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ASIAN INSTITUTE OF TECHNOLOGY

ASIAN REGIONAL REMOTE SENSING TRAINING CENTER

SIXth-YEAR EVALUATION REPORT AND RECOMMENDATIONS

by

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Senior Advisor to the President, AIT

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SIXth-YEAR EVALUATION REPORT AND RECOMMENDATIONS

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EXECUTIVE SUMMARY

This report is to Professor Dr. Alastair M. North, President, Asian Institute of Technology (AIT), Bangkok, Thailand, and to the USAID/THAILAND Mission. It is in response to a Consultancy Contract for the services of Dr. Charles E. Poulton, Consultant in Natural Resources Development and Management and Remote Sensing Applications. The contract is through the Environmental Remote Sensing Institute of Michigan (ERIM) and their Indefinite Quantity Contract (IQC) with USAID/Washington.

Purpose and Objectives:

The purposes of this Consultancy were: (a) to make an indepth analysis of the program content, scope, quality, and management of ARRSTC; (b) to evaluate achievements in relation to the donors expectations at the initiation of the project; and (c) to develop recommendations on the future direction, emphasis, scope, management and staffing of the ARRSTC program.

The objectives were to obtain and analyze such facts and provide such advice as would contribute: (a) to the continued development of ARRSTC toward original or new goals in service to the region; and (b) to its becoming permanently integrated into the AIT academic and administrative framework as an effective component of the multinationally supported Asian Institute of Technology.

A subordinant objective worked out after arrival and in response to changed needs of AIT was to provide expert advice to President North on AIT programs and planning related to a Natural Resources Development and Management (NRDM) curriculum at Master's level.

Major Goals:

The Consultant was guided throughout his inquiries and deliberations by the following goals defined early in his consultancy:

Goal One: The region must have an effective training program in the total technology of ASSESSMENT AND MONITORING OF NATURAL RESOURCES for development and management decision making.

The receptivity and need for a regional training program in the Asian Region is so great that a way must be found for such a program eventually to attain its full potential for highest quality service in the established traditon of the Asian Institute of Technology.

It is doubtful if as much capacity, and prior national investment, exists any where else in the developing world standing ready to capitalize on and benefit from attainment of this and the following goal.

Goal Two: The maturation and eventual implementation of an advanced training program in INTERDISCIPLINARY ANALYSIS AND PLANNING FOR INTEGRATED NATURAL RESOURCES DEVELOPMENT AND MANAGEMENT is a worthy goal which AIT should continue diligently and vigorously to pursue.

This also represents a critical, unfilled need of the Asian Region as well as of all developing countries. The concept embodies an approach to the solution of resource and human problems that should eventually circumvent past abuses and irreversible, adverse side effects of monodiscipline project planning and implementation.

In all too many instances across Africa, the Middle East and Asia, the present planning procedures and courses of action, are irreparably damaging the resource base of substantial areas of the world by ill-advised or short-sighted "development" without the necessary interdisciplinary involvement and critical post-development management. If the fact of these short comings and abuses is faced and admitted, the urgency of correcting the situation is probably, next to hunger, the most crucial problem of human society in the world today.

AIT has unique advantages for providing this kind of education and demonstration service. A strong point is the program and facilities already developed for the application of remote sensing technology to resource assessment and monitoring along with the institution's capability and potential for an integrated program in information management -- an essential bridge between information creation and its effective use in the decision process.

To realize an effective program in resource development and management, the interrelationships and mutual dependency of the three areas of information development, information management and information use must be recognized. They must all three be smoothly and effectively incorporated into the process of development and management decision making. Therefore, this full scope is most logically treated as one integrated program, the basic concept of AIT's NRDM.

The purpose of the program would be to stabilize or maximize resource productivity and the attendant benefits to human society. The potential of such a program is so great under the integrated, interdisciplinary planning concept that this entire, interrelated program of remote sensing applications, information management and natural resources development and management must be brought into full flower at AIT.

Major Achievements of ARRSTC in Summary:

1) Out of an original goal of 300 trainees, 290 from 12 countries have been trained. Of these, 86% are using their training, 65% have received promotions post-training and 39% are in teaching or research.

2) The course program has been fully integrated into the AIT pattern with 5 initial courses; and in the current term, 39% of the students are from other AIT Divisions.

3) The curriculum is strong with substance and depth, even though four deficiencies were identified, all of which are easily correctable.

4) President North has already taken steps to put ARRSTC management under the AIT administrative framework.

5) The program has completed two demonstration projects, has one nearing completion and two new projects just beginning.

6) The AIT Faculty Senate has "approved in principle" an Integrated Natural Resources and Development Program on which design and planning is continuing. This is an outgrowth of ARRSTC thinking and leadership.

USAID New Involvement Opportunity:

From the above it is obvious that this USAID project can be judged successful and that it has had a very positive impact on 12 Asian countries and the lives of 290 people, fully in line with the goals set forth in the Project Paper. A basis for permanence of the remote sensing program within AIT has been established.

The fact is that the conceptualization of a new program has grown out of this beginning. AIT is now in a position to achieve an even greater potential in service to natural resource development and management and to human welfare in Southeast Asia.

The Consultant suggests that USAID most seriously consider participation in the new natural resources program that is taking shape out of the intital project. USAID started the chain of events that lead to this development and they should be in on the recognition and credit line as this new era in strengthening of natural resources development and management in Southeast Asia is brought to full fruition.

After being the leading force in technological advancement, it is simply not in USA's best interest to allow other donors to capitalize, to their interests alone, on the foundation USAID has laid. Further, the best world expertise to guide AIT's Interdisciplinary Natural Resources Development and Managment idea to its full potential will be found in North America or Australia. USAID now has an opportunity to establish a supportive affiliation with the new program and to provide the organizational and critical early-management leadership. Failing in this, the program is sufficiently attractive that other donors will capitalize on the opportunity, and possibly even guide it divergently from its highest potential of service and example to developing countries of the world.

Once matured and demonstrated in Southeast Asia, the Program has the potential of direct cloning to developing nations in other regions.

Recommendation Priorities:

The alpha designation combined with each recommendation number assigns a priority or urgency according to the following:

A. These are most urgent, "Must Attain" recommendations. Some are given a AA which means "Urgent Action".

B. These are longer term "Must Attain" recommendations.

C. These are "Highly Desirable" recommendations, profes sionally, technologically or managerially important.

D. These are the "Good to Have" recommendations.

Summary of Recommendations

In the main body of the report recommendations are made immediately following the discussion of each topic to which they pertain. Each recommendation is, in turn, followed by suggestions for "implementation". As individual recommendations are of interest to busy administrative reviewers, they may wish to turn to the page indicated and also read the generally brief "Implementation" section. It is further suggested that reference be made to the Table of Contents to review other areas of individual interest or certain background documents.

RECOMMENDATION 1C): The most appropriate initial acquisition would be a stereo zoom transfer scope even though the Center already has a mono zoom instrument. From the training point of view, the Center should eventually have a fully equipped Richards-type light table for the visual interpretation of stereo transparencies as well. (p. 34)

RECOMMENDATION 2C/D): Replace the present mirror stereoscopes with a binocular magnifying type (with 45 degree, not vertical mount). (p. 34)

RECOMMENDATION 3A): When Mr. John Castiglia returns in November 1986 to complete installation of the Photographic Laboratory equipment, his offer for consultancy should be accepted as an interim measure to produce whatever photographic products the ARRSTC instructional or demonstration projects needs at that time. The Consultant considers Castiglia's proposal in this regard to be reasonable and cost effective for AIT. (p. 37)

RECOMMENDATION 4AA): When Mr. Castiglia gets the above work done, he must be asked to drain and flush all developing equipment and "mothball" the laboratory until a fully qualified Photographic Scientist/Manager can be employed to supervise, manage and insure quality control in the laboratory. (p. 37)

RECOMMENDATION 5A): Following is a job description that should be followed in recruiting the Photographic Scientist/Manager: (p. 37)

Job Qualification: Remote Sensing Photolab Manager
BA or equivalent in photoscience/graphic commun.

A. Five (5) years darkroom experience inc:
   1. BW developing, enlarging, printing
   2. Color processing and materials
   3. Preparation, registration of transparencies
   4. Mechanical and electrical skills sufficient for design and maintenance

B. Two (2) years facility management experience inc:
   1. Personnel mgt and training
   2. Photosupply inventory and control
   3. Cost-accounting and product orders
   4. Image archive and catalogue

C. Experience with graphic arts:
   1. Visual presentations
   2. Printing processes (letter press, offset, etc.)
   3. Layout and design

Estimated salary range: $30 - 40K (U.S.) if employed in U.S.A.

RECOMMENDATION 6AA): On his next visit in November 1986 ask Mr. Castiglia to prepare a list of all additions to the present equipment plus ancilary items to enable pin registry of 9 x 9 color separation transparencies in making false color/color enlargements. This would include such items as registration punch, pin registry attachements for enlarger, point light source, filters, any additional magnifiers, timers, etc., so that the equipment will work as a system to produce highest professional quality enlargements with this technology. Either with the listing or at an early date, Mr. Castiglia should also tabulate current retail costs of all recommended additions for budgeting purposes. (p. 38)

RECOMMENDATION 7B): Include the above budget requirements in the comprehensive planning and proposal for the future of the remote sensing program at AIT. (p. 38)

RECOMMENDATION 8C): That AIT strengthen its audiovisual and related drafting and slide preparation capabilities as well as to consider the possibility of well prepared video tapes in support of teaching and self learning. (p. 39)

RECOMMENDATION 9C): That the ARRSTC Information Officer devote some time to preparation of a selected library data base of those accessions truely relevant to the regional needs. He may then want to figure out an efficient way to segregate the relevant from the non-relevant during searches. (p. 43)

RECOMMENDATION 10B): That the ARRSTC staff, on a continuing basis discuss library needs in some depth and recurrently with a view to filling gaps, such as those suggested above and also to strengthening the position of the Library for an eventual natural resources program. A standing list of accession needs should be developed and maintained. The Information Officer should be able to lead this work. (p. 43)

RECOMMENDATION 11B): When a proposal is prepared for support by a new donor, a budget for library strengthening should be included. (p. 44)

RECOMMENDATION 12A) After Mr. Sadequzzaman does the best he can to develop an Error Matrix Table, he and a qualified senior person who is knowledgable about remote sensing accuracies should probably go to the client and explain the anomalies, the significance of the verification results and what can be done to avoid these kinds of problems should there be interest in a future update of the surface water picture in the Northeast. (p. 48)

RECOMMENDATION 13C): That the Information Officer be given full responsibility for getting information for, preparing and laying out the News Letter. When staff are too busy to write feature articles, the Information Officer could get essential information and prepare such articles anonymously or with the responsible staff person as co-author. (p. 49)

RECOMMENDATION 14C): That the Information Officer be charged with responsibility for maintaining contact with former students of ARRSTC and most vigorously strive to establish a dialog, create active alumni support and determine the need for project help from ARRSTC staff. (p. 50)

RECOMMENDATION 15B): The ARRSTC Brochure should be up-dated from time to time and liberally used in mailings. (p. 50)

RECOMMENDATION 16A): That the reconsideration and revised planning for an Asian Remote Sensing Information Center be brought to life only as a part of the planning for the Natural Resources Program and the future of ARRSTC. (p. 51)

RECOMMENDATION 17A): That all workshops and seminars be "put on the back burner" until a new donor is found and the professional teaching staff restored. (p. 53)

RECOMMENDATION 18A): That the AIT Bursar immediately take steps to take over full and normal management and supervision of the budgeting and fiscal control process as related to ARRSTC so that all future budgetary matters move from ARRSTC through his office to the Donor agency. (p. 65)

RECOMMENDATION 19A): When and if a Regional Information Center in the natural resources area is implemented, it should be only part of meeting the greater need for Information Management and Decision Modeling in context of decision making for Natural Resources Development and Management. (p. 65)

RECOMMENDATION 20B): All openings for cooperative ventures, technical assistance and project development should be vigorously looked into by ARRSTC staff. ARRSTC should take the initiative, working from a deliberate and well thought out plan and set of priorities. (p. 69)

RECOMMENDATION 21B): That AIT/ARRSTC plan for and open a dialog with ESCAP/RRSP with the goal of reestablishing and maintaining a viable and effective working relationship in the achievement of carefully identified mutual goals and a mutual recognition of areas where divergent interests or emphasis justifies divergency of programs and independent action. (p. 71)

RECOMMENDATION 22B): That topic 1 be strengthened as a unit topic and consistently presented in lectures and that it be emphasized in all project planning courses. (p. 72)

RECOMMENDATION 23A): That a good, unit lecture be designed for both the beginning course, RS.01, and for Digital Analysis, RS.03, that makes clear and illustrates (1) the mutually supporting role of visual and digital techniques, (2) that remote sensing encompasses a set of systems and analytical techniques (ever growing and expanding) and further that (3), having clearly defined a problem to be solved and its attendant information needs (or gaps), the most sound approach is to select from among these options that system and technique or combination thereof which most cost effectively provides the specified information. (p. 74)

RECOMMENDATION 24B): That a thorough discussion of legend development theory and of plant community structure, floristics and devisive classification concepts be developed and regularly presented as part of the course on project planning or as supporting subunit in the visual interpretation course. (p. 75)

RECOMMENDATION 25A): That lectures and field and laboratory experience in this subject be restored to the formal teaching and emphasized at every opportunity in each and every course. (p. 76)

RECOMMENDATION 26B): Under the new program an adequate sequence of formal courses in the AIT pattern plus periodic short courses/workshops addressing specific needs of the region should each be considered an integral part of the instructional offerings of ARRSTC. (p. 76)

RECOMMENDATION 27A): Either at the outset or under caption 11, the beginning student needs a strong orientation to problem analysis, objective setting and the specification of information needs so his remote sensing results will address these specific and real needs. (p. 80)

RECOMMENDATION 28B): Most logically in the beginning course with reinforcement in the Image Interpretation and Mapping course, RS.02, all students need training in how to make an ecologically integrated analysis of landscapes for the purpose of developing mapping legends and understanding better how to convert image characteristics and/or spectral data into information. (p. 81)

RECOMMENDATION 29A): Course RS.01 should cover "Line-Scan Imagery Characteristics" in sufficient detail in Topic 4 that all other courses can move ahead without repeating lectures on the basics (see item 2.A. under course RS.02). (p. 81)

RECOMMENDATION 30AA): Much greater emphasis must be directed to making students fully aware of the importance of verification of final results as a critical part of an applications project and also imparting the knowledge of how to preceed and how to present results. (p. 81)

RECOMMENDATION 31B): This course should concentrate on the principles and practices in visual interpretation of both aerial photography and top quality FCC satellite imagery (both Landsat and SPOT if available). Its goal should be to lay the groundwork for complete proficiency so each student can progressively build skill from this beginning. (p. 82)

RECOMMENDATION 32A): Delete topic 2.A., Line-Scan Imagery Characteristics, from this course as a detailed, full lecture presentation. (p. 83)

RECOMMENDATION 33B): Add a lecture on black and white photo quality and color image quality so the student is in a position to judge when and how he can work with the photo lab technician in producing the quality he must have as an image interpreter. (p. 83)

RECOMMENDATION 34A): Delete laboratory practice on the interpretation of B&W landsat imagery; but if a sample of the 10-meter SPOT can be obtained, it would be desirable to build one laboratory or homework exercise around visual interpretation of this imagery. (p. 84)

RECOMMENDATION 35A): Delete coverage of Thermography and Radar from this course. Use the time to strengthen essential areas. (p. 84)

RECOMMENDATION 36A): In working up the legend for the land use interpretation exercises, it should be developed at least to a tertiary level, in some cases possibly quaternary levels. (p. 84)

RECOMMENDATION 37A): Design the laboratory exercise also to demonstrate the mutually supportive realtionship between visual and digital analysis. (p. 85)

RECOMMENDATION 38C): In so far as available equipment allows, students should be introduced to and trained on the analytical system having the largest number of work stations. One should not attempt to make the beginning student operationally familiar with all of the analytical equipment available. (p. 85)

RECOMMENDATION 39A): Structure course sequence so topic 3 in RS.03 does not repeat, but builds on the same subject introduction in RS.01. Make this a truly advanced treatment to increase under standing of the nature of MSS data and what a good cross section of spectral signatures look like. (p. 86)

RECOMMENDATION 40C): Until the diverse hardware problem can be rectified, concentrate training in this course on the smallest possible number of systems. Leave the learning of other available systems to RS.05 or to student initiative on an extra time basis. (p. 86)

RECOMMENDATION 41A): Make sure that topic 2 includes emphasis on importance of problem analysis and determination of information needs so that remote sensing project planning does match needs of the client. (p. 87)

RECOMMENDATION 42A): The importance of budgeting adequate time and money for ground truthing and verification must be strongly emphasized. (p. 87)

RECOMMENDATION 43A): Students should also be reminded of the option of a sampling approach rather than a complete survey. (p. 87)

RECOMMENDATION 44B): Systematic Aerial Reconnaissance as an approach to verification, as well as obtaining supporting statistical data, should be thoroughly explained in project planning. (p. 87)

RECOMMENDATION 45A): Move the subject matter for week 10 to either week 6 or 7 so that verification and the statistical treatment of results and classifications is seen as an integral part of the process and that the procedure flows directly from field data collection into interpretation/classification and then into the all important verification function. (p. 88)

RECOMMENDATION 46D): GIS and Information Management are important topics, but it would be better to focus on a separate course in Information Management, including GIS. In the short term, it may be more effective in RS.04 to cut GIS to one week and expand topics 10, 11 and 12 in the course outline. (p. 88)

RECOMMENDATION 47A): Work up a tutorial exercise from which all students can learn to use "Wordstar" and "Mailmerge" on their own and devote the time in the workshop to something more critical. (p. 88)

RECOMMENDATION 48A): Make sure that topic 6 includes information on what the student needs to know about the ecology and resources of the area before he goes to the field. (p. 88)

RECOMMENDATION 49B): After the experience of the January 1987 term, initiate the full sequence of AIT 90's series courses: RS.96, Seminar; RS.97, Research Studies; RS.98, Selected Topics; and RS.99, Special Studies. (p. 89)

