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AID/NASA PILOT PROJECT IN TECHNOLOGY TRANSFER TO A DEVELOPING NATION — KOREA —

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FOREWORD

This is Report No. IITRI-V6110-16 (Semiannual Report) on IITRI Project V6110 entitled "AID/NASA Pilot Project in Technology Transfer to a Developing Nation — Korea." The work reported herein was conducted for the National Aeronautics and Space Administration under Contract No. NASW-2083 during the period December 23, 1970 to June 22, 1971.

Serge Uccetta was the project leader, and Gerald B. Bay provided technical and administrative supervision.

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I. INTRODUCTION

Industrialization has been the prime factor in stimulating the impressive economic growth of Korea which over the past decade has averaged nearly 10 percent per year. Ten years ago, industrial products made up about only one fifth of the 43 million dollars in Korean exports. In 1970, however, exports totaled over 1 billion dollars — four-fifths of which were manufactured goods. Today's Korean industry is generally labor intensive and in many cases based on foreign technology, components and process machinery. Foreign capital outlay, in terms of loans, investments, technical assistance, and joint ventures has played a key role in helping Korea both to achieve its rapid growth rate and to progress from an agricultural economy to their present state of industrialization.

This program represents an experimental approach at providing a developing nation with an additional technological resource to aid and speed its industrial advancement. A pilot study is being conducted to determine the feasibility and to establish refined techniques for the transfer of aerospace-related technology to developing nations. The IIT Research Institute under contract to the National Aeronautics and Space Administration is carrying out this effort in a twenty-four month program with the Republic of Korea (ROK), as the selected nation. The Agency for International Development has provided funds to NASA in support of this program. The program consists of 5 discreet phases: namely,

Phase I - Technical Mission to Korea and Program Scheduling

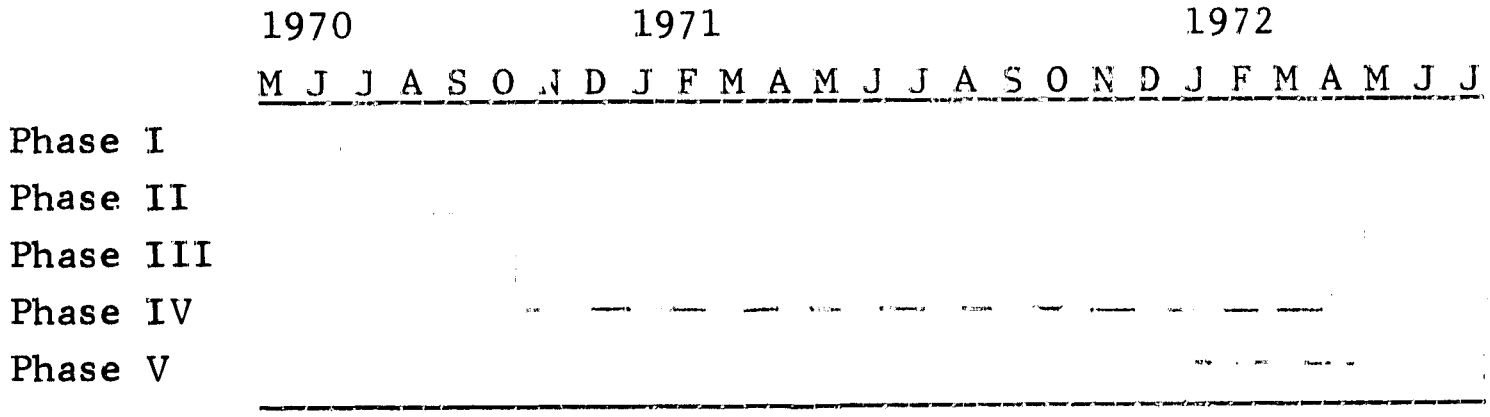
Phase II - Training of Korean Specialists; Organization of Total Project and Communications

Phase III - Technology Identification, Follow-up, and Transfer

Phase IV - Evaluation and Report

Phase V - Development of Plan for Possible Institutionalized Continuation

The scheduling of these phases within the overall program is shown in the figure below.



The program has as its goals:

1. Train Korean personnel in transfer methods and technology resources
2. Evolve and implement modified transfer techniques applicable to Korea and the Korea Institute of Science and Technology (KIST).
3. Achieve specific transfers of technology in areas of potential economic advantage.
4. Develop a revised training and implementation plan based on successes and failures.
5. Evaluate the techniques in terms of applicability to developing nations in general.

During the first six-month period of this program, Phases I and II were successfully completed and met all of their e established objectives. The Phase I visit obtained valuable information about Korea and the resources available for technology transfer - all of which indicated that the pilot program had a good chance of succeeding. The Korean economy is growing rapidly and the government plans and controls indicate strong efforts to support continuing growth. Phase II, the training

of Korean Specialists, succeeded in establishing a base of expertise in technology transfer at KIST and produced 51 technical problems for processing. Comprehensive literature searches for these problems were performed and, after initial evaluation by the KIST Team, 13 problems were identified where potentially relevant technology was located.

Further appraisals of the literature searches and detailed evaluative and analytical studies of the relevant technology findings, involving technoeconomic surveys, experimental work, and feasibility studies, were the initial objectives of Phase III. These efforts were intended to lead to selection of a number of problems where the technology findings were shown to be applicable and transferable to Korean industry. The initial steps in the transfer strategies involved detailed follow-up visits by KIST specialists to learn all aspects of the technology under consideration. Subsequently, KIST would perform applications and developmental engineering, if required, in order to promote adoption and commercialization of the technology by a Korean company.

This report describes the activities and accomplishments of Phase III through June 1971.

