Corporation - community conflicts that lead to strikes and shutdowns.

Conclusions

1. Investigations of the specific implications of locales in India and the Sinai region uncovered no significant difficulties likely to render the nuplex infeasible. Physical, financial, economic, organizational, social, cultural, and political constraints were analyzed. The chief criticism -- lack of market for very large electrometallurgical production -- was met by the uncovering of "power sinks" of suitable magnitude in the prospective regional grid.

2. Six new "building blocks" for the integration of the complex are proposed for immediate study which are based upon by-products and co-products associated with the earlier proposal -- dairy, chickens, fish, paper, plastics, and tourism. The methods for assembling them, together with the estimation of marginal costs, cannot be as rigorous as for the industrial process analysis in the Oak Ridge summary report (July, 1968) because the commodities and services are largely dependent upon the levels of operation and markets for the core group. They could add as much as 30% to the total local output.

3. The transportation-storage-land use interrelationships need careful rationalization before the urban and regional planning can be undertaken.

4. Thoroughgoing legal studies of the charter for the managing corporation, the appropriate legal provisions for land tenure, and employment policy have a high priority at this stage. A creative approach to the law is critical.