RECOMMENDATION 50B/C): A viable option would be to recruit a well qualified plant ecologist or plant geographer to organize and line up contributors to a one or two week seminar and workshop on Tropical Plant Ecology. Conduct this seminar at AIT and then abstract out of the proceedings the material that would provide the specific conceptual and factual basis for a proper treatment of tropical vegetation ecology as it relates to remote sensing legend design and applications. (p. 91)

RECOMMENDATION 51B): That in restaffing ARRSTC a conserted effort be made to recruit people from the natural resource management and development disciplines who have an adequate background in remote sensing applications to their disciplinary area. Further that a serious attempt be made to locate and recruit, among these individuals, one person who could lead the maturation and implementation of a Natural Resources Program and a second individual who could rotate, under existing Administrative-Management policies, into leadership of a new AIT Center for Training in Natural Resources Assessment and Monitoring. (p. 92)

RECOMMENDATION 52A): For restaffing of remote sensing alone, new hires must have in-depth strength in one earth resource related discipline, preferably with a development or management orientation. (p. 93)

RECOMMENDATION 53A): Starting immediately all staff members, regardless of their administrative-management duties, must be actively involved in teaching, demonstration or R&D projects and extension. (p. 95)

RECOMMENDATION 54B): Negotiate an arrangement with the Regional Computer Center to share a person and have the RCC service all of the ARRSTC hardware, even though it might mean hiring an additional person in RCC, the likelihood of efficient use of the individual's time is much greater. (p. 97)

RECOMMENDATION 55A): Stagger the termination dates of all seconded and contract hire personnel so that whole groups do not leave at the same time and even though implementation will require an initial one-year contract for one person. (p. 97)

RECOMMENDATION 56A): AIT must insist on being brought into the loop on selection of all secondees and contract hires and that they have the full right of veto on any and all proposals. (p. 97)

RECOMMENDATION 57B): Embark on a program to gradually reduce diversity of equipment for digital processing to one microsystem with six units (one extra should one go down) and one minisystem with multiple terminals (not less than 5). Then network all these with the RCC mainframe for purposes of image storage and preprocessing, including those data manipulations that can be performed more efficiently on the mainframe than on either the mini or micros. (p. 99)

RECOMMENDATION 58B): Realization of full benefit from RTG agency strengths and willingness to participate will require that AIT take the initiative to step out and invite their participation. This must be done under a policy of willingness, mutually to share the costs in proportion to the relative benefits to each cooperating agency. (p. 107)

RECOMMENDATION 59A): Establish high qualifications for all trainees under the NRDM program and make no exceptions. Require that all applicants: a) have a minimum of a BSc degree in one of the recognized natural resources disciplines or in anthropology/sociology, in land or resource economics/policy, in political science/law, in normal human behavioral psychology, in engineering (emphasis on systems analysis and project/program management being especially valuable); and b) with a minimum of 3 years employment experience where they have applied their professional skills in real-world (non-academic, preferably managerially oriented) situations. (p. 107)

RECOMMENDATION 60A): To be effective AIT must take the initiative by developing job and qualifications descriptions for all positions and then insisting in all new secondments (or direct hire contracts by donors) that the secondees or contractees meet the qualifications and job performance specifications detailed in these job descriptions originating with AIT. (p. 109)

RECOMMENDATION 61A): At least half of the staff, and particularly the leader, should be employeed under longer contracts. (p. 109)

RECOMMENDATION 62A): The first leader, if not permanently posted - after careful and deliberate selection with few if any compromises on qualifications - should serve for at least five to six years, possibly longer. (p. 109)

RECOMMENDATION 63A): The central core and theme courses of the NRDM program will be different from any of the conventional management and planning courses taught in the professional disciplinary schools that emphasize application of recognized "practices" developed under conventions of silviculture, agroforestry, agronomy, range ecology and animal management, etc. (p. 109)

RECOMMENDATION 64B): The maturation of the NRDM idea and the future of remote sensing at AIT should be treated as separate and independent but mutually supporting issues. (p. 110)

RECOMMENDATION 65A): That AIT move forward immediately and vigorously to complete the maturation of an integrated program in natural resources development and management, adhering to the guidelines set forth in this document. (p. 111)

RECOMMENDATION 66A): That the name of the remote sensing training center be changed to the "AIT Center for Natural Resources Assessment and Monitoring (CENRAM)", and that its purposes and activity be redirected in keeping with the functions and emphases diagramed in Figure 3. (p. 112)

Summary of Major Subjects Discussed

In making the curriculum evaluation, the Consultant generated considerable statistical information which is presented in summary tables. This lead to the conclusion that, under the short course program, a good curriculum and excellent set of course outlines were developed. These were tested and proven in the real world of staff-student interaction to the point that, over the past three terms, the teaching stabilized with no major changes. An outstanding file of course outlines and reference material is organized and available from Course One onwards.

The only curriculum and teaching criticisms are that: (1) the courses were disproportionately heavy in digital analysis (over 20 percent of lecture/lab time) as compared to visual analysis (less than 10 percent), (2) and the concept and advantages of deliberately working the visual and digital methods together was not effectively put forth, and (3) the lack of effective laboratory sessions on information verification. The latter ideas were briefly discussed in lecture, with perhaps too little on methods of verification. The staff took immediate steps, in the current term, to correct this deficiency when it was pointed out.

The new curriculum of five courses which have been melded into the AIT pattern, is a very good development. Fourteen AIT students from other Divisions, in a total class of 36, registered for the September 1986 term. This provides the opportunity for Remote Sensing training to be incorporated into degree work at AIT. Flexibility in short courses is greater in that each short course may now focus on specific disciplinary needs or on advanced concepts and methods. When the staff is restored to full strength, it should be feasible to offer one good short course or comprehensive seminar per year in natural resources assessment and monitoring at AIT.

The report devotes considerable attention to a comparative evaluation of the old and the new curriculum. Many suggestions about each of the new courses are incorporated for consideration by the teaching staff. Suggestions are also made on additional courses needed to bring the new teaching format up to what had been routinely accomplished in the former 15-week short courses.

The past use of staff time was critically evaluated, and it was concluded that the initially conceived size of staff was consistent with the directive to develop both training and an outreach program with demonstration projects. This kind of scope should be retained as the program moves ahead. Staffing recommendations are made with this in mind in both professional and technician areas. An appointment priority is suggested for the technician positions. It was concluded that 5 to

7 professional teaching staff plus the Photographic Scientist/Manager should be considered minimum for the remote sensing program, provided the administrative staff also carried a full proportion of the teaching load. In addition to proportionate teaching load, each staff person should be expected to have one demonstration/research project or the equivalent in extension/out reach or technical advisory activity.

A number of recommendations are made for improved management of the program.

Physical facilities and space for the program are adequate as is equipment in both digital and visual analysis areas. In the future the program needs to look to a gradual reduction of numbers of kinds of systems in the digital area and replacing certain marginal and obsolete equipment in the visual analysis laboratory.

A serious deficiency in the production of state-of-the-art false color composite images for visual analysis and digital support still exists. The Photography Laboratory, mostly installed at this time still lacks pin registry capability for color separation enlargements. The most critical need now is for employment of a top Photo Scientist/Manager for this laboratory with technician support specified by him and as dictated by work load. The consultant has unequivocably recommended "mothballing" the Photo Lab until such a person is on board. The potential is real for this unit be partially self-sustaining by the sale of value added products throughout the region. The same is true of the digital unit, especially as more users in the region begin to use microcomputers in analysis and need preprocessing which they cannot do on the micro.

A serious regional problem deserves the attention and positive action of every government and agency concerned about the future of satellite remote sensing. The problem is simply that state-of-the-art capability to produce false color composite enlargements at working scales and under critical quality control standards seems not to exist. Products are going out from both the Thai and the India receiving stations that are of such low, inconsistent quality that they cannot avoid a damaging impact on receptivity to the technology of Earth resources satellite sensing. ARRSTC recently bought a Landsat TM FCC from the India station that does not meet the quality of a 1972 MSS from the EROS Data Center. This is seriously detrimental to the acceptance of TM imagery by the user community.

Given good quality CCT's from these stations, the AIT Photographic Laboratory has the potential of contributing to a solution by providing users in the region with value added products so they, the users, will come to demand state-of-the-art quality from all laboratories in the region.

The remote sensing unit has made a start in the demonstration project area and have devoted one staff position, planning energy, an effective brochure and a good periodic News Letter to an outreach program. Demonstration projects should receive major developmental attention in the current "dry period" in funding and staffing. Carefully plannned, cooperative projects professionally carried through under high performance standards can do more than anything else to strengthen the reputation of AIT in the Natural Resources area throughout the region, while there is nothing that can kill it faster than unprofessional performance on applications projects. A number of guidelines are presented for further development of the extension/outreach program.

As the consultancy progressed and concentrated attention shifted to the question of a Natural Resources Development and Management Program at AIT, it became increasingly clear that AIT is in a unique position to move successfully into this field if a few critically important guidelines are followed. They have the opportunity, along with those donor agencies who choose to support the program, to provide the Asian Region with a new and critically needed training element for successful Natural Resources Development and Management.

It is a Program that, if properly planned and implemented, will contribute more to the success of natural resources and human development projects than any other single innovation that can be added to traditional procedures. The unique elements are that the approach is non-traditional and one that will train interdisciplinary groups of resource specialists in the techniques and procedures of effective team planning and design for both resource development and program implementation. Given the support and planning that will make the program successful at AIT, it will stand as a model throughout the developing countries of the world in the proper way to approach and implement resource development for the real benefit of human society.

A flow chart is included that organizes and presents the philosophy and approach that will be taken in the functioning of an Interdisciplinary Natural Resources Development and Management Program at AIT. Guidelines are set forth for the further development and staffing of the program with criteria for student selection. An organizational chart is proposed that sets forth the scope and functions of the Program and which incorporates a continuing remote sensing effort as one of the functional areas. Renaming of the remote sensing program is suggested to give it an obvious thrust toward natural resources development and management The name suggested is "Center for Natural Resouces Assessment and Monitoring (CENRAM)."

ASIAN INSTITUTE OF TECHNOLOGY

ASIAN REGIONAL REMOTE SENSING TRAINING CENTER

SIXth YEAR EVALUATION REPORT AND RECOMMENDATIONS

by

Charles E. Poulton, Consultant
Senior Advisor to the President, AIT

INTRODUCTION

This report is to Professor Dr. Alastair M. North, President, Asian Institute of Technology (AIT), Bangkok, Thailand, and to the USAID/THAILAND Mission. It is in response to a Consultancy Contract for the services of Dr. Charles E. Poulton, Consultant in Natural Resources Development and Management and Remote Sensing Applications. The contract is through the Environmental Remote Sensing Institute of Michigan (ERIM) and their Indefinite Quantity Contract (IQC) with USAID/Washington.

Situation Leading to Mission:

With the Royal Thai Government's interest and participation in the Earth Resources Technology Satellite (ERTS-1) Program in 1972 a chain of events began that lead to their decision in 1978 to build a receiving station near Bangkok. Because of this and the ideal location of the Bangkok station to service Southeast Asia, a number of particularly significant developments have followed.

In 1972-79 USAID and other donors supported the Thai ERTS-1 experiment conducted by the National Research Council of Thailand (NRCT). USAID's support totalled $261,000. This was followed by another grant of $290,000 for additional training and equipment and to establish capability within the RTG agencies to use satellite remote sensing in resource management. These were effective seed-money grants that are still being greatfully acknowledged by personnel of Thai Government Agencies.

Concurrent with this latter grant, USAID authorized another program in 1979 to develop a regional training center for Southeast Asia where it could have the advantages of the proximity to the Thailand Receiving Station and the potential of a home in the Asian Institute of Technology (AIT), a multilaterally supported institution for advanced education dominantly in the engineering-related sciences.

Under USAID auspices and a total grant of $5.006 million, the Asian Regional Remote Sensing Training Center realized its first milestone with signing, on August 30, 1979, of an agreement between USAID and the

Asian Institute of Technology to house the program. With this came an initial grant of $3.7 million to equip and initiate the Center.

The building and equipping phase was completed to the point of partial operability in 1982 and USAID sent in the first team of five multidisciplinary scientists, under separate personal services contracts, to design and conduct the first training course. Course one was started in September 1982. The first team stayed for two years, developed and tested an effective curriculum. A mid-term project evaluation was conducted in their last year, May and June 1983, by Resources Development Associates (see Appendix C).

A second USAID team of four new people with one hold over followed to carry the program into a maturation phase. Almost concurrent with the second team, the French Government seconded three additional persons to the Center to teach and work on research and development projects. All these people, along with four Asian scientists and varying numbers of technicians, have further refined the curriculum and improved individual courses as well as the laboratory and field exercises. A demonstration project on NE Water Resources Monitoring substantially improved the digital analysis software for one system, and the staff has made other software improvements as the instructional program has moved ahead.

The second American team completed their contract without extension or replacement on August 31, 1986. At this writing it appears that one of the French scientists has terminated; one, a Geologist, may continue and the third and senior French scientist will conclude his term at the end of April 1987 but with replacement intended by the French government. The staffing outlook in the near-term is uncertain, but the two remaining French scientists and their Asian associates are determined to keep the program going through the January 1987 term. By that time additional secondees from France may be on board, if not the teaching program may have to be severely curtailed or temporarily suspended.

USAID did extend the project from August 31, 1985, the initially projected termination date, to August 31, 1986; but this was a dry extension, without additional funds. Operations continued on funds unutilized by ARRSTC management over the previous five years.

USAID has taken the position that they will no longer support the Training Center as their emphasis and interest is now on applications projects.

It is into this setting and unfortunate hiatus in continuity that the Consultant arrived to evaluate the program and help to chart a positive course for the future.

Purpose and Objectives:

The purposes of this Consultancy were: (a) to make an indepth analysis of the program content, scope, quality, and management of ARRSTC; (b) to evaluate achievements in relation to the donors expectations at the initiation of the project; and (c) to develop recommendations on the future direction, emphasis, scope, management and staffing of the ARRSTC program.

The objectives were to obtain and analyze such facts and provide such advice as would contribute: (a) to the continued development of ARRSTC toward original or new goals in service to the region; and (b) to its becoming permanently integrated into the AIT academic and administrative framework as an effective component of the multinationally supported Asian Institute of Technology.

A subordinant objective worked out after arrival and in response to changed needs of AIT was to provide expert advice to President North on AIT programs and planning related to a Natural Resources Development and Management (NRDM) curriculum at Master's level.

Constraints and Limitations:

There were no constraints or limitations placed on the Consultant as to how he would do his work beyond specifying a rather complete task list and accomplishment schedule in the contract.

The only problem that had to be resolved, post contract, arose from the fact that the needs and interests of AIT for Consultancy assistance had expanded somewhat since the mission was conceived. It developed that AIT was hopeful of more direct assistance and advice in the development of its newly anticipated academic program in Natural Resources Development and Management. It was anticipated this program would give ARRSTC a more specific focus and thus enhance the position of the Remote Sensing Training Center as well as the service of AIT to the Asian Region.

A solution agreeable to both President North and USAID/THAILAND was worked out, although it probably did not provide AIT with as much input as the President had initially hoped. It was agreed that the question of Natural Resources consulting would be addressed on a very personal and direct basis by interaction with Professor John Lukens, Coordinator of the NRDM Program, through discussions with him and AIT Division personnel, passing notes on program suggestions which Lukens might then incorporate as appropriate into his writing, by reviewing and commenting on manuscript and idea drafts prepared by Lukens and by frequent discussions of the topic with President North.

The Consultant also discussed the NRDM Program idea with all interviewees. The results of these interviews were passed on to President North as a routine part of periodic conferences.

The contributions of the Consultant to the Natural Resources Development and Managment Program are briefly summarized at the end of this report.

Acknowledgements:

The ARRSTC staff was particularly cooperative and helpful as were virtually all interviewees on and off campus. The ARRSTC Secretary, Ms. Thityia Srikitjakarn, arranged meetings and provided perfect instructions for getting to the right place on time. On authority from ARRSTC Director, Dr. Kaew Nualchawee, Ms. Thityia was particularly helpful in sometimes locating and always making all necessary file materials available. Staff Liaison Officer, Mr. Samut Siriburi, was also helpful in arranging off-campus interviews. Mr. Ehsan Ullah, ARRSTC Information Officer, also arranged some most timely and beneficial on campus interviews. Ms. Emilie Ketudat, Academic Secretary, was particularly helpful in suggesting both on and off-campus interviewees and in some cases laying groundwork with an advance phone call. A list of all interviewees appears in Appendix D. Sincere thanks is extended to all these people for their open and frank discussions and many good ideas conveyed to the Consultant.

The consultant was provided an excellent office with telephone, personal access as needed to word processing equipment and all reasonable support.

President North went beyond expectations in making transportation available both to increase the efficiency of the Consultant's work and to enable travel for interviews and off-campus contacts as needed. His driver was outstandingly helpful and prompt in all appointments.

Drs. Thomas W. Wagner and Jim Cooper of the Environmental Remote Sensing Laboratory of Michigan (ERIM) both made valuable contributions to the project work and to elements of the report.

The Consultant also wishes to acknowledge with deep appreciation the editorial assistance of his wife, Marcile B. Poulton, and his daughter, Mrs. Betty J. Strong, who came to Thialand as tourists but devoted a much needed six days of their time as expert editors in helping to complete this report.

TASKS AND SCOPE OF EVALUATION

Abbreviated Task Description:

The work was carried out in the period June 30, through September 28, 1986 in Bangkok, Thailand. A review draft of the Consultant's report and recommendations was submitted to President North and the USAID Mission Director on September 19, 1986.

The primary activities consisted of direct examination and analysis: (a) of ARRSTC facilities (space, equipment, hardware and software) and teaching materials; (b) of files, reports, related professional papers, budget records and other relevant documents indicating the nature of achievements; (c) of specific course outlines and hand-out materials for the current and one previous year; (d) of curriculum organization and presentation for the year 1982 and 1984 through 1986, including the newly integrated course structure for the September 1986 term; (e) of the adequacy of AIT Library and Document Center in support of Remote Sensing and Natural Resources Development and Management; and (f) of teaching loads, research/demonstration involvement, project development and class contact hours and work load of the faculty.