II. OVERVIEW

Phase III aims to accomplish a program of international technology transfer using the groundwork established in the preceeding phases of the project. The specific transfer mechanism involves using KIST and its staff as the "gatekeeper" between foreign technology sources and Korean industry. KIST performs as an active intermediary to channel appropriate technology specifically adapted to Korean needs into their economy. A simplified model of the overall technology introduction process for Korea is shown in Figure 1. The four generalized ways in which Korean industry can obtain new technologies are:

First: A Korean firm may find the expertise and know-how of a desired technology within itself, or obtain it from another Korean company.

Second: Some export bonded foreign-based firms have found it worthwhile to aid Korean companies in implementing a new technology when this would enable the foreign firms to more economically "source" the domestic market for necessary parts and supplies.

Third: Korean business can obtain the technology directly from a foreign source (usually a company or corporation), leading to outright purchase, licensing, technical assistance agreements, or joint ventures.

Fourth: The technology can be obtained from outside sources through the action of intermediaries such as Korean government agencies, Korean business associations, or KIST.

Presently, the most widely used methods are the third and fourth modes. The latter is the most effective means since most Korean industries do not yet have the expertise necessary to pinpoint exact technology requirements or make comprehensive evaluations of a specific technology under study.

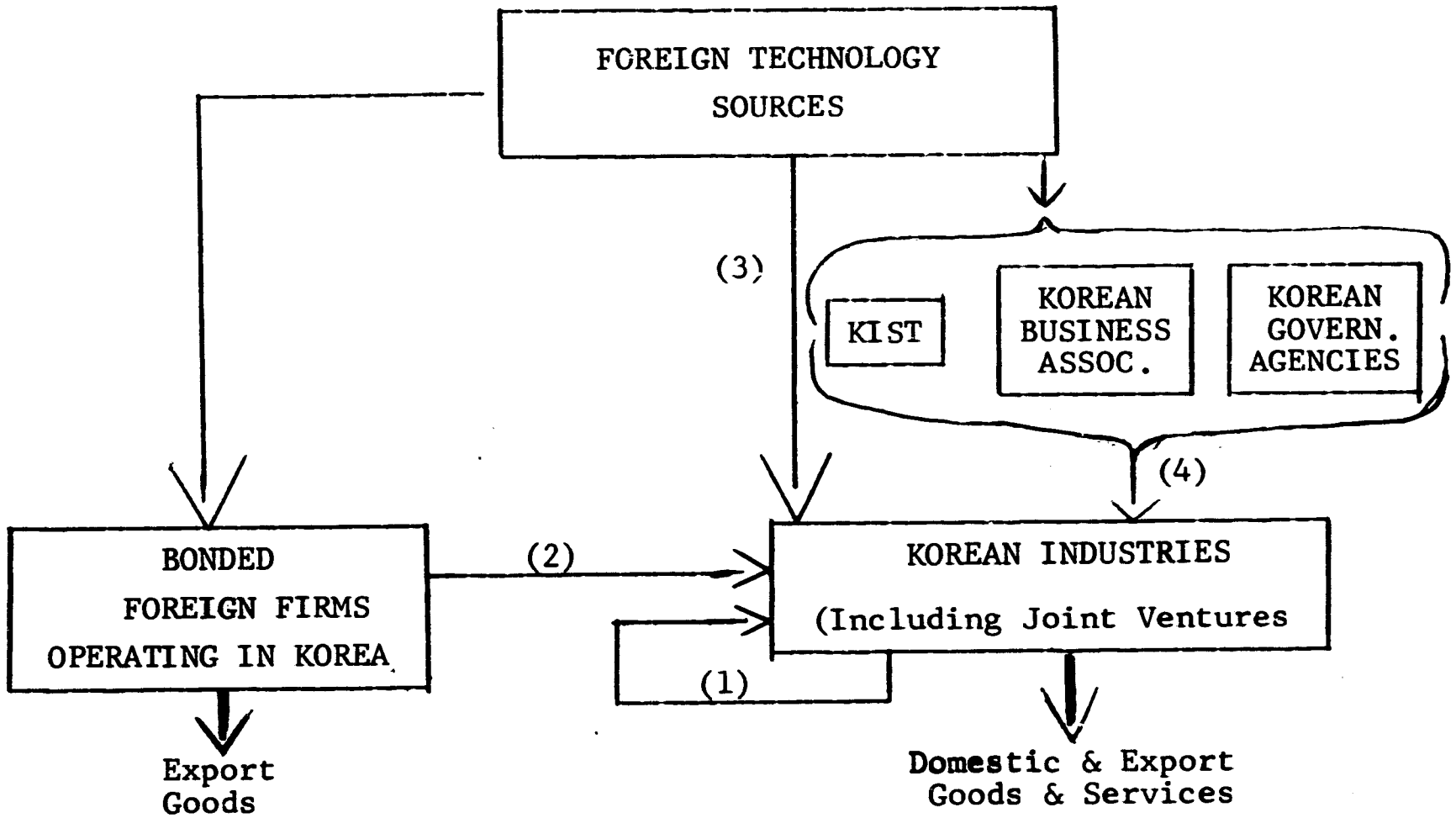

FOREIGN TECHNOLOGY SOURCES
(3)
KIST
KOREAN BUSINESS ASSOC.
KOREAN GOVERN. AGENCIES
(4)
BONDED FOREIGN FIRMS OPERATING IN KOREA
(2)
KOREAN INDUSTRIES (Including Joint Ventures
(1)
Export Goods
Domestic & Export Goods & Services

FIGURE 1

The methodology of this project is designed to make use of the intermediary approach with KIST as the participant. Figure 2 shows a generalized breakdown of the process of technology transfer to Korean industry through KIST. Basically, KIST obtains technical problem definitions (either externally or internally) and brings to bear the available expertise and technology sources to produce an effective solution which can then be commercialized by Korean industry. The successful completion of this process for the specific problems identified and selected by the participating KIST staff members is essentially the goal of Phase III and the overall program.

