PREFACE

This volume reports on two efforts each of which relates to development of the region on the western coast of the Arabian (Persian) Gulf. Parts I, II, and III resulted from efforts initiated as a multidisciplinary design subject "Special Studies in Systems Engineering". This particular project, which explored the possibility of establishing an agro-industrial complex based upon natural gas, was carried on at the Massachusetts Institute of Technology during the Spring term of 1971. Part IV grew out of an effort by Professor Ali Kettani and several associates at the College of Petroleum and Minerals (C. P. M.) in Dhahran, Saudi Arabia during 1970 and 1971. This latter study concerns the possibility of constructing a dam across the mouth of the Gulf of Bahrain and utilizing the difference in water level resulting from evaporation behind the dam to generate electric power. In addition to this heliohydroelectric power generation it is proposed that minerals be recovered from the concentrated brine in the Gulf.

Professor Kettani's work came to my attention during a visit to C. P. M. in October of 1970 as did the idea to investigate ways to utilize the gas currently being flared from oil wells in the area. The results of the M. I. T. Spring Term study were presented orally in May of 1971 to an audience representing a number of groups interested in various aspects of the project. We maintained contact with Professor Kettani during the Spring Term and he visited M. I. T. in May to listen to the final presentation of our project. At that time he indicated an interest in a joint publication of the results of the M. I. T. and the C. P. M. studies.

Our discussions led to the agreement that Professor Kettani would spend several weeks at M. I. T. during the Summer of 1971 for the purpose of preparing a description of the heliohydroelectric project. A few of the participants in the M. I. T. study had also agreed to come together during the Summer to prepare a final report on that study. It was agreed that since each of these studies related to the same general area their publication in a single volume would be desirable.

The original charge given to the students in the Special Studies subject merely

stated that they should explore the feasibility of utilizing the natural gas which is a by-product of the oil production in Saudi Arabia as the basis for agricultural and industrial development. Currently a large fraction of this gas is being burned off merely to dispose of it. The students were to investigate the possibility of desalinating sea water in order to use it for irrigation of crops, of producing magnesium from sea water, and of establishing other activities which, because they were energy intensive or because they could utilize the gas as a feed-stock offered a potential for economic development of the region.

Ten graduate students and one undergraduate representing five different departments in the school of Engineering took part in the spring term project. The students and their departmental affiliations are indicated in Table P.1.

The first task the students faced was to gain some familiarity with the geography and present state of industrial development of Saudi Arabia and with proposals made by other groups for the development of agro-industrial complexes. This background was provided through lectures given by the participating faculty (see Table P.2), by invited speakers and through individual reading. In addition, we were fortunate to have two Saudi students participating in the project.

Table P.1

Students Participating in Special Studies in Systems Engineering
Spring Term 1971

Name	Department Affiliation
Al-Sowayel, Saud I.	Mechanical Engineering
Andresen, Jon A.	Mechanical Engineering
Bakr, Mohammed A.	Civil Engineering
Blatchley, William C.	Chemical Engineering
Cox, Virgil G.	Electrical Engineering
Espanola, Wilfrido R.	Mechanical Engineering
Giannotti, Julio G.	Ocean Engineering
Kettaneh, Tarek M.	Civil Engineering
Mathews, Robert S.	Mechanical Engineering
Mullen, Duane P.	Mechanical Engineering
Stellinger, Thomas S.	Ocean Engineering

The students then assumed responsibility for investigating in greater depth the potential for growing specific crops or producing specific products utilizing gas. It soon became apparent that a methodology was needed for appraising the relative advantage of alternative possibilities. The group decided that the initial evaluation would be made based on economic considerations alone. Furthermore, economic feasibility was based on the value of the project to the Saudi economy as a whole. No attempt was made at this stage to determine the interest of specific industrial organizations in actually engaging in any of the projects. Nor was any attempt made to appraise the social implications which implementation of any of these projects would have for the region other than to indicate the number

Table P.2

Participating Faculty

Faculty Member	Department
John W. Devanney, III	Ocean Engineering
Joseph Lassiter	Ocean Engineering
William W. Seifert	Civil and Electrical Engineering
Robert E. Stickney	Mechanical Engineering

of jobs which would be created directly by the projects. While the group recognized the importance of these considerations, they felt that the magnitude of the task before them was too great and the time available too short to permit them to tackle these broader problems and still be able to develop the technical and economic aspects of the problem in sufficient detail to determine the general feasibility of the various possibilities. We hope that this report will excite sufficient interest that others will extend the work and include these and other considerations which we were unable to investigate. Although these studies are directed specifically to the Arabian Gulf area we also hope that the methodology as well as some of the specific considerations employed herein may be of interest to others concerned with the possibility for comparable developments in other areas.

Special credit for correlating, correcting, expanding and editing the material generated during the Spring Term goes to Mohammed Bakr, who was one of the student participants. He labored diligently during the summer of 1971 and also over the Christmas Holidays. Without his efforts publication of this report would have been very significantly delayed. During the summer Messrs. Blatchley, Mathews and Stellinger also amplified specific sections of the report while Joseph Lassiter provided technical assistance. I served as senior editor. We all owe special thanks to Mrs. Louis Fischer who typed reams of draft material, to the several typists who contributed to preparation of the final copy and to Mr. Arthur Giordani of the Electronic Systems Laboratory for his great care in preparing the illustrations.

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William W. Seifert

Cambridge, Mass.
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