In addition the Consultant participated in staff meetings had numerous interviews and discussions with ARRSTC staff and key AIT staff, visited classes in progress, observed students at work on projects and had some discussions with individual students. Discussions were had with key personnel of UNDP, UNEP, and UN/ESCAP, the National Research Council of Thailand, some Thai University personnel concerned with remote sensing and natural resources and with selected agencies of the RTG concerned with Natural Resources and Planning. A full task list as per contract is included as Appendix A.

Scope of Evaluation:

It is easily seen from the above that this was as thorough and indepth evaluation as should be necessary (a) to make an objective assessment of the accomplishment and quality of performance of the project, (b) to determine how the project actually looks along side the expectations of USAID at project conception (c) to obtain the facts needed to recommend for future development of a permanent Remote Sensing Training and Outreach Program that will have a lasting and beneficial impact on Natural Resources Allocation, Development and Management throughout Southeast Asia and the Pacific and (d) to advise President North of AIT regarding further development of the NRDM idea and, if such appears feasible, to provide guide lines for refinement of this potential program.

Approach and Philosophy of the Mission:

USAID/Washington had indicated a number of areas of concern about the project, particularly including project management and a perceived low level of activity in demonstration projects and extension or "outreach". The Consultancy has been approached, however, from a very positive and objective position. It was felt that a fair and objective result would be obtained if the Consultant first prepared a brief summary of the expectations of the donor (Appendix B) and then examined accomplishments and findings alongside these expectations and hopes.

This should result in a clear definition of goals achieved. As in practically every project in the Developing Nations with which the Consultant is familiar, each one falls short, to some degree, of projected goals and objectives in any given time frame. An objective of the Consultancy is to segregate those unattained objectives which are still viable from those which are not. On the basis of the total assessment taken in context, the Consultant's recommendations for the future will be made and a strategy and possibly a time-table for attainment will be suggested for the original or newly recognized goals and objectives that are still a feasible part of the ARRSTC Program.

Major Goals:

The Consultant was guided throughout his inquiries and deliberations by the following goals defined early in his consultancy:

Goal One: The region must have an effective training program in the total technology of ASSESSMENT AND MONITORING OF NATURAL RESOURCES for development and management decision making.

The receptivity and need for a regional training program in the Asian Region is so great that a way must be found for such a program eventually to attain its full potential for highest quality service in the established tradition of the Asian Institute of Technology.

It is doubtful if as much capacity, and prior national investment, exists any where else in the developing world standing ready to capitalize on and benefit from attainment of this and the following goal.

Goal Two: The maturation and eventual implementation of an advanced training program in INTERDISCIPLINARY ANALYSIS AND PLANNING FOR INTEGRATED NATURAL RESOURCES DEVELOPMENT AND MANAGEMENT is a worthy goal which AIT should continue diligently and vigorously to pursue.

This also represents a critical, unfilled need of the Asian Region as well as of all developing countries. The concept embodies an approach to the solution of resource and human problems that should eventually circumvent past abuses and irreversible, adverse side effects of monodiscipline project planning and implementation.

In all too many instances across Africa, the Middle East and Asia, the present planning procedures and courses of action, are irreparably damaging the resource base of substantial areas of the world by ill-advised or short-sighted "development" without the necessary interdisciplinary involvement and critical post-development management. If the fact of these short comings and abuses is faced and admitted, the urgency of correcting the situation is probably, next to hunger, the most crucial problem of human society in the world today.

AIT has unique advantages for providing this kind of education and demonstration service. A strong point is the program and facilities already developed for the application of remote sensing technology to resource assessment and monitoring along with the institution's capability and potential for an integrated program in information management -- an essential bridge between information creation and its effective use in the decision process.

To realize an effective program in resource development and management, the interrelationships and mutual dependency of the three areas of information development, information management and information use must be recognized. They must all three be smoothly and effectively incorporated into the process of development and management decision making. Therefore, this full scope is most logically treated as one integrated program, the basic concept of AIT's NRDM.

The purpose of the program would be to stabilize or maximize resource productivity and the attendant benefits to human society. The potential of such a program is so great under the integrated, interdisciplinary planning concept that this entire, interrelated program of remote sensing applications, information management and natural resources development and management must be brought into full flower at AIT.

Recommendation Priorities:

Initially the Consultant had planned a separate section on Recommendations and Implementation. Since all Recommendations will be listed in the Executive Summary, it was decided to present both recommendations and suggestions for implementation in the context of the evaluation of each subject. Implementation suggestions will immediately follow each recommendation. This procedure will be followed from this point forward in the report.

President North requested that, in making recommendations, the Consultant assign a priority to each so that he could judge the urgency of attainment and amount of flexibility available in working out solutions in each case. Accordingly, the Consultant has incorporated a priority letter following the number of each recommendation. This sets forth the Consultant's judgement on importance and urgency according to the following categories:

A. These are most urgent, "Must Attain" recommendations.

Action should be initiated immediately with a goal of attainment in the shortest possible time. If the recommendation relates to new programs or developments, then initiation of the new activity should be contingent on attainability of the recommendation. Withhold initiation or further development until achievement of the recommendation can be assured.

B. These are longer term "Must Attain" recommendations.

One can work on achievement of these recommendations while the program is moving ahead but the recommendation should be implementable in a one to two year time frame or less.

C. These are "Highly Desirable" recommendations, professionally, technologically or managerially important.

These recommendations are essential for maximum effectiveness of the program. There is room for professional disagreement on relative importance of the suggestion but little disagreement would be expected on the recommendation's receiving very serious consideration toward implementation within a two to five year time frame.

D. These are the "Good to Have" recommendations.

This priority is in the nature of "wants" vs. "needs" with categories A through C representing the needs/essentials. Category D recommendations are not critical or determinative of program success but, in the Consultant's judgement, they represent considerations that would strengthen the program.

Recommendations are sequentially numbered throughout the manuscript without respect to subject. The Executive Summary references the page on which each can be found with implementation suggestions.

RESULTS OF ARRSCT PROGRAM REVIEW

Current Program of ARRSTC, an Overview:

The Asian Regional Remote Sensing Training Center (ARRSTC) has a commendable program although not without opportunity and need for improvement. ARRSTC has established a good reputation in the region. This is judged by the steady and increasing patterns of participation among many of the countries and from numerous discussions both on- and off-campus.

In all discussions the Consultant opened the option of closing down the program in view of USAID's pulling out and the reduction in teaching and demonstration project staff. Without exception this was not picked up as a viable option. One person expressed the view that if it was not possible to maintain high quality of performance in the training program because of this problem, it would be better to temporarily close down. Even this person felt that the program should be maintained in the long-term interest of the region.

One of the outstanding strengths of the present program is the way two major field and laboratory problems are presented and handled. One is concerned with a resource analysis problem of particular interest to a small group of students and another deals with a Geobased Information Systems (GIS) application. Both of these are carried out by small, interested groups of students working as a team. They plan their work as a group, defend their work plan before their peers and the faculty, and similarly present and defend their findings and report in both cases.

Another significant milestone is the recent incorporation of five courses into the AIT pattern so that they may be taken for credit by AIT students from other Divisions. The duration has been cut from the former 15-weeks followed by the ARRSTC short courses to 12 weeks, matching the regular AIT term. This will increase and add a measure of stability to enrollment in the program. For the September 1986 term, other Divisions have pre-registered 14 students. These developments open the way to use Remote Sensing as an Area of Study supporting a wide spectrum of major educational endeavours. It will complement other disciplinary training where the skills and knowledge of remote sensing are important professional tools.

The first course offering was in September 1982. Three terms have been taught each year since, and the courses have gradually improved to a rather set pattern. This outline and course structure formed the basis of the new pattern initiated in September 1986.

The teaching staff, by and large, has been dedicated and diligent in the development of their courses and in teaching. The Center's head Secretary and office manager is particularly efficient and has done an outstanding job of documenting course, student, project and other records in-so-far as they were made available to her. She has, for example, well organized records on each and every student as well as those who could not be accepted into the program, largely for want of scholarships. Every individual term of instruction is fully documented in 3-ring binders with all lecture outlines and all handout materials, lab problems and assignments.

One of the major deficiencies of the program has been that the photographic laboratory was not installed until late August, 1986, and state of the art images for visual interpretation and support of digital analysis simply have not been available from the Thai Satellite Receiving Station and Photo Laboratory. There are a few additional equipment needs in the Photographic Laboratory, beside the need for a competent manager; but these equipment needs can probably be handled later as the laboratory establishes an excellent reputation as a source of state-of-the-art, value-added image products in the region.

Another severe deficiency in relation to initial expectations is the failure to develop an outreach program and vigorously to pursue demonstration project possibilities. The Center has hired an Information Officer to function in the area of outreach and extension but his program is bogged down for a number of reasons.

Finally, the Center is very well equipped in both the computer and software areas; and, while they should look to replacement of their mirror stereoscopes with a binocular magnifying type, they are workably equipped in the visual analysis area although they still lack an optimum amount of aerial photography. Just before leaving the Consultant was able to create a situation where the Center was able to order state of the art FCC images of both Landsat MSS and SPOT in sufficient numbers for laboratory use. The student attitude with respect to usefulness of visual interpretation (as well as how effectively to use it) should shortly be correctable, starting with the September 1986 class.

Major Achievements in Summary:

1) Out of an original goal of 300 trainees, 290 from 12 countries have been trained. Of these, 86% are using their training, 65% have received promotions post-training and 39% are in teaching or research.

2) The course program has been fully integrated into the AIT pattern with 5 initial courses; and in the current term, 39% of the students are from other AIT Divisions.

3) The curriculum is strong with substance and depth, even though four deficiencies were identified, all of which are easily correctable.

4) President North has already taken steps to put ARRSTC management under the AIT administrative framework.

5) The program has completed two demonstration projects, has one nearing completion and two new projects just beginning.

6) The AIT Faculty Senate has "approved in principle" an Integrated Natural Resources and Development Program on which design and planning is continuing. This is an outgrowth of ARRSTC thinking and leadership.

From this overview, we will look more analytically at the separate elements of the current program.

Evaluation of Student Backgrounds:

In interviews off campus, the Consultant was told on two occasions that ARRSTC should concentrate only on digital training

> "because there are many remote sensing training centers and university programs in the region and students are coming with an adequate background in visual interpretation techniques."

The decision to comply or not is more involved and other considerations have to be taken.

In Photo Interpretation: To check out the hypothesis, however, the Consultant tabulated the backgrounds of students from the January and the May 1986 terms. This involved a total of 46 trainees. Of these:

- o 23 (50 percent) had had no exposure what-so-ever to the principles, techniques and equipment used in visual interpretation of either aerial photographs or hard copy satellite images;
- o 12 (26 percent) had had one course in photo interpretation or very limited experience;
- o 7 (15 percent) had had some significant on-the-job experience; and
- o 1 person had taken a course at ITC in The Netherlands on Rural Survey.

From the May 1986 class of those responding to a questionnaire, 44 percent had no prior training in visual interpretation, a like percentage had had only one course or some on-the-job training and 63 percent were expecting not to have access to computers on returning home.

Professional Diversity: These same two classes of trainees break down as follows by professional training areas:

Geology & Mining Engineering	20 %
Geography & Planning	17 %
Agric., Soils & Forestry	15 %
Other Engineering	15 %
Environmental Engineering	13 %
Basic Sciences	9 %
Social Science & Education	7 %

Computer Science	2 %
Meteorology	2 %

In spite of the highly diverse professional backgrounds of the trainees, rarely have they included students with a background in field botany, plant ecology, plant geography, geobotanical or vegetation-soil relationships; yet this is an important part of the expertise needed in all remote sensing applications dealing with naturally vegetated landscapes. Such expertise has never been included on the staff by intention or design. This equates to a deficiency and omissions in training.

Although the proportions will change, it is not likely that the diversity of student backgrounds will decrease. The need for a training module designed to help the trainee better understand the ecological and resource characteristics of the landscapes with which he works will continue. Students need enough ecological training to understand what they see when they document the landscape features and when they identify information and image classes.

Evaluation

Initial Training Course:

For the initial training course all of the facilities were not operable and the initial team brought many of their own illustrative and working materials with them. This was the immediate price paid for failing to order initial working materials and a selected historical archive of data from EROS Data Center.

The first course experienced a somewhat trying start occasioned by late withdrawal of the intitial contractor who was to have provided and managed the initial instructional team. The first team, under personal services contracts, was forced into a bit of innovation and to somewhat hastily prepare courses and instructional material with refinements as the course progressed. Fortunately they were all experienced remote sensing instructors. Schedules were met, however, and the first course was taught in the period September through December 1982.

The treatment of visual interpretation and verification was much better in this term than in subsequent terms. It is, therefore, suggested that future instructors concerned with these two topics review the course outlines prepared by Dr. Larry Fox under dates of September 1982 and January 7, 1983 with a view to incorporation of missing elements and concepts.

Especially notable was the full participation of HRH Princes Maha Chakri Sirindhorn as a student of the ARRSTC short course in the June 1984 term at AIT. This event had a significant positive impact on the program.

Curriculum Evaluation:

The courses over the last 8 terms have averaged 15 weeks and ranged from 14 1/2 to 16. Field trips have ranged from 7 1/2 to 10 1/2 days total duration (Table 1).

The curriculum evaluation was done by examining the last two, a mid-period and the first set of lecture outlines and handouts and by preparing a tabulation of Class Contact Hours by Terms (Appendix E). In developing Appendix E and the related tables, the assignment of lectures to subject categories is a matter of the Consultant's interpretation and is somewhat subjective.

Table 2 summarizes this information as percentages of time by major instructional categories. This gives a more quickly grasped picture of topic treatment, deficiencies and imbalances. The course is commendably strong in field and problems work and disproportionately heavy on the digital analysis lectures. In addition, there is minimal treatment that leads to understanding of land cover so that the analyst "knows what to expect" when making interpretations, whether visually or machine-aided. Since about half of the students come with none or a bare minimum background in visual interpretation methods, allowance of less than 10 percent of the time for visual instruction and laboratory could be questioned. This proportion will have to be increased if the complementarity of visual and digital analysis is effectively taught.

Notes made during review of courses and lecture outlines are included as Appendix H for such value as they may have to the teaching staff when considering course revisions.

Points Covered, but Not Getting Through:

Through contacts with the May 1986 graduating class and the results of a questionnaire circulated to them, the Consultant identified some weaknesses in instruction. In spite of two good project planning exercises, the really important preplanning elements and particularly the importance of verification are simply not getting through to the students recallable awareness. Students are not learning how to verify their own interpretation results.

The students were asked to list the most important questions they would ask their client or agency person as they started to design a remote sensing applications project. Of 21 students only 9 responded; but of these 9, only one got even close to the kind of specifics that are important. Even though the response was small this low percentage does convey a message.

Similarly they were asked how many would have computer facilities available for satellite image analysis when they got home. Of the nine, five said none (56%); and of the three who would have access to the computers, two had no functioning software and the third said his software package was only partially satisfactory.

Table 1: Term Duration, Amount of Field Work and Distribution of Teaching Load.

Item	1984 A	1984 B	1985 A	1985 B	1985 C	1986 A	1986 B
Weeks Duration	14	15	15	15	15	16	15
Field Trips (days)	7 1/2	8	8 1/2	10	10 1/2	9	9 1/2
Instructors	Classroom Contact Hours						
Administrators							
Kaew	9	3	0	0	12	0	0
Atwell	39	3	3	3	21	12	6
Expatriate Staff	237	132	285	417	300	255	219
Asians	42	15	18	36	45	84	93
All Faculty *	48	0	87	78	9	36	48
Guest Lecturers	1	0	9	24	3	36	9

* This reflects the number of hours in which all members of the Faculty were schedule to be participating as a group in the discussion or laboratory time. These totals do not include field trip time.

Table 2: Percentage of Time Devoted to Key Topics

Subject Matter Covered	Percent Time
Orientation	1.1
Basics/Background/Matter & Energy	4.2
Cartography, Mapping & Photogrammetry	3.0
The Resource & Legends	3.2
Visual Interpretation	9.2
Radar & Thermography	3.0
Project Planning and Management	1.8
Managing an Image Processing Facility	0.6
Student Project Planning and Execution	19.4
Information Verification & Ground Methods	2.3
GIS Principles & Practice	2.8
Applications and Case Studies	4.1
Library, Future of R/S & Roundtable	2.8
Field Work	14.9
Total	100.0

The courses over the last 8 terms have averaged 15 weeks and ranged from 14 1/2 to 16. Field trips have ranged from 7 1/2 to 10 1/2 days total duration. This field time would add to the totals under Student Project Planning and Execution if included in the table.

Since two interviewees had made a strong point that "lots of people in the region are trained and doing visual interpretation now", the question was asked, "Do you have available at home a good mirror stereoscope for photo interpretation?" Only 50 percent of the respondees answered yes and one additional person had access to a pocket stereoscope. It appears that both from the training and the equipment points of view we have a way to go to ensure that all trainees will be able to do the work for which they were trained at ARRSTC.

This represents an area where the outreach and cooperative demonstration project idea could really pay great dividends merely by a consistent and effective follow-up program to continue contact, assistance and work with graduates.

Primary Points of Curriculum Deficiency:

The total analysis of the curriculum and student contacts reveal four (4) areas where strengthening is essential. Only one is in a technological area, the other three concern a) the perspective and purpose from which the subject is approached, b) the philosophy of remote sensing as a system of mutually supporting technologies and skills and c) the roles of landscape ecology and legend design in efficiently producing comprehensible and sufficiently accurate in formation for decision making about those landscapes. The four needs are:

1) Consideration and planning of remote sensing applications from an awareness of a recognized problem and an orientation to specific information needs. Given this emphasis, the new practitioner thinks from an identified problem and need rather than from the viewpoint of all the great things the technology can do -- going, after the fact, in quest of a user with a need.

2) Presentation and treatment of remote sensing as a system of interrelated and mutually supporting technologies from which the best combination or most appropriate system element is focused on each applications project.