KIST itself is a relatively young organization established by government support to interact directly with Korean industry and provide the technical research and development necessary to bring about technological advancement and diversification. Over the past few years, KIST has been recruiting skilled, highly competent scientists to develop their staff. The generally conservative Korean industrial scene is now beginning to accept KIST's role as Korea's "technological change agent." Over the past few years, KIST has been establishing itself as a valuable technological resource in Korea through slow but steady progress in developing industry relations, successful performance of projects for both government and industry involving important problems of immediate concern, and by building up a broad technological base of experience in all scientific disciplines.

K.I.S.T.

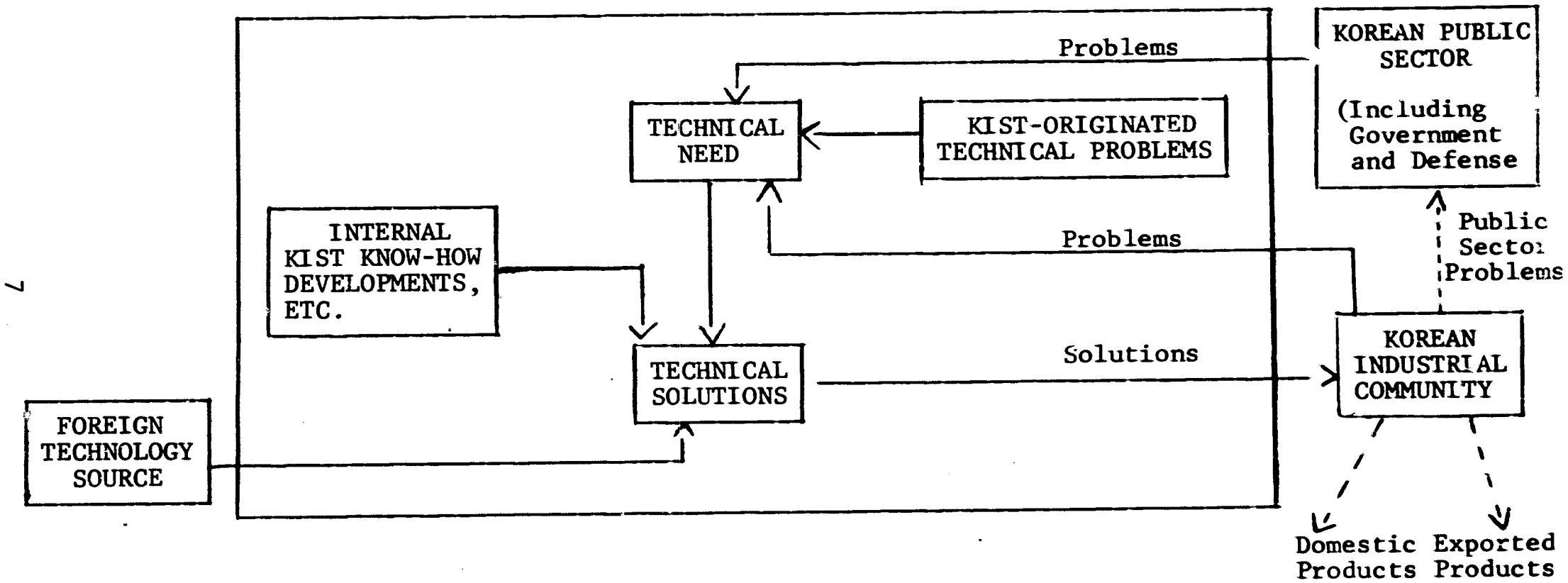


FIGURE 2

III. DISCUSSION

On returning to Korea at the end of Phase II, the KIST Project Team reviewed the literature search results, conducted evaluations and established priorities for the pursuit of each problem. An early decision was made to focus the follow-up effort on those problems dealing with electronics technology. This decision was made for the following reasons:

- Concentration of resources on a single industry would insure a technology transfer which could then be used to demonstrate the concept to other industries.
- Aerospace technology applicable to the electronics problems was found during the Phase II activities.
- The Korean electronics industry is reasonably well advanced.

This decision and the supporting analyses led to the selection of four problems for heavy follow-up in the U.S. by KIST personnel and the selection of an additional four problems for longer range follow-up and transfer. The problems selected in each category are listed in Table I. Four KIST researchers spent a total of four man months in the U.S. working with IITRI personnel to follow-up on these problems. Three of the four were new to the technology transfer program. They were selected because their backgrounds fit the problems being pursued and also to expose other Koreans to the project concept. Forty-four organizations were contacted to discuss all aspects of the technology under consideration. The details of the visits are included as Appendix I. Before each visit, IITRI conducted pre-visit studies, prepared additional data packages relevant to the topic being pursued, and arranged for on site visits with a variety of aerospace contractors, NASA Field Centers, and industrial companies. A synopsis of the key events and the status of each active problem is presented in the following paragraphs.

TABLE I: PROBLEMS SELECTED FOR FOLLOW-UP

Selected for In-Depth Follow-Up

- Miniature Transceivers
- High Sensitivity Transceivers
- Solid Tantalum Electrolytic Capacitors
- Technology of Inductorless Circuits

Selected for Limited Follow-Up and Monitoring

- Retort Pouch as a Flexible Can
- Survival Rations
- Carbon Monoxide Elimination
- Explosive Metalforming

Selected for Heavy Follow-Up

Miniature Transceivers

This problem consists of two sub-problems:

1. The development of an improved citizens band transceiver.
2. The development of military transceivers.

KIST is presently sponsored by Han Jin Electronics to develop a commercial prototype citizens band transceiver. Drs. Chung and Sohn followed up on this problem in the U.S. and visited three NASA Field Centers, and fifteen aerospace contractors and industrial firms. Final technology selection has not been made but it appears that it will be a combination of commercial and NASA technology. The aerospace technology applicable to this effort includes integrated antennas developed by Jet Propulsion Laboratories, integrated circuit technology developed by Westinghouse under contract to NASA, and circuitry from the Apollo suit communications set developed by RCA. A prototype is tentatively scheduled for completion by December 1971.