3) Emphasis on the importance of the analyst's understanding the resource, the landscapes under study, to the point that he knows what to expect as he analyzes and interprets each landscape. The curriculum should create a realization that even digital analysis cannot convert spectral numbers into information in a vacuum of knowledge and understanding. Achieving this requires that the analyst understands landscape classification and legend theory well enough to successfully translate this understanding into a comprehensible mapping legend appropriate to the information needs of a client or user.

4) It is vitally important to instill a realization of the critical importance of verification of interpreted results in the mind of the trainee. This is essential before a final map and/or report is turned over to the client (information user). This implies an ability to develop reliable verification statistics and to present those data on accuracies, commission and ommission errors comprehensibly to the

client. He in turn must appreciate the limitations of the data in advance of their use in the decision process.

Recommendations on handling of these deficiencies are made as a part of comments on the new curriculum format in the section on Future Program.

Teaching Accomplishments:

Situation: In their Project Paper and in the Contract with AIT, USAID suggested the goal to train 300 students by the end of the contract period.

Performance: The program has performed very well in relation to this goal. At the end of the September 1986 term ARRSTC will have trained 290 students from 12 of the 25 countries USAID listed in their regional scope and from 6 countries outside the region. Based on a questionnaire mailed to all ARRSTC alumni, 86 percent have actually used their training since returning home and 65 percent have received promotions or now have greater responsibility partly as a result of the training. 49 percent have done further research after training, 96 percent expressed interest in additional ARRSTC Workshops and 88 percent expressed interest in a diploma or degree program. About 1/3 of the students have been women and 4/5 are in the 26 to 40 year age bracket. 26 percent of the responders are geologists and 20 percent are from agriculture, plant and soil science. The remaining disciplines are represented by less than 10 percent each. Many diverse disciplines have been influenced by the program. 39 percent of the respondees are presently in teaching or research where their impact is proportionately greater than if they were simply in a management or service agency.

From this brief summary of statistics, it can be said unequivocably that the ARRSTC training program has had a strong, positive impact on the region and the program is well received.

Determinants of Student-Teacher Ratios:

An important factor in teaching load evaluations is the small groups required for effective work with these kinds of resource evaluation applications. Effective teaching of remote sensing techniques and skills requires direct supervision and assistance in small groups, especially while students are learning procedures. Another important factor is a result of the diversity of background among the students and their generally limited understanding of resource ecology and land cover types. Such people require close supervision and frequent one-on-one help. The May 1986 graduating class indicated that the 5 people placed on one terminal was definitely too many, that 3 would be much better for the hands-on learning experience but that 4 were desirable in view of the large amount of work each team had to do on their projects. The Consultant concurs that, as a learning experience, 3 is ideal and whenever number per terminal or stereoscope exceeds 4, at least one or two trainees are shortchanged with the disadvantage always accruing to the less aggressive, retiring students.

Evaluation, Teaching Load and Available Time:

The current curriculum was thoroughly evaluated by careful perusal of all course outlines for the past three terms and preparation of a summary of broad categories covered in the courses. The weekly lecture and laboratory topics and teaching assignments were then summarized for the May 1984 through the May 1986 terms and these results were tabulated in a Contact Hours and teaching load summary, Table 3 (see also Appendix E). Finally a comparison was made between the current program and the proposed new 12 week program. These tables are self-explanatory and the implications obvious. A more detailed evaluation of teaching loads in relation to staffing is presented in a later section.

Student-Staff Relations:

The student-staff relations at ARRSTC are very good. The students respect the staff and respond well to them in discussion and other sessions. Most of the staff make themselves available to the students as counselors and advisors in connection with the major field problems which the students must plan and execute themselves. The staff do not appear to lead any students by the hand, which is good; they leave developments in this area to student initiative as it should be.

The staff also takes the initiative in maintaining contact with students whenever they travel to countries in the region where alumni live. Recently the Director traveled to Malaysia and Dr. Apisit to Sri Lanka. In each case contacts with former students was on their agenda. In addition, the staff responds promptly to former student inquiries which they receive in small but consistent numbers. All of the staff appear to be active in this regard.

Physical Facilities:

The physical facilities for ARRSCT are made available by AIT as part of their contribution to the program. These facilities consist of a well grouped complex of staff offices, an ample conference room, a visual image interpretation laboratory, three separate digital analysis laboratories, and a photographic laboratory.

The secretarial office and storage room is equipped with files, two photocopy machines, work table space, an IBM PC with dual floppy-disk drives, Fujitsu Micro 16 with external hard disk drive, a computer mainframe console, two dot matrix and one letter-quality printer and two electric typewriters. The room is large enough that activities can involve all this equipment without confusion or crowding. An additional IBM PC is housed in one of the digital laboratories and can be used with Wordstar, d Base III, Lotus 1,2,3 or other software packages. Students are trained and encouraged to use this equipment in their report writing.

Table 3: Summary of Formally Assigned Class Contact Hours by Staff

Staff Person	Total Class Contact Hours Per Term*									
	J'84	A'84	S'84	J'85	M'85	A'85	J'86	M'86	Mean	S'86
Kaew	5	0	5	0	0	12.5	0	0	2.8	32.5
Atwell	32.5	17.5	2.5	2.5	2.5	17.5	10	5	11.3	
Johnson	60	55							57.5	
Hodson	90	20							55.	
Lind	92.5	22.5							57.5	
Borel	5	35	30	25.8	75	20	45	22.5	32.3	65.5
Fox	.5	40							20.3	
Apisit	72.5	65	25	10	20	17.5	45	37.5	36.6	62.0
Sathit	42.5	2.5							22.5	
Samut		7.5	0	5	7.5	22.5	22.5	22.5	12.5	9.0
Golden/Rudahl			90	60	65	57.5	42.5	40	59.2	
Bryan			60	17.5	15				30.8	
Lukens**			40	25	37.5	25	2.5	10	23.3	
Worcester			15	27.5	15	27.5	20	15	20.0	
Kozminski				15	37.5	17.5	15	17.5	34.0	28.0
Gachet				15	72.5	32.5	27.5	22.5	34.0	
Guest Lecturers				7.5	20	2.5	10	5	9.0	
Korapin	5									34.0
KAY										33.0
Other AIT (HSD)										19.0
Visiting Faculty										12.0
Field Trips***	60	64	64	68	80	84	72	76	71.0	
Problem Work****	87.5	118.	55	77.5	75	62.5	62.5	85	68.2	
No. Lectures	55				67	66	56	52	59	
No. Laboratories	58				39	43	49	52	48	

Total Hours in Term - 525 hrs

* This tabulation summarizes lecture and lab hours for which the individual had responsibility deisgnated by name in the class sched- ule. It does not include extra time working with small groups in laboratory, a heavy part of the teaching load, or where the schedule designated full "faculty" responsibility.

** During the last two terms Dr. Lukens devoted substantial time to NRDM program design; when teaching only, his total class contact hours averaged 31.9 hrs. per term.

*** Class contact time does not include field trips in which generally all faculty except Golden, Rudahl, Atwell and Kaew participated.

**** Problem work time involved little faculty consultation. None was counted in contact hours.

Equipment, Hardware and Software:

Visual Interpretation Laboratory:

The visual interpretation laboratory is adequate in size and is equipped with 15 Abrams pocket stereoscopes, 15 height-finders (parallax bars) and 15 Philips mirror stereoscopes. The mirror stereoscopes are really not adequate for proper instruction or project work because they do not allow binocular magnification and are slow and clumbsy to set up and adjust.

The lab includes professional-quality drafting and cartographic work stations with attached drafting machines as well as 5 light tables, one KEK stereoscopic plotter and one B&L mono zoom transfer scope.

The equipment also includes a color additive viewer but, in the Consultant's opinion, now obsolete and occupying space that could much better be used with proper facilities for stereo viewing color transparency film (such as a Richards-type light table with stereo scope and color standardized light) or a stereo zoom transfer scope. Acquisition of these items is not high priority because of the difficulty of getting access to state-of-the-art aerial photography in Thailand. However, access to stereo SPOT could change this priority.

RECOMMENDATION 1C): The most appropriate initial acquisition would be a stereo zoom transfer scope even though the Center already has a mono zoom instrument. From the training point of view, the Center should eventually have a fully equipped Richards-type light table for the visual interpretation of stereo transparencies as well.

IMPLEMENTATION: If the Center develops a project with a Thai Government agency so they can have access to good aerial photography, including color or false color transparencies, or if they get access to SPOT stereo, opaque or transparencies, they should build some of this additional equipment into the project budgets. It would be an entirely reasonable element of project planning because efficient work from stereo models to updated maps requires this kind of equipment for the most efficient transfer. With the stereo zoom B&L transferscope, interpretation and transfer can take place in a single operation. Many people, given the option, prefer to work from transparencies rather than opaque copies of the aerial photography, especially in the case of color and false color. Thus the importance of the Richards-type equipment.

This could be a most feasible mechanism for acquisition although the inclusion of both these equipment items into a major program support grant should not be overlooked.

The importance of this recommendation is reflected in the fact that the Forestry Department at Kasetsart University has a mono zoom and a stereo zoom B&L transfer scope and a binocular light table for stereo interpretation of transparencies.

RECOMMENDATION 2C/D): Replace the present mirror stereoscopes with a binocular magnifying type (with 45 degree, not vertical mount).

IMPLEMENTATION: This is an important long-term goal. Perhaps some government agency in the region that does minimum work with aerial photography could be encouraged to buy the present stereoscopes. Perhaps some student's agency could buy one for him at a fair price that would help reduce ARRSTC's loss compared to free disposal. In the long run the goal should be to dispose of the mirror stereo scopes the Center has now even at the cost of giving them to a regional agency who otherwise could not have any such equipment.

Adequate storage cabinets and files are available in the ARRSTC Visual Laboratory, but the lab shows neglect in proper filing of the working materials. This appears to have two causes, (1) no senior staff member is assigned responsibility for the facility and (2) ARRSTC does not have a qualified photo interpretation technician assigned to the lab. Such a person could be responsible for this essential housekeeping as well as assist students with interpretation questions. He could keep the laboratory open after hours for student use on special problems, work in support of digital analysis or extra practice and experience in the important art of visual analysis.

Digital Laboratories:

The digital laboratory was not fully functional until after the second American team arrived. The DIMAPS system was not completely upgraded until mid 1984 and tested in 1985. Before departure in September 1986, Dr. S. E. Goldin and Mr. K. T. Rudahl prepared a particularly informative memorandum of conditions and needs in this facility. The quotes and some of the statements that follow are extracted from the work and recommendations of these two experts. Rudahl's full memorandum of 6/11/86 is included as Appendix F.

Since the digital facility was not up to speed at the time of the first class in September 1982, the instructors devoted substantially more time to visual interpretation than has subsequently been the case.

It appears to the Consultant that ARRSTC has two major problems with their digital analysis facilities: a) they are far more diversified than can be justified in a teaching or operational project framework. This makes it difficult and time consuming for the students to learn to operate the different systems so they can carry out their projects; b) the diversity creates a tremendous maintenance overload for AIT to carry, both in hardware and software. In brief summary these diverse systems include:

1) The DIMAPS Mainframe System is based on an IBM-3031 with 6 meg main storage, 4,000 meg on-line disk storage, seven 6250 bpi tape drives and 2 high speed printers. The system is shared by 60 display terminals. The DIMAPS has been modified and improved to the point that it hardly resembles the original DIMAPS system and probably could be justifiably renamed.

2) An ATLAS minicomputer System which theoretically is very powerful, but which has hardly functioned since installation and still is not useable.

3) The Numelec Pericolor 1000 System is a good menudriven system which the French are proposing to replace soon with a larger and better system. The present system has quick response time and is popular with the students.

4) Two ERDAS Microcomputer Systems are currently available and based on the IBM-PC/XT with good support peripherals.

In addition ARRSTC also has a pair of OPTRONICS Scanner/Plotters that provide high quality input and output devices for research and contract work, but not without frequent maintenance and other problems. Other peripherals are available, see Appendix F.

Except for the exceeding diversity, ARRSTC has a very high level of capability in the digital area and is in a strong position to provide state-of-the-art instruction in this area provided they make some changes in instructional format that builds greater trainee awareness of the complementarity of visual and digital analysis when actually used together.

Photographic Laboratory:

This is a critically important area that ARRSTC management neglected in its developmental program, with serious consequences to student understanding and ability. The problem was made even more severe because it has been impossible to obtain state-of-the-art, "standard" FCC image products from the Thai Receiving Station. Their quality control does not provide consistent color balance and most of the enlarged images lack sharp definition associated with state-of-the-art products.

This problem was further compounded, from the instructional point of view, because ARRSTC did not elect to follow USAID's advice to acquire a good archive of then available Thai images from the EROS Data Center. This should have been one of their initial steps in equipping the Center to function effectively.

The net result has been that the installation of equipment, some of which is still in transit, did not begin until August 1986. The photo laboratory is, therefore, still not functional; and even if it were, a capable photographic scientist/manager is not on staff to manage, train technician staff and insure quality control from the new laboratory.

Following is a list of equipment presently installed in the photo graphic facility:

1. Durst Color Enlarger, CLS 1840
   Durst Electronic Control Unit/ECU 1000
   ESCO Speedmaster Color Analyzer 2010 SM 500

2. Durst B&W Enlarger, CLS 501

ESCO Speedmaster Exposure Photometer, M-100

3. R-3 Color Print Processor w/ mirro-computer controls, KRE-MATIC, KME-31-R3-A

4. B&W Processor, KRE-MATIC, KM-31-2-BW-A

5. E-6 Photographic Processor, WING-LYNCH, Model 4

6. Densitometer, ESECO Speedmaster, 5005 TRC-60-D, w/ transmission and reflection measurement capability

RECOMMENDATION 3A): When Mr. John Castiglia returns in November 1986 to complete installation of the Photographic Laboratory equipment, his offer for consultancy should be accepted as an interim measure to produce whatever photographic products the ARRSTC instructional or demonstration projects needs at that time. The Consultant considers Castiglia's proposal in this regard to be reasonable and cost effective for AIT.

RECOMMENDATION 4AA): When Mr. Castiglia gets the above work done, he must be asked to drain and flush all developing equipment and "mothball" the laboratory until a fully qualified Photographic Scientist/Manager can be employed to supervise, manage and insure quality control in the laboratory.

IMPLEMENTATION: If this is not done when Castiglia is unable personally to supervise the laboratory, it is the Consultant's opinion that the print development equipment will be seriously damaged by uninformed neglect, the reputation of the Laboratory will be in jeopardy from substandard products submitted to clients and a substantial investment is likely to "go down the tube!"

The only exception to Recommendation 4 that can be allowed is on the condition that Mr. Castiglia can be retained as a working consultant to essentially do the required work, insure quality control at the state of photographic art, and personally to insure proper maintenance of the facility. If he should be retained on this basis and have to leave for a time, the facility should again be "mothballed."

It is not considered advisable to have Castiglia attempt to train presently available staff. Recruitment and training of such persons should be left to the Photographic Scientist/Manager eventually hired by AIT. He must have the option of selecting his support staff.

RECOMMENDATION 5A): Following is a job description that should be followed in recruiting the Photographic Scientist/Manager:

Job Qualification: Remote Sensing Photolab Manager
BA or equivalent in photoscience/graphic commun.

A. Five (5) years darkroom experience inc:
   1. BW developing, enlarging, printing
   2. Color processing and materials

3. Preparation, registration of transparencies
4. Mechanical and electrical skills sufficient for design and maintenance

B. Two (2) years facility management experience inc:
1. Personnal mgt and training
2. Photosupply inventory and control
3. Cost-accounting and product orders
4. Image archive and catalogue

C. Experience with graphic arts:
1. Visual presentations
2. Printing processes (letter press, offset, etc.)
3. Layout and design

Estimated salary range: \$30 - 40K (U.S.) if employed in U.S.A.

Additional Photographic Laboratory Needs:

One major omission in planning the Photographic Laboratory equipment will need to be corrected to achieve the potential the Consultant perceives for this laboratory to function at its potential in serving the Asian Region. The most refined and professionally superior way to produce FCC's of satellite imagery is with pin registration of color separation, 9 x 9 B&W positives, each representing one of the three spectral bands. This capability was not acquired but can be added. The photo scientist at ERIM suggested the following obvious needs and approach to a solution.

RECOMMENDATION 6AA): On his next visit in November 1986 ask Mr. Castiglia to prepare a list of all additions to the present equipment plus ancilary items to enable pin registry of 9 x 9 color separation transparencies in making false color/color enlargements. This would include such items as registration punch, pin registry attachements for enlarger, point light source, filters, any additional magnifiers, timers, etc., so that the equipment will work as a system to produce highest professional quality enlargements with this technology. Either with the listing or at an early date, Mr. Castiglia should also tabulate current retail costs of all recommended additions for budgeting purposes.

RECOMMENDATION 7B): Include the above budget requirements in the comprehensive planning and proposal for the future of the remote sensing program at AIT.

IMPLEMENTATION: Since these items cannot be purchased immediately, insure that one copy is placed in the ARRSTC Photographic Equipment file by Khun Thitiya, place one copy in the Presidents ARRSTC file and send one copy of this information to the Consultant as assurance of availability of the information when funds can be raised for expansion of the laboratory capability.

Audio Visual Equipment:

The Center is reasonably well equipped with an investment of about $10,000 in Audio Visual Equipment. Following is the inventory made available to the Consultant:

- 2 Microfiche Readers
- 1 Microfiche Reader/Printer
- 2 Overhead Projectors
- 1 Movie Projector
- 2 Slide Projectors w/ Audio
- 2 Projection Screens

The items that could someday be added are sound facilities so the staff could prepare automatically controlled audio-slide tapes unless the group should decide to go the video route. These kinds of materials can be used to reinforce training or for self study and review. They also present the option of off-campus correspondence study in some areas.

RECOMMENDATION 8C): That AIT strengthen its audiovisual and related drafting and slide preparation capabilities as well as to consider the possibility of well prepared video tapes in support of teaching and self learning.

IMPLEMENTATION: This kind of facility should serve the entire institution. Rarely can a single unit or Division afford the professional quality that might be justified as a single, institution wide facility.

Remote sensing may be a bit unique in that it presents many opportuniti es to use these kinds of advanced learning aids and supporting materials to enhance the learning experience or to reinforce important concepts.

As the extension or outreach program develops, having materials of this type available from the instructional and demonstration project work can greatly increase effectiveness of extension. Where they summarize outstandingly successful, high quality demonstration projects or R&D efforts, audio-visual presentations can be very effective in spreading the word about AIT's capability.

Data Archive:

Computer Compatible Tapes:

As of 9 May 1986 the total CCT inventory at ARRSTC was 108 and of these 72 are in Thailand. These are organized in a readily accessible computerized record from which selections or sub-lists can be prepared. 20 additional MSS CCT's, one TM scene and two SPOT CCT's have been acquired for project work. The non-Thai tapes are from India, Malaysia, Indonesia, Philippines, Nepal, Sri Lanka, South Vietnam and China. There is one USA TM tape and one USA Landsat-4 MSS tape. Five Radar imagery tapes are also included in the inventory. A few CCT's, but no FCC images were obtained from the EROS Data Center. Most are from the

Thai Receiving Station. The Thai TM is from the India Station and the SPOT images from France. The inventory included 45 CCT's on 20 February 1985, increasing by over 100 percent by 9 May 1986.

The unit is also receiving diazochrome transparencies from NRC and as of 19 February 1986 had an inventory of 54 from Landsat 1 through 4 with 32 from LS-4. The unit just recently received another standing order which is not yet indexed. The primary use of these is as screening to decide on orders.

False Color Composite Enlargements:

The Center has less than a half dozen single examples of good quality, 1:250,000 FCC's, some non-Thailand; but as of this writing, none that students can use in laboratory work. On the initiative of the Consultant working with Mr. Willy Baum of USAID/Thailand and President North, it appears that this serious deficiency will shortly be corrected.

A few scenes of B&W Enlargements, 1:250,000, are on hand for student project and field trip areas. These have been used in visual interpretation exercises with some degree of emphasis on landforms and geology.

Quarter-Frame, FCC's from NRCT/Thai Receiving Station, scale 1:250,000, are on hand in multiple copies for use by the students in visual laboratory. These are extremely variable and are not state-of-the-art quality in either definition or color balance. Actually they are misleading in terms of what can be done with visual interpretation of Landsat MSS and should not be used in laboratory exercises. Their only value is in showing students what poor quality looks like and when to refuse to pay for inferior quality materials.

Aerial Photographic Archive:

It is hard for ARRSTC to get aerial photographs to support their training and interpretation work in Thailand because of restrictions of RTG. They have, however, assembled 34 stereo models that can be used on a sampling basis with certain Landsat scenes. Fortunately they have uniformly obtained stereo triplets or quadruplicates and these are all indexed for ready reference by 1:50,000 topo sheet number and by date of photography. They are all B&W at scales of 1:15,000.

The whole of Thailand has been covered twice with B&W aerial photography at a scale of 1:50,000 and 1:15,000. Years of photography in the archive are 1974, 75, 76, 82, 83, 84.

The Consultant learned from off campus interviews that, by developing cooperative demonstration or research projects with Thai Government Agencies, most will be willing to provide AIT with all the aerial photography to which their organization has access and as needed by the project. This is obviously a good way to build support aerial photography that can be used for instruction and student projects.

Table 4: Tape Inventory Summary, September 1986.

Location	No. Tapes	Dates (mo./yr.; No.-mo./yr.; No.-yr.)
China	1	12/73
Malaysia	1	5/83
Nepal	4	3/77,12/82,10/83
India	2	4/83
Indonesia	3	4/83,9/83,6/85
Philippines	2	4/83
Sri Lanka	2	1/83
Thailand	70	35-70's,2-80,17-82,1-83,9-84,3-85,3-1/86
" SPOT	2	8/86
USA	8	7-9/82,1-10/82
Vietnam	1	1/79
Radar Imagery	3	2-7/83,1-11/84
NOAA	6	1-83,2-84,3-85
GMS Visible	1	10/83
GMS Infrared	2	10/83

Library Accessions in Support of Remote Sensing:

The Consultant devoted some four hours to browsing in the library with particular attention to maps and periodicals and in talking with the periodical acquisition and cataloging department. In addition he had discussions with a few ARRSTC students, with the ARRSTC Information Officer and with the Director of the Library and Regional Documentation Center. In addition the June 1986 printout of remote sensing literature prepared by the ARRSTC Information Officer was perused. Following are the findings/conclusions of the Consultant:

1) The ARRSTC students encountered no problems in getting access to all the publications they needed. ARRSTC does hand out a very good cross section of reprints. Students have expressed concern about too much assigned reading, perhaps a good sign.

2) The basic, essential references in English language remote sensing are available. Since English is the official language of AIT and for all students it is a second language, the consultant sees no point in acquiring non-English remote sensing or supporting literature except as it has been translated.

3) In some supporting areas the library is weak, most notable being vegetation and plant ecology. Vegetation science is the foundation of much of the image interpretation work at ARRSTC. Well known North American books on Plant Ecology are largely missing as are writings from the UK and Australia and some important translated European works. Even a small scale vegetation map of Thailand is not indexed, perhaps such does not exist. The FAO Manual on Forest Inventory (1981), some forest soils accessions and 8 forest surveys are indexed as well as the Forestry Bibliography of SE Asia (1982). Most of the "plants" accessions have an Environmental Engineering or water-related emphasis. While there are obvious reasons for this, a serious attempt should be made to correct this deficiency.

4) Another area needing attention is in soils, geology and geomorphology from the resource assessment point of view. These areas are presently covered but from the current emphasis of the concerned Divisions. Accessions added in the morphology, genesis and classification of tropical soils are important. Works on vegetation-soil relationships, on soil responses to land use change in the tropics and on geobotany are particularly relevant. Nothing was found on the UN/FAO soil classification system (other than the World Soil Map of SE Asia, Volume 10). Soils classification concepts from Australia, Canada and UK are not represented in the accessions unless the Consultant, in haste, missed them. Literature in the area of soil suitability/capability needs updating as well. The Australian land systems approach to this topic should be well covered in literature available at AIT. A US Soil Conservation Service publication on Land Capability (1961) and a similar publication of the agency on grazing lands (1962) were indexed, but they do not reflect current thinking of the agency.

5) From browsing in the stacks and examining printouts, a feeling was developed that there was a preponderance of accessions pre-1975 and '76. This was reinforced when browsing in the periodical stacks. The ARRSTC staff assures me, however, that they have been diligent in requesting important books and periodicals in the regular library accessions process.

6) Many remote sensing accessions seem quite irrelevant to SEAsia. Those that address principles or concepts are of course applicable but many do not.

7) Maps coverage, particularly 1:50,000 topographic sheets of Thailand, seems good but suffering from student use and refiling practices. After what the ARRSTC staff has said about the difficulty of access to Thai 1:50,000 togographic sheets for student project work, one can't help but wonder if they made use of the AIT Library Map File, or perhaps the file is not as complete as a quick look suggested.

8) The ARRSTC staff has done a very good job of assembling many key reprints in remote sensing and getting them in the hands of the students. All this is also very well organized in the individual short course documentation, even to the point of heavy redundancy.

9) Just browsing, the Consultant found 9 MSc Thesis titles in which remote sensing had been used in the thesis. Some specifically addressed remote sensing applications problems in the disciplines represented at AIT. This confirms what some of the ARRSTC staff had said about advising students from various Divisions as well as the impact ARRSTC has had on other educational programs at AIT.

10) AIT has developed a computerized library data base with terminals from which students can make their own searches. The printouts, prepared periodically by the Information Officer for remote sensing accessions, are categorized under 19 Key Word selections.

RECOMMENDATION 9C): That the ARRSTC Information Officer devote some time to preparation of a selected library data base of those accessions truely relevant to the regional needs. He may then want to figure out an efficient way to segregate the relevant from the nonrelevant during searches.

RECOMMENDATION 10B): That the ARRSTC staff, on a continuing basis discuss library needs in some depth and recurrently with a view to filling gaps, such as those suggested above and also to strengthening the position of the Library for an eventual natural resources program. A standing list of accession needs should be developed and maintained. The Information Officer should be able to lead this work.

IMPLEMENTATION: Recommendation 10 may not be totally implementable until restoration of the staff and, hopefully, the addition of a plant ecologist or vegetation scientist before it can be given fully appropriate attention.

RECOMMENDATION 11B): When a proposal is prepared for support by a new donor, a budget for library strengthening should be included.

Regional Outreach, Programs and Projects:

One of the very important, original expectations of USAID was that the ARRSCT program would develop, at an early date, a strong and effective outreach or extension program involving cooperative demonstration projects, information dissemination and other services. Second to effective teaching, this activity should have been a major thrust over the past six years.

The Consultant devoted considerable effort to investigations in this area; and, because there had been only one demonstration project implemented by August 1983 and still in progress, a special effort went into an objective analysis of this project. Following is a summary of the Consultant's findings:

Staff Participation:

The staff has been variously active as participants in meetings and seminars; but the amount of involvement has been somewhat restricted, according to comments by departing staff, because of administrative policies of protecting funds for other activities and because of limitations imposed by the Associate Director on the freedom of the American staff to exercise their own initiative in developing outside contacts. Another factor expressed by the Americans during their first year of service arose from uncertainty of an extension of their personal services contract. This may have been imagined, but did dampen early initiative since many worthwhile projects cannot be undertaken in a one-year time frame.

The French staff has been more vigorous in this respect and may now have more project work than can be effectively handled with the heavier teaching commitments in the September 1986 and January 1987 terms.

The Consultant neglected to take notes on many staff activities during interviews because he expected that Trip and Contact Reports would be a routine administrative tool of communication. This not being the case, a complete accounting of staff involvement cannot be given. Suffice to say that most of the staff indicated some to substantial outreach work either on campus, off campus or both. All of the American staff reported follow-up contacts with former students and one gave me a report of actual numbers and nature of each.

Vigorous staff involvement without restraint could have developed a high image of ARRSTC and increased awareness of what the program could offer to the region. If one looks critically at the Time Available Analysis (Tables 5 through 7), one cant't help but wonder why each staff person did not have one demonstration or personal research project under way or completed. The reason of course is the collective failure of the staff in Time Management. Under such circumstances "any job always expands to use up all available time". With encouragement or insistence, the staff and even management personnel could have used the facilities to follow some of their own research and development interests. The combined result of such activity should have been more cooperative projects and a better regional image.

Project Performance:

The Consultant went through the ARRSTC files on Projects and read all project plans and project reports he could locate. He also reviewed the files on project inquiries and correspondence. He talked with project leaders and writers of project proposals when ever they were available. He then selected the following project for an in-depth review.

Critique: Surface Water Evaluation in Northeast Thailand:

This is the only project for which an in depth evaluation be made. In addition to reading the project plan and all project reports the Consultant interviewed two staff members working on the project and Dr. Atwell, Project Leader. Another reason why this project was selected for critical review is that it is the only one about which many people, both inside and outside AIT, had volunteered criticism during discussions. Many people were voiciferous about their feelings that the work was of very poor quality and that it had in fact "reported more water in the dry season than in the wet while offering no explanations."

With this background the Consultant expected to find something quite different than he did discover as he got deeper and deeper into his own investigation. Following are the Consultant's findings in summary:

1. The software experts did a thorough job of developing a good software package for the classification and surface water mapping part of the project. It seems to be close to state-of-the-art and they selected the same superior algorithms that the Consultant would have thought entirely adequate for the job.

2. The Consultant claims no expertise on the hydrological side of the problem so makes no statements about the water demand methods except that it seems to be patterned after a procedure used extensively by the Soil Conservation Service in the USA.

3. The Consultant does feel that the ARRSTC staff probably knew during the proposal stages that a very large amount of software development was going to be needed to bring their DIMAPS and RECOGX up to current acceptability. With no one to ask at this point, it is not apparent from the project plan that this fact was made totally clear to the client. It is said that the client is unhappy about the delays in the project, and software development is one of the major causes. If the client did receive some surprises on the software development costs, then this could be behind some of the criticisms of the project.

4. It was found that, once the software was developed and tested, the procedures used by ARRSTC staff to classify and map water surfaces

were acceptable and appropriate. They probably could not have done better from the computer side alone.

5. They might have saved some embarrassments, however, had they purchased a state-of-the-art quality, 1:250,000 False Color Composite of each working scene. This would have enabled visual interpretation checks on many of the water identification questions that were encountered and which the Consultant found were also a subject of concern to the working staff of analysts. He also learned from the technician analysts that the project leadership was not much help to them in these and other advisory matters. In fact one person indicated that senior management was hardly available for advice and guidance on either how to do the work or how to handle the problems. He described the situation as frustrating. The analyst staff obviously were innovative, diligent and exercised acceptable judgement in relation to their experience level.

6. The quality of FCC images required for this kind of study simply are not available from NRCT. Tapes would have to have been shipped to USA or Europe or possibly Australia for processing. This could have been done on a one- or two-week turn around in USA while the software was being developed or even by sending a duplicate tape while they were developing the multispectral statistics sets for classification.

Especially in the absence of current aerial photography, the impossibility of low elevation aerial checks on a sample of the question able classifications and the recognized difficulty of ground travel in some areas, the omission of not budgeting for and having good FCC's made for a project of this importance is totally inexcusable. For 20 frames the cost would have been 432,000 Baht at present USA commercial rates. Having images made of dry season (at half this cost) would have resulted in a substantial increase in the professional quality of the end product. The FCC imagery could have been used to explain many of the anomalies in the results and to make a "much better than none" error matrix table for both the land cover and the water detection results. Just having such an error matrix table in the report so the client would have known what kinds and magnitude of errors to expect would probably have quieted most or all of the criticism the Consultant initially heard of the project.

Based on information picked up during off campus interviews, the Consultant feels that, had senior leadership made the need for sample aerial photography clear to the client in the planning stages, there is high likelihood that some current sample photography could have been arranged for such an important project.

7. Based on the examination of one computer printout set and a lengthy discussion with Mr. Sadequzzaman who is the present analyst, the Consultant does not believe the number of unexplained anomalies in the data are more than one would expect when classifying and mapping this kind of subject with no ground examination and with computer methods alone.

8. Most of the anomalies/disparities are concerned with dry season results or with a possible mismatch between the wet and dry season locations. All of these could be explained as either a classification error, a mismatch error which should have been correctable, or as a true and accurate fact such as a paddy being flooded or burned shortly before the dry-season image was taken. The most unfortunate situation is that, even though the analysts saw these discrepancies and speculated on causes, the leadership did not stay close enough to the project to know of these concerns or did not consider them worth a field or other cross check.

In fact, Dr. Apisit of ARRSTC told the Consultant he used the same algorithms on a student trainee exercise in water detection with dry season imagery. They classified an unexpected number of water bodies and total area of water surface. Upon trying to determine why, they checked weather records and found that, in the exact area of their study, a few days before the imagery had been taken there was a heavy and unusual storm that was sufficient to account for the unexpectedly high water pond detection rate.

If project leadership had been as astute as Dr. Apisit and just bothered to check out a few of the anomalies, making a tally so they could have created an error matrix table from the results, the criticism that has been leveled at the project would probably have never been raised.

9. It is the Consultant's concluding expert opinion that the results of water detection and differences calculated are by and large useable by the client agency, they are not 100 percent correct, nor should they have been expected to be.

Accuracies may in fact be as low as 60 to 80 percent on small water bodies, on very shallow water bodies or variously silt laden waters. Lakes or ponds with considerable emergent or floating vegetation would have been totally missed or measured smaller in size than they should be. A differential phenological development of rice, if in fact it was growing at both imaging dates, would be another source of error as could even be the effect of strong winds on water surfaces at the instant of imaging.

Further, on large bodies of water (a hundred hectares and larger) it seems highly probable that accuracies could be expected in the vicinity of 90 to 95 percent (consistent with the projects checking of comparative acreages in Phase I).

Very small ponds, approaching the detection threshold, may have error rates no better than the flip of a coin. This is not only because of their small size but because such ponds tend to be shallow and if the bottom shows through clear, very shallow water the pond might look like wet soil. In addition, such ponds are more likely to have floating and emergent vegetation which would cause them to be detected or undetected largely on the basis of the proportions of vegetation and water.

Mr. Sadequzzaman stated that in developing the spectral class statistics he tried very hard to anticipate situations that might be confused with water (cloud shadows and shaded steep slopes, marshes, etc.) and to develop unique recognition signatures for these features-- thus creating a maximum likelihood that they would be segregated from water, not confused with it. In addition, new sets of classification statistics were developed for each date and each Landsat image -- standard operating procedures. One can expect no more from the analyst and the computer alone. Assuming reasonable care and highly critical work in developing the statistics for recognition, this is state-of-the-art performance from the computer analysis side alone. Failure to check anomalies is not state-of-the-art, nor is it professional.

Mr. Sadequzzaman further told the Consultant that he started on this project early this year, had never done this kind of work before; but that he had absolutely no advice or consultation from the project manager even when first starting to work. He learned what he could about procedures from other staff who were leaving and the rest he learned on his own. He was not told to check probable causes of anomalies, but he had noticed some of the same kinds of inconsistencies the Consultant had asked about. He had been able to explain them to his own satisfaction either by comparison with available maps or by natural phenomena that could have accounted for the anomaly. He did not know, nor had he been told, about error matrix tables so he did not think to record the observations he had been making so his own checks could have been organized and calculated in a matrix table format. He asked how to do it so I showed him and provided a real example of such a verification exercise.

The Consultant further suggested to Mr. Sadequzzaman that he do some error checking, as he had been doing, on a number of random sample locations from among the various landsat scenes in the project so he can present some kind of an error matrix analysis to the client with the final report. Since he only has second best material to do this it was further suggested that he look through the tabulations of areas for the kinds of anomalies we had been discussing and that he make a special effort to check out all these with the best maps or ancillary data he has at hand and include these checks in his matrix table. This will at least give the client some basis for under-standing and judging the seriousness of errors which all knowledg-able people are sure exist in remote sensing work.