The development of improved military transceivers is sponsored by the Korean Ministry of Science and Technology under a two-phase program. The first phase involves converting old tube-type transceivers to solid state circuitry. Aerospace technology similar to that described for the citizens band transceiver may be selected for the first prototype. Prototype completion is scheduled for June 1972. A second prototype will be an original design and in addition to the technology described above, phase-lock-loop technology may be used. A combination of aerospace technology developed at Goddard, JPL, and the Air Force and commercial technology may be used in developing the phase-lock-loop. In addition, a new technique for designing high frequency electronic circuits without the use of inductors, developed by Goddard Space Flight Center, is being considered.

High Sensitivity Transceivers

Rather than a specific problem needing a solution, this area represents the Koreans' need to develop capabilities in a new technology and exploit its applications along a broad front. Based on the improved capabilities of phase-lock-loop technology to increase receiver sensitivity and stability, Drs. Chung and Sohn foresee applications in TV repeater networks, military transceivers, and commercial transceivers. They have an immediate interest in the applications of this technology to TV repeater network design. A decision on the use of this technology is expected by December 1971.

Solid Tantalum Electrolytic Capacitors

The Koreans wish to establish a complete manufacturing capability for these capacitors. Aerospace technology has played a key role in developing U.S. capabilities in this area. Aerospace technology will be particularly useful to the Koreans in the areas of quality control and reliability engineering. Dr. Yoon visited seven aerospace contractors and industrial firms while visiting the U.S. A decision to develop an initial pilot facility is expected by December 1971.

Technology of Inductorless Circuits

This area is again indicative of a need to exploit a basic technology to a number of application areas. Dr. Park visited Goddard Space Flight Center, the developer of the technology, and Gaertner Research, Inc., a Goddard contractor. In addition to commercial and military transceiver applications, Dr. Park foresees use of the technique in color TV circuits, electronic calculators, and various portable, low power-drain devices. IITRI is presently awaiting word from Dr. Park concerning additional application engineering projects.

Selected For Limited Follow-Up and Monitoring

Retort Pouch as a Flexible Can

Based on a search of the Aerospace Data Bank, Dr. Kwon identified a new packaging material which would be useful to the Korean food industry. Rights to this technology belong to Continental Can Corporation, and KIST is currently conducting preliminary inquiries about obtaining a license.

Survival Rations

A search of the Aerospace Data Bank revealed a substantial amount of information concerning new food developments and survival rations. Dr. Kwon used this information to assist him in structuring a research program at KIST. The project is presently being sponsored by the Korean Army. The project team will supply additional information in support of this activity as needed.

Carbon Monoxide Elimination

Korea needs improved technology for carbon monoxide elimination in gas masks. While a search of the Aerospace Data Bank did not reveal any immediately applicable technology, it was identified that the Army Natick Labs had sponsored a substantial amount of research in this area. Contact with the laboratory will be maintained and any new developments will be communicated to the Koreans.

Explosive Metalforming

The Koreans wish to establish a pilot facility to demonstrate the effectiveness of explosive metalforming techniques. During Phase II, Dr. Yoon inspected a major facility at the Denver Research Institute. After his return, a cost estimate was prepared indicating the level of resources needed to establish a facility in Korea. Dr. Yoon coordinated with

Korean industry to determine the characteristics of the metals and parts that might be formed. Based on these inputs he has concluded that the facility is not cost effective at the present time but could become so within the next few years. These factors will be again reviewed towards the end of the present program.

Interim Evaluation Meeting

A key event towards the end of the period was an interim evaluation meeting. In addition to the IITRI project team, NASA, and AID, three Koreans traveled to the U.S. to discuss program results and their view of the project. They were:

1. Dr. Hyung S. Choi, President of the Korea Institute of Science and Technology
2. Mr. Hyun K. Kim, Ministry of Science and Technology, Republic of Korea.
3. Dr. Young Ku Yoon, KIST project leader.

Shortly after his arrival in the U.S., Dr. Choi learned of his appointment, by President Chung He Park, to be the Minister of Science and Technology. Though under pressure to return to Korea immediately, Dr. Choi felt it important to remain in the U.S. and participate in the evaluation meetings. IITRI believes this is indicative of the Korean commitment to the program and of its visibility.

In addition to reporting on the status and progress of the transfer activities in Korea, Dr. Choi made a number of salient points and observations. He emphasized the fragmented nature of the infrastructure of developing nations and the corresponding need to bring in major new commercial manufacturing capabilities. Thus, technology transfers from this program are likely to be a mixture of both aerospace technology and commercial U.S. practice. He stated that an added benefit of this program was that the affiliation with AID and NASA

assisted KIST in their job of promoting the concept of R&D to the generally conservative Korean industrial scene.

Dr. Choi expressed some concern about the time scale of the technology transfer project. He emphasized that the time required to move from prototype development into manufacturing was considerably longer in Korea than in a developed nation due to the need to train Koreans in a variety of new skills. An example cited by Dr. Choi, was the manufacture of TV remote control units which took KIST three years to implement.

An early indication of institutionalization of the technology transfer program was cited by Dr. Choi. Dr. Hyun, one of the original team participants, has been appointed Head of the Information Sciences Group at KIST. He has been assigned the task of educating others at KIST, defining new problems, preparation of problem statements for transmittal to IITRI, and evaluation of search results. Approximately twenty new problems will be identified and submitted to IITRI for processing.

In summary, Dr. Choi was quite pleased with the results and progress of the program. He expressed confidence in the progress that his staff was making on the applications engineering programs related to the four potential transfer areas. He felt that the program was important, would continue to have high visibility within KIST, and that he would maintain an active interest in the program while performing his new duties as Minister of Science and Technology.

IV. CONCLUSIONS AND RECOMMENDATIONS

With the completion of the Phase III activities to date, the following conclusions can be made:

1. The Phase III activities and the overall program has been successful and is meeting its stated objectives.
   - -- A total of 51 problems were defined and processed, producing potentially transferable technology for 13. After further evaluation, KIST plans continued follow-up on eight problems of which 4 are progressing toward hard transfer.
   - -- Phase III has provided follow-up trips in the U.S. for 6 Korean participants with a total of about 5 man months of activity in the U.S.
   - -- Because of a fragmented infrastructure, the technology required is a mix of aerospace and commerical technology.
   - -- This program is enabling KIST to make progress in promoting the concept of R&D to the generally conservative Korean industrial scene.
2. Implementing technology transfers will take longer than originally anticipated.
   - -- Study, analysis and evaluation of the large amount of technical information obtained from the NASA data bank has been accomplished within the time frame originally specified. However, since KIST has only recently embarked on an applications engineering program, hardware development time of 6-12 months is anticipated.

- -- Since Korean industry is in its developing stages, KIST requires a substantial block of time to assist industry with developing their manufacturing capabilities and to train appropriate staff.
- -- Within the confines of KIST resources and time available for development, only a limited number of problems can be pursued.

3. Progress towards institutionalization has been made.
   - -- A decision to focus remaining resources on the area of electronics was made by KIST. Upon demonstrating success in this area, they will be able to approach other industries and will have an easier time of demonstrating the program's value.
   - -- Dr. Hyun, one of the original team participants, has been appointed the Head of the Information Sciences Group at KIST. He has been assigned the task of educating others at KIST, defining new problems, preparation of problem statements for transmittal to IITRI, and evaluation of search results.

Based on these conclusions the following recommendations are presented:

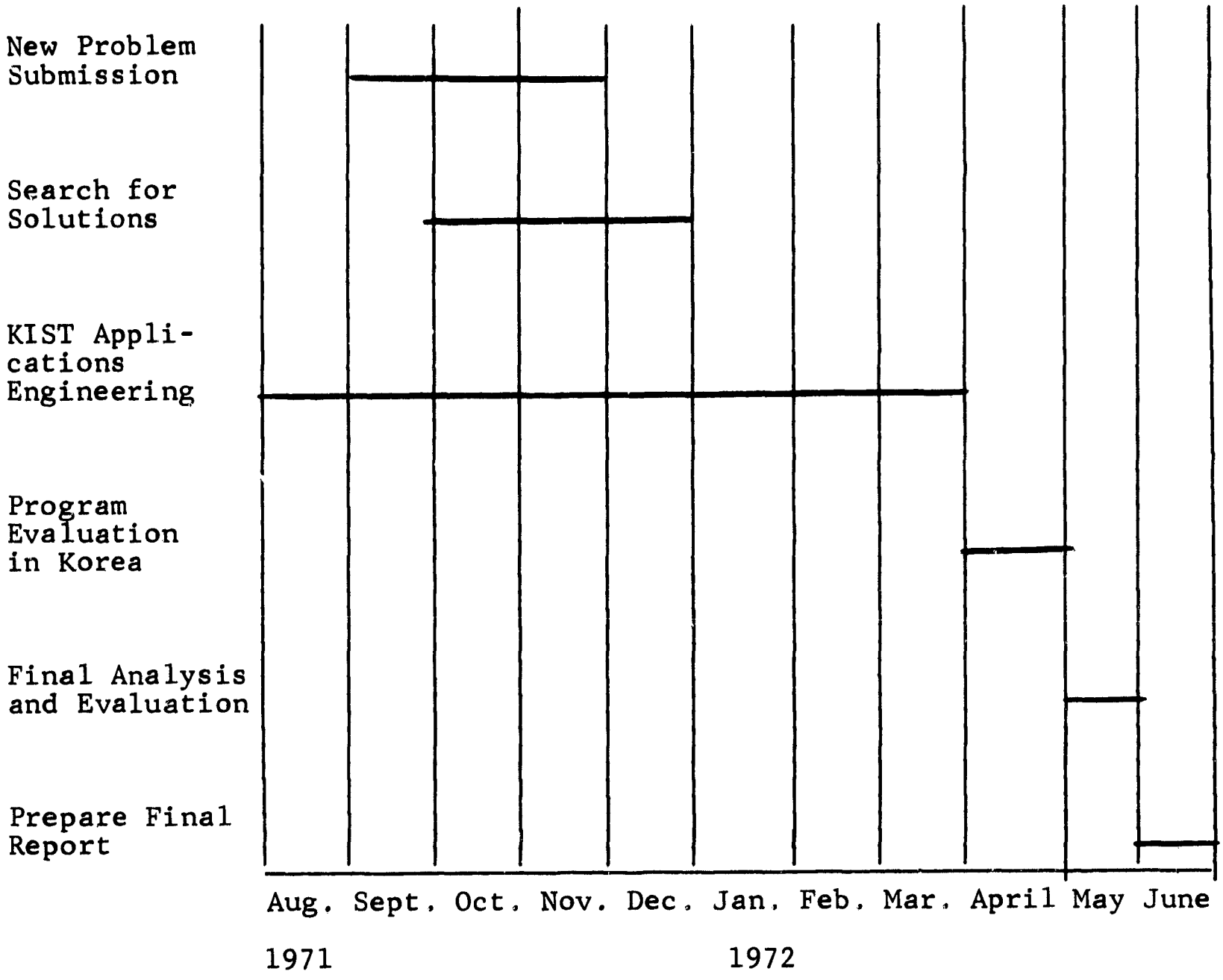
1. Technology transfer should be defined as follows: Transfer will occur when prototypes are developed at KIST as a direct result of the technology transfer efforts of this program, and a commitment is obtained from a Korean company agreeing to go into commercial production.