RECOMMENDATION 12A) After Mr. Sadequzzaman does the best he can to develop an Error Matrix Table, he and a qualified senior person who is knowledgable about remote sensing accuracies should probably go to the client and explain the anomalies, the significance of the verification results and what can be done to avoid these kinds of problems should there be interest in a future update of the surface water picture in the Northeast.

IMPLEMENTATION: Present project leadership has given little indication that they could handle this important public relations task. Mr. Sadequzzaman may be capable of handling this himself. He did very well in his discussions with the Consultant.

It would be possible, by a random or fixed drawing of 3 sure areas, to rerun the water recognition and mapping program at future dates and develop some very useful trend statistics for the client.

The Consultant has purposefully avoided, to this writing, a contact with the client in this case. There is always a chance that there is less dissatisfaction with the project from this quarter than from other professional remote sensing critiques who, like the Consultant, reacted strongly to the fact that any project leader would so subordinate the important step of verification. Perhaps senior management at AIT should check out this point before anyone from the project were to attempt a reconciliation and before the final report (now in draft form) is filed with the client.

ARRSTC News Letter:

The ARRSTC initiated a News Letter in 1983 and has distributed six issues with a seventh in press at the time of this writing. The current distribution list includes 666 names, 136 in Thailand, 5 in the Southeast Asian Peninsula, 21 in mainland Asia, 4 in the Oceanic Zone, 6 in Europe, 3 in Africa, 4 in North and South America (Appendix G).

The News Letter has followed essentially the same format with each issue. The following topics are treated:

A "Highlight Article" covering an important event
News Brief, an Editorial about the Center
Special Announcements, Training/Workshops
Graduating Trainee List
Research News (Projects/R&D Highlight)
Faculty Activities
Faculty Article
Current Events (Meetings and Training World-Wide)
Workshop/Training Course Application Form

RECOMMENDATION 13C): That the Information Officer be given full responsibility for getting information for, preparing and laying out the News Letter. When staff are too busy to write feature articles, the Information Officer could get essential information and prepare such articles anonymously or with the responsible staff person as co-author.

IMPLEMENTATION: Previously American staff members prepared the News Letter. It appears steps have already been taken to move, at least partially in the direction of Recommendation 13. In selecting or writing articles for the News Letter great emphasis must be placed on quality of the work on which the article is based. It must be something that will enhance the professional reputation of ARRSTC.

The News Letter could be a vehicle for correcting or strengthening some of the training elements which, in the past, have been deficient, or have even given students wrong impressions, e.g., the value of visual interpretation. These needs are discussed elsewhere in the Consultant's report.

RECOMMENDATION 14C): That the Information Officer be charged with responsibility for maintaining contact with former students of ARRSTC and most vigorously strive to establish a dialog, create active alumni support and determine the need for project help from ARRSTC staff.

IMPLEMENTATION: There are many advantages to be derived from implementation of Recommendation 14 in this or some other way. One of the greatest is that ARRSTC staff could be of substantial help to alumni in using the knowledge they acquired at AIT. Opportunities could be created to further the understanding or training of former students. These contacts could lead to cooperative projects between former students and ARRSTC, or simply to the opportunity to help former students plan their applications programs.

ARRSTC Brochure:

In 1983 ARRSTC produced its first informational brochure as an insert in the Regional Computer Center (RCC) brochure, having started as a unit within RCC.

A large stuffer designed around a Landsat FCC of the Bangkok region was next used as an advertisement and attention-getter for the new center.

In September 1982 ARRSTC came out with its own brochure in color with a Logo. It was professionally done and informative. This was a 15 x 21 1/2 cm brochure. It was subsequently redesigned and printed as a 10 x 21 1/2 cm envelope stuffer. This edition includes an inquiry address and a tear-off training application form for use by people who either want more information or are interested in training at AIT.

RECOMMENDATION 15B): The ARRSTC Brochure should be up-dated from time to time and liberally used in mailings.

IMPLEMENTATION: A totally new brochure would be appropriate after AIT has responded to the recommendations in this report.

Asian Remote Sensing Information Center:

The Library and Regional Documentation Center at AIT has established 4 successful Asian Regional Information Centers, some of which have become nearly 50 percent self-supporting through subscription and service fees after approximately 10 years of deliberately planned development and service. These centers are each limited to the interest of individual Divisions within AIT.

Within their subject matter areas of responsibility, each has developed a computerized listing of books, periodicals, journal articles reports and other relevant writings that can be searched to meet specific needs of subscribers. They vigorously acquire accessions within their responsibility that are relevant to Asian Regional needs. They publish periodic lists of all accessions on hand with titles, authors and a key word index to facilitate literature searches. They publish abstracts of AIT reports and publications, a periodic news letter and in some cases publish a professional journal limited to their subject matter area for researchers in the Asian Region.

The UNDP/ESCAP Mission on Regional Remote Sensing Programme of 12 May 1980 recommended that such a facility be set up for Remote Sensing in the Asian Region and recommended AIT as a logical and experienced home for such a service.

Pursuant to this interest and need, ARRSTC has employed an Information Scientist. He has initiated planning in this direction while helping ARRSTC to meet its information dissemination commitment. In February 1985 the Information Officer had drafted a proposal in cooperation with the AIT Library and Documentation Center and distributed it to potential donors and others for review. The proposal attracted some opposition as duplicatory of aspiring interests of other groups who, since 1980 have moved in the direction of information servicing. With this development, ARRSTC management moved the idea to the back burner; but the Information Officer is still on staff, having recently taken over the news letter and other duties relating to student records.

The Consultant has had lengthy discussions with the ARRSTC Information Officer, with the Senior Information Officer in one of the established Regional Information Centers and with the Director of the AIT Library and Regional Documentation Center. In addition he has carefully reviewed and commented on the proposal by ARRSTC.

This is an important regional service; but, in view of the funding and support hiatus ARRSTC now faces, it is most fortunate that the proposal was withdrawn. Other concerns and priorities for ARRSTC now transcend the immediate establishment of an Asian Remote Sensing Information Center.

RECOMMENDATION 16A): That the reconsideration and revised planning for an Asian Remote Sensing Information Center be brought to life only as a part of the planning for the Natural Resources Program and the future of ARRSTC.

IMPLEMENTATION: It is imperative that planning for the information center not be revived as an isolated, single effort. It can only be done as an integrated part of planning and design for the larger picture. Its planning should only move ahead if put in the perspective of its potential role in and contributions to the objectives of integrated natural resources development, part of which is resource assessment and monitoring.

Completed and On-Going Projects:

Forest Monitoring: Cooperative with Environmental Engineering Division AIT; Project Leader, Dr. Denis Borel (ARRSTC) and Dr. Herman Orth (DEE); TITLE: Effect of Deforestation and Agricultural Land Use on the Nutrient Level and Suspended Solids Load of Tropical Streams; STATUS: ARRSTC's part on the resource assessment and mapping phase is completed; supported by EEC.

Dadaelus Scanner Data: Assisted Thai Airforce in making analog to digital conversion of Dadaelus Scanner data and with data analysis; Project Leader, Dr. Kaew Neualchawee & Dr. Buddy H. Atwell. STATUS: Completed, some separations successful, some unsuccessful.

SPOT Evaluation Program, PEPS: Cooperative with the Mekong Secretariat; Project Leader, Dr. Denis Borel; TITLE: Preliminary Evaluation Program for SPOT (PEPS). STATUS: Just beginning, imagery very recently received, initial field work done, on back burner because of heavy teaching load through January 1987 term supported by French Government.

Human Ecology: Cooperative with or a part of the PEPS project; Project Leader, Dr. Lind (supported by Fulbright Scholarship); TITLE: Human Ecology of the Mekong Valley, A Remote Sensing Study. STATUS: Was held up initially because of delays in availability of data from SPOT.

NE Water Monitoring Project: Conducted for National Economic and Social Development Board (NESDB) Thailand; Project Leader, Dr. Buddy H. Atwell (terminated 31/8/86), Dr. Kaew Nualchawee, Coinvestigator; TITLE: Surface Water Evaluation in Northeast Thailand: A Pilot Project Using Satellite Remote Sensing. STATUS: Nearing completion, projected for November 1986, most analytical work done, final report drafted, some verification work remaining.

Geomorphological Interpretation Guides: Conducted with support from Thailand National Research Council (NRCT); Project Leader, Dr. Apisit Eiumnoh; TITLE: A Preliminary Study on Soil-Geomorphology Mapping by Remote Sensing Techniques. STATUS: Just beginning, some imagery on hand.

Outstanding Proposal: To Sri Lanka on rice crop monitoring; Project Leader, Dr. Kaew Neualchawee. TITLE: Remote Sensing for Agricultural Development: A Case Study on Rice Cultivation Monitoring in The Sri Lanka by Analysis of Remotely Sensed and Ancillary Data. STATUS: Not awarded, are other proposers.

Perhaps the best indication of Regional interest in projects is found in responses to an ESCAP/RRSP questionnaire. 65 percent of the respondees listed the following areas of interest in order: GIS, Digital Image Processing, Vegetation Studies, Soil Surveys, Fisheries Resource Survey, Marine Resource Survey, National Hazard Monitoring, High Resolution Data Analysis, and Coastal Zone Monitor ing. In the 50 to 65 percent interest group, the following were listed: Geology, Oceanography, Agriculture, Forestry, Mineral Exploration, Cartography, Meteorology, Surveying and Water Resources. While there is some redundancy and conflicting priorities in the listing, ARRSTC would do well to consider these indications as they develop additional projects in the dry period between fundings.

Projects Management:

The Consultant went through the full project file and judging from the latest correspondence in many potential project files, follow through has been very lax. There were a number of instances where the most recent letter was to ARRSTC with no indication in the file that the questions, expressions of interest, etc., has been answered. A number of staff members expressed concern to the Consultant that this was a problem needing attention.

Workshops:

The staff has conducted a number of workshops in addition to the short course program. These seem to be in about the right proportion, one or two per year with some repeats, e.g., Geobased Information Systems. There are proposals in the wings for additional workshops and the departing American staff members left three proposals behind for possible implementation by the remaining staff or by short-term return of the proposers.

RECOMMENDATION 17A): That all workshops and seminars be "put on the back burner" until a new donor is found and the professional teaching staff restored.

IMPLEMENTATION: Available energy and time will be better invested in development of program plans and strategies for the future as first priority and project and/or technical assistance cooperation in Thailand or border countries as second priority.

Management of ARRSTC Program:

The Consultant was specifically asked by USAID to evaluate management of the remote sensing program. He felt this should be done from three viewpoints, USAID oversight activities, ARRSTC itself and AIT's role as host of the facility.

Looking first at the USAID side, it is now unfortunate in hindsight that they insisted in setting up the unit budgetarily indedpendent of AIT's normal fiscal control procedures. This was done on the logical conclusion that the large amount of equipment purchase could be handled more efficiently in this manner. For essentially the same reason the decision was made to establish an Associate Director position within ARRSTC primarily to free the Director of all such detail. Since USAID normally operates on a "buy USA" policy, it seemed entirely appropriate for the Associate Director, an American, to handle these details directly through USAID. As it turns out now, this made it impossible for AIT to exercise the measure of fiscal oversight that was needed and the unique budgetary and management independence of ARRSTC had some unfortunate side effects.

Further from the USAID side, monitoring of the project was lax until Mr. Willy Baum was assigned this responsibility within USAID/Thailand. The most surprising discovery by the Consultant was that there was no insistence on an annual progress and performance report from ARRSTC as specified in the USAID-AIT contract. Had this been required by USAID, it should have brought to light, at least by mid-project, some of the deficiencies in project direction and emphasis and the need for some new arrangements. At that time, needs could have been met with much advantage to the program. More of USAID's expectations might have been achieved, even though there might not have been the "savings" that enabled a sixth year of operation under the grant. The serious shortfall in obtaining quality hard copy imagery for student use could easily have been corrected at an early date, had USAID known that orders for imagery and a selected archive of CCT's were not placed in USA as recommended.

It is understandable that the 4-month progress reports might have been waived, but the exercise of preparing an annual assessment would have had many spin-off benefits to ARRSTC staff and management. Even the annual reports from individuals required by their Personal Services Contracts were not followed up and none were prepared.

In the early days of the project it appears that the Mission lacked personnel to take an active and understanding role in monitoring such a complex, high technology project. It seems also that the project was primarily an outgrowth of USAID/Washington interest in fostering satellite remote sensing applications -- possibly not totally compatible with the Mission's priorities at the time, although a preplanning mission to the Asian Region was conducted and recommended favorably.

In retrospect it would have been a good investment had technical staff from USAID/Washington maintained contact with the project in the early stages. As an alternative (for its value as a guideline for the future), they might have assigned a technically qualified natural resources person with remote sensing experience to the Mission as project monitor or engaged a single, well-qualified consultant to monitor the project on a 12 to 18 months interval and provide 4-way advice to the Project, AIT, USAID/Thailand and USAID/Washington. Considering the potential value of the technology in AIT's service area, one of these alternatives would have been a justifiable project overhead cost and achieved a better balance between problem-solving project work, extension activities and short course training.

Again in retrospect, and recognizing the mutual confidence that prevailed at the outset, it is unfortunate that AIT did not insist that budgeting and fiscal management of the project be subject to their normal accounting and oversight procedures and that they did not further insist, from their position as contract signatory, on the preparation of an annual project accomplishments and planning report by ARRSTC management and staff.

Lack of the annual assessments and other kinds of documents normally expected from day to day project management greatly increased the amount of research and inquiry by the Consultant and substantially complicated his work, although recognizing that he was contracted to do whatever was necessary to achieve the objective, in depth evaluation.

All the above not withstanding, the fact remains that many of the kinds of documentation customarily considered a part of internal communications and effective administrative-management are not be found in the ARRSTC files. To mention a few important examples:

There was apparently no policy on Contact Reports to keep Management and Staff informed of important discussions staff and management had within and outside ARRSTC that might affect work performance and effectiveness of the team. Some were prepared by individuals on their own initiative.

Although established as a requirement in a recent memorandum to staff, travel seems inadequately documented by essential brief reports. The file contains 7 travel reports by members of the initial American team, some by the current French team, one by the Associate Director, a large number of inappropriately detailed travel reports by the Director, and none by the recently departed American team. The substantial travel expenditures, much of it outside Thailand, seems to have produced very little tangible results in terms of intraregional cooperative projects or program support beyond scholarships.

All this is related to the most common complaint registered by ARRSTC staff that communication within the staff and between staff and management was poor to the point of inhibiting/complicating effective work.

Budget planning and actual cost accounting records for the USAID funds seem not to exist outside of records maintained by USAID/Thailand and the Standard Form 1034 submitted to USAID/Thailand with paid receipt copies requesting reimbursement to AIT/ARRSTC for expenses incurred. The USAID grant seems to have been treated merely as one large fund with no line item planning other than that established by USAID. As of this writing the Consultant has been unable to obtain an annual (or other) summary of actual project operation costs by the usual line items of Salaries and Wages, Equipment, Travel, and Operations Expense. Neither has he been able to obtain from ARRSTC a current indication of unobligated balances in the project. The Consultant was able, however, to obtain a summary of AIT's contributions to the project. By a combination of diligent work by the ARRSTC head Secretary and the Director of Finance, Khun Pongsagdi and Financial Accountant, Khun Narong, the Consultant was able to put together Table 5 showing the important contributions of AIT to the remote sensing program.

Other than a superficial, inadequately documented 5-year plan for the period 1986-90, no forward looking planning seems to have been done by ARRSTC management.

Curriculum and individual course planning and development has been well handled by the responsible ARRSTC staff. This work has traditionally been guided by a rotating Curriculum Coordinator designated from among the staff. Other than this position, no oversight or technician supervisory authority seems to have been delegated to the senior staff.

Table 5: Financial Contribution of AIT to the Remote Sensing Program

Budget Items	1-6/83	83-84	84-85	85-86	86-87	Total
		FISCAL		YEARS		
Total Exp. only:	$ (7,000)	$(22,500)	$(20,000)	$(25,481)	$(23,148)	$ (98,165)
DISBURSEMENTS						
Sal.& Assoc.		69,661	81,021	82,571	107,333	233,253
Expenses		20,947	19,243	24,481		64,671
Postage		1,685	1,275	1,839		4,799
TOTAL		92,293	101,539	108,891		302,723
Overhead (Facil.)		48,763	56,715	57,800		163,278
Computer Services		129,788	95,684	93,760		319,232
Grand Total		270,844	253,938	260,451		785,233

Staff Load and Non-Teaching Time Available:

The Consultant made some calculations of staff teaching load in terms of contact hours. The calculations were based on a summary prepared by Dr. John Lukens of the number of half-day periods each of 12 staff members contributed to Lectures, Exercises and Demon Demonstrations, Field Trips, and to Advising, Project/Planning Critiques and Miscellaneous Lectures for the January 1986 Term. Since the curriculum had become quite stabilized, this gives a good measure of staff load under the current instructional program. It also enabled an objective look at the amount of time the staff realistically had available for non-instructional activity (Table 6).

Note from Table 6 that organization of field work into five separate and transportationally independent teams requires five supervisory staff (faculty or locally knowledgable technician staff fully competent in ground truth and verification procedures) to accompany each of the five field working groups. This requirement fixes the minimum size of faculty plus fully competent field technicians. A total of five must be available to the instructional program. The culmination of training is the field problem which each of the five trainee working groups has individually designed.

In a separate analysis, the Consultant had already determined that the time allocated to instruction varied substantially among the staff from term to term; but the totals in the last three terms were quite consistent with the above Table 6. The term totals and averages per staff position are summarized for easier evaluation in Table 7.

If one looks at these data (Table 7) in terms of the 8 seconded staff members, the average instructional contact hours for the term is 62 instead of 41. However, in this period Dr. Lukens was occupied, except for 12.5 contact hours with resolving viewpoints among AIT staff and rewriting the Natural Resources Development and Management Proposal. Thus the 7 primary instructors had an average of 71 instructional contact hours exclusive of the field trip on which four of them built up an additional 64 contact hours and one an additional 40 hours for totals of 135 and 111 hours.