2. Because the KIST prototype development programs are planned for completion by June 1972, the program should be extended 6 months and a new completion date set for June 22, 1972. This extension will also allow for a more comprehensive evaluation of the program which will take place in Korea in the spring of 1972.

3. Approximately 20 additional problems should be defined in Korea, searched by IITRI, and evaluated by KIST as the basis for a continuing program. The following figure shows the revised program.

4. Consideration should be given to expanding the technology transfer process to other Korean priority areas such as housing, heavy machinery, and secondary petrochemicals.

Plan Based on Recommendations 2 and 3.



APPENDIX I: FOLLOW-UP TRIPS

FOLLOW-UP TRIPS

Three separate follow-up trips were performed in Phase III. The trips involved 4 KIST specialists working on the following problems:

Problem	KIST Principal
Miniature Transceivers	Dr. Man Young Chung(3/18-4/16)
High Sensitivity Transceivers	Dr. Sung Jai Sohn(3/18-4/28)
Solid Tantalum Electrolytic Capacitors	Dr. Young Ku Yoon(6/1-6/25)
Technology of Inductorless Circuits	Dr. Song Bai Park(6/29-7/16)

The total time spent in the U.S. on the follow-up efforts was approximately 4 man-months. All of the Koreans felt that their visits were productive and successful in that they obtained the necessary information and know-how to return to Korea and begin implementation and prototype development. IITRI planned and organized the trips to ensure maximum utilization of the time available.

The following is a complete summary of the schedule of activities for the Koreans during their follow-up visits.

Miniature Transceivers and High Sensitivity Transceivers

- combined visit by Drs. M. Chung and S. Sohn -

March 18,19 - Arrived at IITRI, introduced to project staff, discussed NASA TU Program aspects, presented goals and objectives of Korean Program, discussed background information of Phase II and initiation of Phase III, individual discussions by IITRI project staff and divisional electronic experts with Koreans to obtain an accurate picture of the problems and the solutions being sought.

March 22,23,24 - Drs. Chung and Sohn attend IEEE convention in New York.

March 25 - Dr. Chung attended IEEE conferences, Dr. Sohn and IITRI staff member visited Mr. Edward M. Ulicki, formerly of Simmonds Precision Products, now with Halobeam, Inc to discuss the design of the PRC-65 radio set. The emphasis of the discussion was on the design characteristics of the phase-locked-loop circuitry and the voltage controlled oscillator.

March 26 - Drs. Chung and Sohn and IITRI staff member visited Mr. C. L. Ruthroff at Bell Telephone Labs to discuss his work on the development of an injection-locked-oscillator FM receiver. Also, a visit was made to see Mr. Roger Devantier at RCA/ Defense Electronics Products to discuss their work on the Apollo communications system.

March 29,30,-31 April 1,2 - Koreans reviewed information obtained from IEEE conference and technical visits, studied pre-visit documentation of commercial firms producing desired products, hold discussions with IITRI project staff and divisional experts on their additional technical needs, and prepare a proposed list of companies to visit.

April 5 - Drs. Chung , Sohn, and Mr. S. Uccetta (IITRI) visited Mr. Mike Gaudiano in the Microelectronics Section at the Manned Spacecraft Center, Mr. Max Engert and Mr. Bob Hymer of the Instrumentation & Electronics Section and Mr. Lennet and Mr. Fowler of the R.F. Communications Section. Discussions were held concerning the NASA/Westinghouse CLEM block, Westinghouse CLEO block (a proprietary design of Westinghouse), various microelectronic devices designed and built at MSC, the Apollo communication system built by RCA Defense Communication Systems, and high frequency S-band transmitters developed at MSC.

April 6 - The group contacted Mr. Roger Weber at Texas Instruments, Dallas, Texas to discuss the design and development of the PRC-95 transceiver built for the U.S. Navy. Mr. Lewis Claiborne of T.I. was also interviewed regarding his work on a surface wave filter used in the PRC-95.

April 7 - The team visited the Goddard Space Flight Center, Greenbelt, Maryland and met with Mr. John Lyons and Mr. Dave Dargo of the Microcircuit Fabrication Lab, who described their work in the development of P-channel MOSFET digital IC's. Mr. Somerlock and Mr. Robinson were brought in to discuss GSFC's work in the area of phased-locked-loops. Mr. Len Kleinberg was contacted to discuss his work on circuit miniaturization through use of "inductor-less" circuits. In addition, the team met with Mr. Walt Nagel to discuss transponders used in weather balloons, and Mr. Y. Sundararajan regarding the Intelsat Satellite System currently under study to broadcast TV to India.

April 8 - The Koreans met with Mr. Steve Glassman, NASA, to discuss the current follow-up activities. Dr. Sohn and Mr. Uccetta visited with Page Communication Engineers, Inc. and spoke to Mr. Bill Cleverly in the Transmission Engineering Section regarding their long range communication projects in the Far East (Indochina) and the Middle East (Iran).

April 9 - Dr. Chung met with a Korean associate working at the Jet Propulsion Labs in Pasadena, Calif. Dr. Sohn met with representatives of the Korea Fine Instrument Co. in New York.

April 12 - The team visited the Jet Propulsion Laboratory and met with John Drane, Len Sauer, and Jim English of the Technology Utilization group. Technical discussions were held with Mr. Richard Postal who helped develop a tone modulated transmitter for remote activation of police car transceivers. Dr. Chung received detailed technical information on the system and saw a demonstration of the device.

April 13 - Dr. Sung Jai Sohn returned to JPL and met with the following individuals: Dr. Edward Posner, Mr. Frank Ott, Mr. William Herd, and Mr. P. Whitney. The topics of the discussions included a description of a past project at JPL to modify U.S. Army transceiver AN/GRC-109 from its existing tube electronics to a solid state design; multiplex communications and data transmission systems used by JPL and possible applications to commercial areas; and specifications and frequency limits of JPL developed microcircuits and IC's.

Dr. Man Y. Chung and Mr. S. Uccetta visited TRW Semiconductor in Lawndale, Calif., to see their hybrid and IC production facility, and obtain technical information on their R.F. transistors, microelectronic active filters, UHF-VHF broadband amplifiers, and other communications equipment components.

Dr. Chung and Mr. Uccetta also met with the president and sales manager of Silicon General Inc. to discuss their "quick chip" breadboard IC. The concept of their product is essentially identical to the NASA/Westinghouse CLEM block. It became apparent in these discussions that this device offers notable advantages over the CLEM block to Dr. Chung's application in terms of versatility, cost, and design requirements for the prototype work on transceivers to be performed at KIST. Dr. Chung received cost information on the "quick chip" and some samples for experimentation.

April 14 - The team met with the following individuals at Motorola Semiconductor Products, Phoenix, Arizona: Mr. Chuck Kinard, Mr. Mike Gay, Mr. Dave Burnett, and Mr. Harry Koski. The technical discussions held with these individuals covered integrated circuits for FM-IF amplifiers, micro-discreet low-power devices, voltage variable capacitance diodes for tuning applications, and phase-lock-loop circuits.

April 15 - The team met with Mr. Bill Ehlsam and Mr. Ted Hanna of National Semiconductor, Santa Clara, Calif., to get specific technical information on their integrated circuits and their applicability to Dr. Chung's transceiver development program. Drs. Chung and Sohn obtained specification sheets and applications notes along with numerous samples for study.

The team met with Mr. Jack Taguchi, Mr. Sam Sir, and Mr. John Nichols of Fairchild Semiconductor, Mountain View, Calif., to learn of their work in the design and development of frequency synthesizers, and to obtain specifications on their miniature discreet components for R.F.-low power applications.

The team met with Mr. Andy Holmes and Mr. Alan Gregory of the Signetics Corp., Sunnyvale, Calif., to obtain data sheets and discuss the various parameters of their phase-locked-loops, with regard to applications in frequency synthesizers and discriminators in transceivers.

April 16 - The group saw Mr. Wes Wickham of Hewlett-Packard, Palo Alto, Calif. to discuss the capabilities of their instrumentation to measure transistor and circuit parameters. Dr. Chung was especially interested in accessories to a recently acquired spectrum analyzer at KIST.

At this point, Dr. Man Chung departed for Korea and Dr. Sohn remained for another 9 days.

April 19,20,-21 Dr. Sohn organized, reviewed and evaluated the technical material obtained on the trips, visited a local supplier to purchase additional electronic components for experimentation at KIST, and held some technical discussions with experts both at IITRI and the Zenith Radio Corporation regarding the design and application of surface wave devices.

April 22 - Dr. Sohn and Mr. Uccetta attended a special meeting of representatives of Goddard Space Flight Center, Martin-Marietta, and the University of Wisconsin at GSFC discussing current and future work in the area of inductorless electronic circuits. Martin-Marietta has recently received a contract from the Air Force and LEAA to develop miniature police transceivers using all inductorless circuits. Some sample operational circuits were shown and data sheets on various inductorless circuits were distributed.

April 23,26,- Dr. Sohn completed a preliminary analysis of the technical information obtained on this follow-up trip and requested additional reports treating some of the topics covered in the personal visits in more detail. Based on an earlier visit with Mr. Ed Ulicki to discuss the design of the PRC-65 radio set, we learned of some additional work being carried on at the Rome Development Center, Griffith Air Force Base, Rome, New York. We visited Mr. Frank North at the center and were shown several designs of transceivers currently under development. Dr. Sohn was very interested in AN/VRC-79 being built by Bendix for the Air Force. This device is an all FM transceiver with 2880 channels incorporating micro-discreet devices and integrated circuits.

April 28 - Dr. Sohn departed for Korea.

We met with Drs. Chung and Sohn prior to their departures to determine what specific actions they would be taking at KIST relative to the findings of this trip. They stated that after returning to KIST, they would evaluate the information obtained and select the technology to use in citizens band and military transceiver projects. The technologies to be evaluated break down into the following:

1) discreet component circuitry; characterized by the design of the RCA-built Apollo E.V.A. Communication System, with low-power components for this type of design commercially available from sources such as Motorola;

2) combination discreet components and thick/thin film circuits; application of inductorless circuits devised by NASA in the receiving section of the transceiver incorporating micro-discreet components and thin film resistors and capacitors;

3) hybrid circuitry; characterized by the PRC-95 military transceivers built by Texas Instruments;

4) monolithic linear integrated circuits; involving application of devices such as breadboard IC's (NASA "CLEM" block, Westinghouse "CLEO" block, Silicon General "quick chip") or commercial IC's supplied by National Semiconductor, Fairchild, etc.

5) Circuits incorporating phase-locked-loops; as characterized by JPL hardware, PRC-65 military transceiver, with use of commercial devices supplied by Signetics, Motorola, etc.

Solid Tantalum Electrolytic Capacitors

- visit by Dr. Young Ku Yoon -

June 1-3 - Arrived at IITRI, participated in review meeting.

June 4 - Departed for East Coast.

June 7 - Visited Bell Telephone Laboratories, Murray Hill, New Jersey, and met with Mr. D.A. McLean to discuss some publications on development work for tantalum capacitors.

June 8 - Visited the Pfizer Co., Minerals and Pigments Division, Easton, Pennsylvania to obtain technical information on various products.

June 9 - Met with Mr. Neal Dolton, Mr. Roy Miller, and Mr. Mike Maggio of Kawecki-Berylco, Inc., Boyertown, Pennsylvania; discussed the processing of tantalum powder, cost, manufacturing of tantalum capacitor pellets, and suppliers of manufacturing equipment. Dr. Yoon obtained samples of Ta powder and wire for experimentation at KIST.