It is informative to look at the amount of time remaining for other activities in terms of these averages. Given a 15 week course with 4 days of Tai or AIT vacation in this particular term and assuming a maximum, realistic 7-hour work day under AIT travel conditions, there are a total of 6,300 staff hours available in the term. From this, taking the above figures with certain assumptions about class preparation time and allowances for staff self improvement, one finds the average remaining staff time for non-instructional activities as summarized in the following Table 8.

Obviously this average applies to no individual staff member. The 5 heaviest loaded teachers in this term had 95 to 131.5 contact hours and the lightest loads only 5, 12.5 and 17.5 contact hours. The first of these latter three was the Information Officer and the other two the Director and Associate Director.

Table 6: Summary of Staff Contact Periods and Hours, Jan. 1986 Term

Name	Lectures No.	Lectures Hrs.	Labs & Demos No.	Labs & Demos Hrs.	Field Trips No.	Field Trips Hrs.	Advising No.	Advising Hrs.	Total No.	Total Hours
Kaew	2	5.0	0	0.0	0	0.0	3	7.5	5	12.5
Atwell	4	10.0	0	0.0	0	0.0	3	7.5	7	17.5
Borel	10	25.0	0	0.0	10	40.0	12	30.0	32	95.0
Gachet	8	20.0	9	22.5	16	64.0	10	25.0	43	131.5
Kozminski	6	15.0	2	5.0	16	64.0	10	25.0	34	109.0
Apisit	5	12.5	6	15.0	16	64.0	10	25.0	37	116.5
Worcester	9	22.5	2	5.0	16	64.0	6	15.0	33	106.5
Goldin	8	20.0	9	22.5	0	0.0	10	25.0	27	67.5
Rudahl	9	22.5	9	22.5	0	0.0	10	25.0	28	70.0
Lukens	1	2.5	0	0.0	0	0.0	4	10.0	5	12.5
Samut	4	10.0	1	2.5	16	64.0	14	35.0	34	111.5
Ehsan	0	0.0	2	5.0	0	0.0	0	0.0	2	5.0
Totals	66	165.0	40	100.0	90	360.0	92	230.0	278	855.0
Lect+Lab				265.0				265.0		
Class Contact Hrs								495.0		

Table 7: Term Total and Staff Average Contact Hours by Teaching Function.

Item	Total	Average, 12 Staff
Term Total Lecture Hours	165	14
Term Total Lab Hours	100	8
Advising et al. Teaching	230	19
Total Instruction Cont. Hrs.	495	41
Total Field Instruction Hrs.	360	30
Grand Total Contact Hours	855	71

Table 8: Calculation of Average Discretionary Time Available for Non-Teaching Activity.

Item	Balance Time Available
Total Staff Contact Hours, 855 hrs.	5,445
Assume Prep. Time of 1 hr/contact (-106 hrs.)	5.339
Assume 1 day/wk. Self Improvement, (-1,344 hrs.)	4,005
Hours Available, per Staff per Term	334
Hours Available, per Staff per Day	4.4

The heaviest loaded instructor had an average of 3.4 hours per day available for other ARRSTC functions, the lightest loaded professional had 5.5, the Administrators 5.3 and 5.2 respectively.

The heaviest loaded teacher had 43 contact days out of an available 76 and the lightest only 2. The other 5 primary professors had an average of 34 contact days out of 76.

If one assumes 15 days per year or 5 days per term vacation, the primary teaching staff as a whole had 213 discretionary staff days in the January 1986 term. This total does not include Lukens who was dominantly involved with NRDM or Goldin and Rudahl who were heavily involved with computer hardware/software prob lems, planning for technician staffing and maintenance and some interdivisional collaboration within AIT. The entire staff, adjusted for vacation, had 574 staff days of discretionary time available during the term that they were free to use entirely as they chose or as the administrators might direct to further the non-instructional goals of ARRSCT.

If one considers that a minimum teaching load should be 3 contact hours of lecture plus one 3-hour laboratory or the equivalent in advising, 96 contact hours per term, then the instructor under this load has 260 discretionary hours after allowing one hour preparation per class contact and one day per week for self improvement. Comparable figures for ARRSTC staff ranged from 262 to 407 hours. In making these statements it is realized that there is a discrep ancy between the ARRSTC and the AIT terms, but keeping the comparison on the basis of the same total available time makes more sense than trying to consider the difference in calculating comparisons.

Conclusion, Staffing Plan: This leads the Consultant to the conclusion that, while staff teaching loads range from reasonable to very light, the original design in terms of staff size in relation to intended program was planned in a realistic manner. The jobs to be done included curriculum design and testing, outreach, demonstration projects and regional advisory functions.

Program Impact: The effective use of this extra manpower can, however, be validly criticized at this six-year point in the program. When available time and total funding level is weighed against measurable and documented outreach accomplishments, projects performed to high standards, and regional and AIT collaborations matured, the record is dissapointing.

When it is further seen that the leadership failed often to keep its staff informed so they could cohesively and vigorously work together in a timely manner for attainment of common, agreed upon goals, it can only be concluded that a large, total amount of staff time was not well used.

Strengths and Weaknesses of ARRSTC:

Particular Strengths of the Program:

1) Dominantly a very good curriculum with substantial depth of training, especially in digital analysis, but a scope that may not be maintainable under the new curriculum pattern without adding more courses.

2) Some truely superior features of training -- the two most creditable are the excellent field problems, the project planning procedure incorporated therein and the thoroughness of the digital analysis presentation.

3) Teaching staff is motivated and dedicated to doing a good job in spite of a few challenges here and there.

4) Strong evidence of emerging leaders among the group who have risen to the occasion when needed.

5) Curriculum and courses have been dynamic, having evolved into something very good although not without a few serious weaknesses. The curriculum has stabilized over the past three terms but is in no way stagnant.

6) Very good digital analysis facilities and adequately equipped in the visual analysis area.

Particular Weaknesses of the Program:

1) No operating photographic laboratory; and, even though equipment was installed in August 1986, there is no competent person available to operate such a sophisticated laboratory.

2) All of the working FCC's on hand are so substandard they are giving students a totally erroneous impression of what can be done with visual interpretation of Landsat MSS. Students do not appreciate or understand the complementarity of visual and digital analysis.

3) Inadequate aerial photo coverage of field work areas. Difficult but not impossible to obtain under RTG regulations. Staff has settled for less than need be had they developed more cooperative projects with Thai agencies.

4) It is impossible to perform low level aerial reconnaissance in Thailand because of RTG restrictions.

5) Program leadership has not measured up to USAID expectations.

6) In spite of many titles, the library on remote sensing has a few weak areas. Many of the titles are not particularly relevant to Asia. Many of the expatriate instructors have brought their own critical materials. Background information for doing a good job of ground truth documentation is an area of particular marginality.

7) Entirely too much diversity in digital hardware for efficient instruction and effective learning. In the absence of a firm policy ARRSTC has succumbed to pressure from those who want their systems visible to the student audience as a marketing tool.

Interrelationships within AIT:

In the initial period there were apparently a few misunderstandings that had to be overcome. This resulted, in part, because of the way USAID set up the program in relation to AIT administration and secondarily because of instructions given the first American team to get on with program development and, because of the urgency of this activity, not to become involved in AIT affairs. The reasons for these actions appear not to have been made known to AIT staff so for a time the ARRSTC staff were referred to by some as "those remote people."

This situation has been entirely corrected and, especially with the recent activity lead by Dr. John Lukens, a healthy relationship now exists.

In the Consultant's on campus contacts, two questions pursued in all interviews were: a) What are your perceptions of the ARRSTC program? and, b) With the funding problem that now exists, or for other reasons, should the program be discontinued? In every instance, the response to the first question was positive, although sometimes constructively critical. In no instance, was a view expressed that the program should be terminated, although the option of temporary suspension of the short courses was mentioned if funding support caused a drop in quality of instruction.

The potential for continuing to build an outstanding program of training in the assessment and monitoring of natural resources not only still exists, but the environment for even greater service to the Asian Region is better at AIT than any other location known to the Consultant.

Curriculum within AIT:

By bringing the remote sensing training program into the AIT course format, there are a few disadvantages which the advantages far outweigh. Although just now in transition, this development is indicative of the maturity of the original training concept. It is the first definitive step toward the goal of "full integration into AIT" which the donor envisaged. Others have very recently been taken by the President's office.

Some of the obvious advantages are: 1) the potential for future development and service are much greater; 2) better service to AIT students; more flexibility to build varying levels of remote sensing training into other Divisional programs; 3) AIT students can now develop a minor Area of Study in remote sensing to support their Masters thesis work and enhance their professional skills and knowledge; 4) ARRSTC trainees will be able to get full university credit for approved courses and eventually receive a diploma; 5) easier to adapt a curriculum to an individual's background and career interests; 6) a student can start wherever he is qualified in the course sequence and eventually should have the opportunity to do special advanced studies in the AIT laboratories and under faculty guidance; 7) by the addition of a few courses, some truely advanced and of graduate caliber, students will have an opportunity to return or come initially for advanced study, all within the framework of one program; 8) students will eventually be able to learn much more and gain higher levels of skill in remote sensing applications; 9) it opens the door eventually to consider an MSc degree in Remote Sensing of AIT.

The approved curriculum now consists of five courses developed out of the former short course experience, the first two of which may be taken by general AIT students. Eventually, they will probably be able to take the full sequence if their major course of study will allow. This gives a stability of enrollment and potential permanence to the remote sensing offerings.

There has already been a reciprocal relationship between the ARRSTC staff and certain of the Divisions in AIT. Some of the remote sensing staff have served, both formally and informally as thesis advisors and a number of MSc thesis investigations have actually used remote sensing. In the September 1986 term, there are 14 AIT students out of a total of 36.

If financially revived and strengthened in some very important staff areas, the remote sensing program will become an important contributor to many degree programs at AIT. It will enhance the institution's contribution to regional educational and training needs and stimulate essential improvements in the ways in which natural resources development and management is planned and implemented throughout the Asian Region.

Planning Involvement with AIT:

The major area of significant planning engaged in by ARRSTC has been its leadership in the reiterative growth of the Natural Resources Development and Management (NRDM) idea. This had been through at least two iterations when Dr. John Lukens, of the ARRSTC staff, was appointed Coordinator and undertook to draw AIT thinking together into a viable plan. This has resulted in a lot of dialog among Divisions and has been another influence to cause a growth and maturation of AIT thinking in the direction of integrated analysis and planning among the Divisions. As the Consultant conferred on campus, he encountered no hostility toward the idea. He did encounter some "wait and see" attitude and a number of concerns, most of which he shares; but the general attitude is that the work on this idea should continue to maturation and a fundable proposal that can be taken with confidence and pride to the donor community.

Soon after arrival the Consultant studied Dr. Lukens' then current draft of the NRDM proposal and commented at length on it. He had many discussions with Lukens on aspects of the proposed program. The potential program that could grow out of the NRDM idea is much greater than initially envisaged. Something new in the way natural resources development is planned is urgently needed in all developing countries. The kind of program that is really needed will be exceedingly difficult to put together and to manage, but it can be worth the effort. More attention will be addressed to this point later in the report.

Operations and Management:

RECOMMENDATION 18A): That the AIT Bursar immediately take steps to take over full and normal management and supervision of the budgeting and fiscal control process as related to ARRSTC so that all future budgetary matters move from ARRSTC through his office to the Donor agency.

IMPLEMENTATION: This recommendation especially covers any and all future support to the ARRSTC program, whether AIT discretionary funds or donor funds. It is further the Consultant's intent that the same recommendation apply to any residue of USAID funds now existing, once this amount is accurately determined. There is some possibility that the Agency might authorize AIT to use such balances to meet critical remote sensing instructional needs or to enable adequate planning to insure realization of the full potential of an AIT Regional Program in Natural Resources Assessment and Monitoring and in interdisciplinary planning for natural resources development.

The AIT Library and Regional Documentation Center:

This facility is one of the particular assets both to the remote sensing program and to an eventual program in interdisciplinary training for natural resources development and management. The present library is adequate for the former but would require substantial strengthening as a part of a move into the latter kind of program. Details relating to this point are discussed elsewhere in the report.

A unique asset in this regard is the experience AIT has had in developing and implementing Regional Documentation Centers or information dissemination networks and services in specialized areas. A part of the planning that goes into maturation of the NRDM idea should include reconsideration of a Regional Information Service in the combined areas of resource assessment and monitoring and inter disciplinary natural resources development and management, all put together as a unit plan. In this context, the Regional Information Center may drop to low priority.

RECOMMENDATION 19A): When and if a Regional Information Center in the natural resources area is implemented, it should be only part of meeting the greater need for Information Management and Decision Modeling in context of decision making for Natural Resources Development and Management.

Interrelationships External to AIT

National Research Council of Thialand (NRCT):

Thai Satellite Receiving Station Plans:

Considering the new developments in Earth-looking satellites, an important consideration in the continuation of ARRSTC was the intention of the RTG and NRCT regarding upgrading their receiving station for Landsat TM, SPOT and eventually to the Japanese satellite reception. The Consultant learned that NRCT has already moved to upgrade their capability for both TM and SPOT and they are talking with the Japanese about eventual reception of their data. These decisions insure continuing availability of satellite data to ARRSTC and thus make it realistic to place a high priority and value on revitalization and vigorous, agressive development of ARRSTC into a broader spectrum of services.

It is also relevant that use of satellite data from the Thai Receiving Station is increasing dramatically. Through July 1986, for example, the Thai station had sold very close to as much satellite data as they had in 1984 and 1985 combined with a total sale in the first half of 1986 of 5,600,000 Baht ($222,700 US).

Now that ARRSTC has its own photographic laboratory and after they are able to staff the facility with an experienced photographic scientist and manager, the Center will no longer be dependent upon or hampered in its program because of the erratic quality of FCC products from the NRCT photo lab. Hopefully they will soon be able to upgrade the capability of this facility so that their own "standard" image products will be of high and consistent quality as well.

Thai Station Output and Activity:

This information is presented by the courtesy of Dr. Suvit Vibulsresth, Director of the Thai Receiving Station.

Landsat Acquisitions, 1982 to May 1986 were as follows:

1982	-	5,532	Landsat 2 and 3
1983	-	7,309	Landsat 4
1984	-	10,687	Landsat 4 and 5
1985	-	12,302	Landsat 4 and 5
to May 1986	-	7,512	Landsat 4 and 5

The Thai National Research Council (NRCT) is funding the following projects in Fiscal Year 1986:

1. Geomorphic units as appeared on remote sensing imagery.

2. The study of land use and land cover types in the peat swamp forest "To Dang" Narathiwat Province using satellite imagery.

3. Survey of rubber growing areas in Thailand using satellite imagery.

4. Feasibility study of oil palm area estimation in the southern part of Thailand using Landsat data.

5. Micro-computer based Landsat classification software development.

6. On the use of Landsat data to study the extension of coastal land for development planning purposes.

7. Integration and testing of digital package from actual study case on the eucalyptus acreage estimation by Landsat data.

The above tabulation as well as the indications of data sales by the Thai Receiving Station is further indication of the dedication of the Royal Thai Government to remote sensing applications.

It follows, therefore, that this expanding use will create increased need for training, demonstration projects, information dissemination throughout the region and technical advice on applications -- roles that the AIT remote sensing facility can provide from strong imaginative leadership and a highly competent professional staff.

The Canadian International Development Agency (CIDA) is assisting the Thai Remote Sensing Center with applications and demonstrations projects using Landsat and other data.

Universities with Parallel or Related Programs:

The Consultant visited the following departments at Universities in Bangkok:

Chulalongkorn	Kasetsart
Geology and Archeology	Forestry
Botany	Planning
Photographic Science	
Electrical Engineering	
Land Development	
Planning and Development	

The three key findings from all these conversations are that a) ARRSTC's program is respected where it is known, b) there are untapped opportunities for collaboration between ARRSTC and some of the university programs and c) there is a willingness to provide visiting professorships on selected topics, particularly on an exchange lecture basis.

This latter topic should particularly be pursued with the Forestry Department at Kasetsart University and the Botany Department at Chulalongkorn with a view to obtaining lecturers on plant ecology, vegetation-landform-soil relationships and vegetation composition and structure as it relates to image and photo interpretation. The Consultant believes someone from Forestry would be more capable of meeting ARRSTC's need because of the strong program they have in remote sensing as it relates to Forest Management. It did not appear that Chulalongkorn has the expertise in Ecology, Plant Taxonomy or Plant Geography that is needed.

Some expressed a desire to have more contact with ARRSTC than has occurred and further expressed interest in receiving help in planning digital applications projects. Some interest in using AIT computer facilities was expressed, "if affordable."

One person offered the suggestion that ARRSTC should be more involved in helping people in Thailand and the region to plan applications and demonstration projects. One comment was that quite a number of Thai government projects had not been totally successful and the cause may have been inability to do proper planning or to devise appropriate applications.

Another person, who has done some contract or cooperative planning for Thai agencies commented that he had little confidence in the accuracy of most of the remote sensing results without actually doing some field checking himself. He emphasized that a project was not done until an Error Matrix table has been created to alert the user to where the errors are and their likely magnitude.

Another person, in a reasonable position to know, expressed concern that ARRSTC students were "not getting a balanced understanding of the analysis of the ground (or real world) facts," expanding to say that "high visual interpretation capability has to support the digital." The Consultant is in agreement with both these observations.

Feeling was also expressed that the training program at AIT should have a disciplinary thrust.

When it comes to technician level staffing of the Photographic Laboratory at ARRSTC, the Photographic Science Department at Chulalongkorn should certainly be consulted. Dr. Sakda Siripant expressed willingness to review his experienced graduates and make recommendations whenever AIT is ready to move in this direction.

No one expressed a view that there was any conflict of interest or undesirable duplication between ARRSTC's program and their own. Actually none are as well equipped to analyze satellite imagery, except by visual methods, and all who expressed an opinion felt that having this kind of program at AIT was good for the region.

Cooperation, Royal Thai Government Agencies:

The Consultant visited the following Agencies of Thai Government:

Forestry, Land Development, Mineral Resources and Meteorology.