June 14 - Met with Mr. George Papadopoulas of Cornell-Dublier, Sanford, North Carolina; discussed manufacturing technology and equipment requirements for producing Ta capacitors; received technical information on Ta pellet production, anodizing chemicals and binder/lubricant in production.

June 15 - Visited Mr. John Eckfeldt and Mr. Bob Marlowe of the Sprague Electric Co., Sanford, Maine; discussed detailed description of the procedures involved in the manufacture of Ta capacitors, specifically the anode and cathode plates; saw production lines in operation and learned of various quality control practices.

June 16 - Met with sales representatives of the General Electric Co., Syracuse, New York.

June 18 - Visited Varo, Military Systems Division, Garland, Texas.

June 21-24 - IITRI

June 25 - Dr. Yoon returned to Korea.

Technology of Inductorless Circuits

- visit by Dr. Song Bai Park -

June 29 - Dr. Park arrived at IITRI to begin his work on the follow-up of inductorless electronic circuits. Based on previous discussions with Dr Y Yoon, Dr. Park's trip will also include a study of the technology of a simple and economical smoke detector developed by the McDonnell-Douglas Corp. in conjunction with a NASA project. If found applicable, this technology could be adopted by KIST to make a simple and economical fire alarm under sponsorship to a Korean company which would eventually produce the devices for domestic and export use. Dr. Park will investigate this technology and bring all relevant information back to KIST for detailed study.

June 30 - Dr. Park and Mr. S. Uccetta visited with Mr. Len Kleinberg of the Goddard Space Flight Center. Mr. Kleinberg briefed Dr. Park in detail on the designs and applications of inductorless circuits built at GSFC. Dr. Park studied several circuits which used no inductors and obtained schematics for experimentation at KIST. Stressed at the meeting was the fact that this technology was essentially still experimental in nature and required theoretical analysis to allow practical production applications. Nonetheless, Dr. Park did feel that these circuits did offer a high potential for circuit micro-miniaturization and reduced power drain.

July 1 - Dr. Park visited a Korean associate at the Electronics Department of Maryland State University and inspected up-to-date instrumentation equipment used to measure circuit parameters. In addition, he visited the COMSAT research and development laboratories to see their microelectronic fabrication facilities.

July 2 - Dr. Park and Mr. Uccetta visited Dr. Wolfgang Gaertner of Gaertner Research Inc., Stamford, Connecticut to discuss his work for Goddard Space Flight Center on computer aided design, construction, and performance of high-Q micropower filters for the 100 to 500 MHz range without the use of inductors.

July 6 - Dr. Park met with Mr. Gene Jones and Mr. Sam Hartin of the Martin-Marietta Co., Orlando, Florida. Martin-Marietta was the contractor to the Goddard Space Flight Center who helped to design and eventually fabricated inductorless communication circuits. Their work in this field was discussed and a very detailed tour of their micro-electronic production facility was given. Dr. Park received a great deal of information on specialized production equipment used in producing hybrid and integrated circuits.

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July 9 - Dr. Park met with Mr. Wes Wickham of Hewlett-Packard, Palo Alto, California to get detailed information on their S-Parameter measurement systems, spectrum and network analyzers, and high frequency instrumentation needed for establishment of an expanded micro-electronics facility at KIST.

July 12 - A visit was made to the Electronics Research Branch of Stanford University, Palo Alto, California to inspect their electronics research facilities and to discuss the latest developments in the technology of distributed lines. (Distributed lines is a technique whereby complex circuits can be built in an extremely simplified way by alternating depositing layers of conductive, resistive, and dielectric films in various configurations over a substrate. This topography yields a 3-dimensional circuit network which allows increased reliability and ease of fabrication for complex circuits.)

July 13 - A meeting was held with Mr. John Dimeff and Dr. Neigel Tombs of the Instrumentation Division at the Ames Research Center, Moffett Field, California. Discussions were held regarding the work of a previous staff member, Dr. W. Kerwin, who had performed development studies of distributed line networks. Pertinent technical reports and data were given to Dr. Park.

We met with Mr. John Knudson, Manager of the the Microelectronics Fabrication Facility of the Lockheed Missiles and Space Company. Mr. Knudson's group at Lockheed built distributed line circuits under contract to Ames Research Center. Samples of these circuits were inspected

and a tour of Lockheed's electronics production facility was given.

In addition, we met with Mr. Bill Mills, Sales Engineering Manager, of Varian Associates, Palo Alto, California to obtain technical and cost information on their vacuum deposition equipment.

July 14 - We visited TRW, Semiconductor Division, Lawndale, California and met with Mr. Ken Clancy, Mr. Mike Holkenbrink, and Mr. Howard Knipple. Dr. Park obtained technical specifications and cost data on TRW's "varicap" voltage variable capacitors, modularized amplifier systems for transceivers, active filters, and high frequency semiconductor device.

A visit was made to the Jet Propulsion Laboratories in Pasadena, California to speak with Dr. H. Choi in the instrumentation branch. Technical discussions were held regarding the application of surface wave devices as bandpass filters. JPL is investigating various applications for these devices in their spacecraft electronics and Dr. Chung believes these may be applicable to consumer electronic products.

July 15 - We visited the McDonnell-Douglas Corporation, Long Beach, California and spoke with Dr. N. R. Byrd, Mr. Wes Acker, and Mr. Jack Fiskin regarding the application of special solid state gas contaminant detectors built by McDonnell-Douglas to fire alarm systems. It was learned that the feasibility of this application has been shown; however, some R&D work still needs to be performed to develop a workable device for fire applications; namely, (1) identify specific gases and/or contaminants exclusively related to fires; (2) identify and produce a polymer material whose electrical conduction properties are affected by these gases and contaminants; and (3) design a system with adequate redundancy to be reliable and be protected against false alarms.

Dr. Park will deliver the technical information he obtained to a polymer chemist at KIST for evaluation as to its potential for further development at KIST.

July 16 - Dr. Park departs for Korea.