All interviewees had personal familiarity with ARRSTC or had had trainees participate in the program. The following summarizes the viewpoints: a) All felt that the ARRSTC program should continue. b) Many expressed concern that the total ARRSTC program had not been as effective in demonstration projects and in assisting people with applications of the technology on an operational basis as they might have been. One person in this group, as well as one university person, expressed concern about the NE Water Monitoring Project. In fact the agency person commented that he wished it could be done over. c) Numerous untapped opportunities exist to develop cooperative projects with Thai agencies. d) In discussing problems the ARRSTC staff had expressed about access to aerial photos and 1:50,000 scale topographic maps, the Consultant was universally told, "Develop a cooperative project with a Thai agency and the problem is solved." e) Some were critical of the "high cost of computer services" at AIT. f) All were open to the idea of AIT's initiating a program in interdisciplinary planning for natural resources development and management. The Department of Land Development offered to identify one or more problem watershed areas in Thailand that could be used as field laboratories and further to make necessary information available for student use.

RECOMMENDATION 20B): All openings for cooperative ventures, technical assistance and project development should be vigorously looked into by ARRSTC staff. ARRSTC should take the initiative, working from a deliberate and well thought out plan and set of priorities.

IMPLEMENTATION: One of the first things that should be done in this interim period of financial uncertainty is the development of a written plan and time-table of action with respect to new projects and technical assistance. The present staff and teaching-load problems, resulting from loss of the American contingent, do not make specific project design and additional commitment in this area highly attractive at this time, except in the context of planning and preparation for the future.

As opportunities for project involvement are identified, priorities for implementation should be based on ease of developing highly reliable and useful information, whether or not ARRSTC has a highly qualified project manager available and the level of visibility for AIT/ARRSTC.

This recommendation applies to opportunities with universities as well as Thai agencies. It is not limited to Thailand since ARRSTC is regional in its service area.

In the near term, and especially if additional financial support is slow in coming, it might be that dominant, or exclusive attention should be given to project development and technical assistance in project design rather than to training.

The alumni of ARRSTC are certainly the most viable entree to regional service and technical assistance. A roster and mailing list has already been assembled and contacts relating to instruction and short course evaluation have been initiated. An additional contact offering technical or project design assistance may be very attractive to alumni who have been struggling to get a good project off the ground.

This option must not be exercised except in proportion to the ARRSTC Staff capacity to perform in a timely manner and in areas where the individual staff person has unchallenged expertise. Past performance in these respects has not been entirely to ARRSTC's credit so some bridge building or reconstruction may be found necessary. Such activity should not be avoided but actively and imaginatively pursued.

Cooperation, International Agencies:

The Consultant conferred with UNDP, ESCAP/Regional Remote Sensing Program and with UNEP. The following highlights the situations and needs for dialog, understanding, collaborative planning and active cooperation between AIT/ARRSTC and these agencies:

AIT/ARRSTC has a unique charge to serve the region in much the same way as the UN agencies.

The UNDP supported Regional Remote Sensing Program is going to continue and the goal is to make it as totally effective as possible with the resources available.

There are areas of mutual interest and parallel activity between ESCAP/RRSP and AIT/ARRSTC. There are opportunities to cooperate and achieve more jointly than separately. In spite of seeming overlap of activities, there is high complementarity in the two programs because they are being approached from different positions and contact points are different. Effective project coordination is desirable. While major goals are essentially the same, individual and detailed objectives are different.

There is a need for improved dialog between the two programs, some bridge building or repair, joint planning and actual project collaboration in areas of strong common interest.

There are situations where the Consultant perceived ARRSTC has not done as careful job of advanced communication with the UN program as they should have in keeping ESCAP/RRSP informed of pending situations or problems where a joint decision may be called for.

There is a need to reestablish dialog, openly and thoroughly discuss problem areas, past and present, admit omissions if need be and move on in a constructive program to further remote sensing applications in the region. The job is big enough and important enough to require the full, undiluted effort of all concerned.

RECOMMENDATION 21B): That AIT/ARRSTC plan for and open a dialog with ESCAP/RRSP with the goal of reestablishing and maintaining a viable and effective working relationship in the achievement of carefully identified mutual goals and a mutual recognition of areas where divergent interests or emphasis justifies divergency of programs and independent action.

IMPLEMENTATION: To move in this direction, AIT/ARRSTC should develop a plan and strategy for achieving a healthy, supportive relationship with the ESCAP/RRSP. It should analyze the areas of common interest and potential overlap and develop its (ARRSTC's) plan for resolving any differences, decide which areas are critical and in which agreement must be reached as well as those in which agreement is not critical. In all areas of mutual interest, AIT/ARRSTC should decide in advance the points at which it cannot allow further compromise in discussions or negotiation. Having so planned, they should then take the initiative in establishing a dialog with the goal of achieving as many of the "musts" in the situation as rational humans can be expected to agree upon. The principles should then mutually move ahead from this agreement in a totally constructive program.

At the same time, AIT/ARRSTC should not wait indefinitely before moving ahead vigorously and imaginatively to implement its own plan of service to the region. A successful, imaginative program will attract support, even from opponents; but should it not, it will have the strength from purposeful, well-planned action to withstand any onslaught from less active critics.

In discussions with UNEP, the Consultant found a sympathetic ear, especially for the concept of interdisciplinary team planning for natural resources development and management, especially "if the program includes a good measure of on-the-ground planning experience in real situations." AIT/ARRSTC will probably find it advantageous to capitalize on this understanding, interest and potential support.

FUTURE PROGRAM, PERCEPTIONS and RECOMMENDATIONS

Except for the recent work done to refine the Natural Resources Development idea, the Consultant did not find what could be considered adequate coordinated and comprehensive planning for the future already in place.

Handling of Four Curriculum Concerns:

Curriculum Concern No. 1:

Examination of detailed lecture outlines for three terms reveals that topic one, planning from an awareness of a problem to be solved and a defined information need, has been covered regularly in lectures but in varying degrees. Lecture alone has not had the desired impact -- judging from eight responses to a questionnaire given to the May 1986 graduating class and examination of project plans developed by the last two classes.

RECOMMENDATION 22B: That topic 1 be strengthened as a unit topic and consistently presented in lectures and that it be emphasized in all project planning courses.

IMPLEMENTATION: It is most feasible if this subject is briefly treated as an early item in RS.01, developed in substantial detail with interactive discussion in RS.04 and insisted on as a unique planning element in the Workshop course, RS.05. Homework problems to match a specified problem and information need with a remote sensing approach would help reinforce the point.

The topic is sufficiently important that the staff should make every opportunity to reinforce in discussion groups and to repetitively cause students, through questioning, to think about why they are making a particular analysis or considering a particular technique. They should learn to focus on how the data will ultimately be used and by whom.

Curriculum Concern No. 2:

The Consultant has the strong impression that students are developing the view that remote sensing application consists of visual interpretation or digital analysis. The fact of their being strongly and mutually supporting apprears not be to getting through.

Unfortunately, many factors, some real and some imagined, have made it nearly impossible to do a good job of demonstrating this compatibility and the synergistic effects of combining visual and digital analysis. Following are the facts that have contributed to the problem: 1) the difficulty of getting adequate aerial photography, 2) the fact that NRC has been unable to produce consistent, high quality false color images, 3) the failure of ARRSTC to order state-of-the-art FCC's even though funds were budgeted for same, and 4) that the ARRSTC Photo Laboratory is just now installed but with out adequate capability to operate it as a professional remote sensing photo lab.

Another historical aspect of the problem arises from the fact that the importance of visual interpretation and quality FCC imagery was strongly played down by one of the key program managers who freely told the Consultant that he didn't "...see where this visual interpretation and hard copy imagery was all that important." In the developing world this attitude is an untenable luxury to say nothing of the fact that many of the people who strongly held the same view in the late '60's and '70's have markedly changed their position in the '80's.

While the laboratory problems do include good problems on visual interpretation of both aerial photography and landsat imagery, and one opportunity has been given to use aerial stereo models in connection with landsat image interpretation and verification, the students seem to develop a strong view of the visual and digital analysis being mutually exclusive for the most part -- an either/or proposition.

The Consultant would be willing to wager that the majority of students from ARRSTC would always recommend and use a digital analysis system (given the availability of hardware and software) regardless of the information requirements.

Especially in developing nations and where many maps are created at scales of 1:250,000 to 1:100,000, many kinds of interpetations are most economically made, with just as high relaibility, by a qualified visual interpreter, even though digital capability exists at the interpretation location.

When one is mapping broad land cover/landuse types at these scales, the variability among pixels within the classes of interest represents "noise in the system" that has to be smoothed over by much comparison, reanalysis, redefinition of classes and finally by combining of the final spectral classes in order to acheive separability and produce the information classes that are needed. This same separation, to the trained visual interpetter who knows what to expect on the landscape, is made at the "wink of an eye." After all, the computer residing between his ears is "quite fast." When working at the above mentioned small scales, by the time a digital analyst can deal with a couple of 512 x 512 windows, the visual analyst can delineate and identify virtually all of the major land cover types on a whole scene. When the analyst comes down to the hard discriminations, the highly similar to almost identical image types and the need for more detailed segregations within a major type, digital analysis begins to shine and to become really cost effective in relation to inforamtion provided.

Similarly if one wants to develop a resource analysis from Landsat MSS at a scale of 1:50,000 for example, dominant use of digital analysis (but with visual interpretation support) is freqeuntly the fastest and most efficient way to go.

In eight resource assessment projects of which this Consultant has intimate knowledge in 6 developing nations with the output maps at scales of 1:250,000 and 1:200,000 (in two cases covering the whole country and in another half) all eight were efficiently and cost effectively done by visual interpretation at acceptable levels of accuracy as determined by field verification and in some cases by follow-on detailed surveys.

One of these surveys was multistage involving two scales of Landsat imagery, two scales of aerial photography and helicopter ground data collection as well as verification of interpretation. In another, digital analysis was used most advantageously to map a sparce wood land type that could not be discriminated by visual means from surrounding essentially barren rock types.

The higher resolution of SPOT data is ideally suited to interpretation and mapping at scales of about 1:50,000 and larger. At this scale both visual and digital analysis are almost equally effective with the same proviso as above. They are mutually supportive tech niques and again digital begins to gain the dominant edge as discrimination becomes difficult and as more detailed sub-typing be comes necessary. With this high resolution data, however, the digital approach will play an additional role in this writers judgement. When SPOT is used to make highly generalized maps at scales approaching 1:250,000 or 1:1,000,000 it may be more efficient and accurate to use the computer rather than the eyes to generalize the data. The reason is the same as when using the computer to make very small scale, highly generalized maps from Landsat MSS or TM. The higher resolution of SPOT becomes "noise" to the visual interpreter if he attempts to consistently generalize to very broad types.

RECOMMENDATION 23A: That a good, unit lecture be designed for both the beginning course, RS.01, and for Digital Analysis, RS.03, that makes clear and illustrates (1) the mutually supporting role of visual and digital techniques, (2) that remote sensing encompasses a set of systems and analytical techniques (ever growing and expanding), and further that (3) having clearly defined a problem to be solved and its attendant information needs (or gaps), the most sound approach is to select from among these options that system and technique or combination thereof which most cost effectively provides the specified information.

IMPLEMENTATION: Having presented these concepts in lecture, it is absolutely essential that this concept be reinforced by discussion, problem sets, laboratories and workshop exercises throughout the curriculum because it cannot be overemphasized in the face of the tendency of newcomers to gravitate toward one part of the system or one analytical approach.

Looking to the future it is essential that the trainees leave the course realizing that all of remote sensing technology (old and new and techniques yet to be developed) comprise a system, any and all elements of which are available (singly and in various combinations) to match the individual problems, working situations and information needs.

Curriculum Concern No. 3:

The legend and classification theory elements have been rather well handled for soils and geology but in the area of land use and land cover, it has not been adequately treated in lecture or laboratories by the most recent instructional team. The reason is simply that they have not had a staff person with the expertise to adequately treat the subject.

Knowing some of the first team personally, it is likely that they treated this topic much more adequately but the Consultant did not take the time to work back through the course outlines for these initial years. The major missing link is in a treatment of plant sociology, plant community types and structure and floristics so the trainees know how to look at natural plant communities in forests, brushlands, savannas, grasslands and marshes with some degree of awareness of the natural organization and how to document what they see in the most useful ways. This need is even more critical at AIT than some universities because of the extreme diversity of educa tional backgrounds from which their students come -- especially into ARRSTC.

Similarly they need to understand some of the principles of classification where the goal is to support remote sensing activities. For most effectiveness this requires an hierarchical classification that is developed by divisive reasioning (developing classes from the broad and inclusive to the refined) rather than by agglomerating from many highly refined classes to the broader.

RECOMMENDATION 24B): That a thorough discussion of legend development theory and of plant community structure, floristics and devisive classification concepts be developed and regularly presented as part of the course on project planning or as supporting subunit in the visual interpretation course.

IMPLEMENTATION: This part of the instruction needs to be early enough in the curriculum that all students will be exposed as it is essential knowledge for all who do not come with a strong background in resource ecology.

A visiting lecturer from the Forestry Department at Kasetsart University might be able to fill the bill on the ecological side and a person who has a good background in soil survey should be able to handle the classification theory and legend elements.

As a separate task the Consultant could develop a set of lecture outlines that another knowledgable person could use as a basis for presenting these important topics.

Curriculum Concern No. 4:

In the very first series of lectures taught in the September 1982 course, the topic of verification was very well and effectively handled. But one of the current staff told the Conultant that this subject of verification of final results and how to prepare and interpret Error Matrix Tables (some call them Confusion Matrix Tables) was later dropped.

RECOMMENDATION 25A): That lectures and field and laboratory experience in this subject be restored to the formal teaching and emphasized at every opportunity in each and every course.

IMPLEMENTATION: Consult the Manual of Remote Sensing, other standard references and the first term lecture notes for guidelines on how effectively to meet this need.

Under Thai conditions where so many maps are hard to obtain and overflight in small planes is not allowed, it will require a bit of innovativeness on the part of the staff to do a good job in this area.

The consultant learned from his off campus interviews with Thai agencies that they are eager and waiting for an overture to work with AIT/ARRSTC on cooperative projects and that if this is done AIT/ARRSTC can get access to all the maps and aerial photographs the need through the cooperating agency. This option should be cultivated both from the standpoint of demonstration project development and the value of such work in the instructional program.

Future Curriculum

The most encouraging development for the future is in the area of curriculum and course design. The faculty working under the leadership of Dr. Denis Borel should be commended on significant progress toward one of USAID's suggested goals. The NRDM and Curriculum developments are milestones in progress because the AIT Academic Senate has approved an NRDM Program "in principle" and also approved a 5-course curriculum in Remote Sensing that follows the conventional AIT pattern. This is a particularly important step in solidifying the position of ARRSTC within AIT. This new curriculum is evaluated with recommendations in the following section.

Evaluation, New Curriculum:

The layout of courses RS.01 through RS.05 is good and should be conducted for at least the 9/86 term as planned. This will give valuable experience for modification and improvement.

The need for specific short courses and workshops will continue, and this option should not be ruled out when the staff is restored to full strength and the need is discovered through the extension, cooperative project and consultation activity of the staff or when the need is independently expressed by regional agencies.

RECOMMENDATION 26B): Under the new program an adequate sequence of formal courses in the AIT pattern plus periodic short courses/workshops addressing specific needs of the region should each be considered an integral part of the instructional offerings of ARRSTC.

IMPLEMENTATION: A minimum goal, when the staff is restored, should be to offer one well planned and carefully executed short course or workshop per year. More than two would surely detract from other essential activities in the research and extension/outreach areas.

AIT/ARRSTC should now look to extension seminars, short courses and workshops as providing advanced instruction beyond their basic curriculum and responding, occasionally, to special needs of the region which cannot be adequately covered in their basic curriculum.

Participants in these short courses/workshops must, therefore be very rigorously screened to insure that they come with sufficient background to handle the material and that ARRSTC has on staff or through special consultancies the highest quality expertise to handle these advanced and specialized areas.

A point of compromise in dialog with ESCAP/RRSP would be to look to RRSP for organization and conduct of all seminars and to jointly plan, support and conduct most workshops as a fully cooperative venture.

The goal and standard for the short course and workshop programs should be quality and thoroughness always, compromise or superficiality never! It follows that if time available, funding or staff expertise does not permit attainment of this goal and standard of performance, the event should be deleted from the program.

The same standard of excellence and criteria for implementation should be applied to the formal course program at AIT, except to the extent the topic is mentioned in introductory courses to enhance the appreciation by the students of the full scope of remote sensing technology.

The assessment of the Consultant is one of concurrence with those members of the departing staff who have expressed the view that the contemplated course content for the September 1986 term is more than the remaining staff will be able to handle in the time available. It is hardly consistent to expect that material covered in a total immersion short course of 15 weeks average duration and 128 lecture hours can be condensed into 11 weeks, five courses and 83 lecture hours (Table 7). It is the Consultant's concern that the quality of instruction and success of technology transfer to the September '86 class may fall substantially below the generally commendable performance of the past. It would be in the best interest of AIT and ARRSTC to cut the less essential areas of subject matter, even in the current term, and do their predominantly excellent job on the areas retained.

With the intent of being helpful and constructive, the Consultant feels that the following points need reevaluation, certainly before the January 1987 term:

Comments and Recommendations on Specific Courses:

The new course structure is a tremendously over-ambitious program although it does achieve a better balance between visual and digital interpretation methods (Table 9). It is striving too hard to cover in 11 effective weeks all that was formerly covered in 15 (Table 10). Quality and adequacy of coverage of essential topics is very likely to slip and instructional goals to be missed.

Table 9: Course structure under program to begin September 1986.

Course Number & Name	No. 50 min Lectures	No. 165 min Laboratories	Total Number Lect.	Total Number Labs
RS.01; Introduction to Remote Sensing, 3(3-0)	3	0	33	0
RS.02; Image Interpretation And Mapping, 3(2-3)	2	1	22	11
RS.03; Digital Analysis of Remotely Sensed Data, 3(2-3)	2	1	22	11
RS.04; Remote Sensing Project Planning & Mangt., 3(3-0)	3	0	33	
RS.05; Remote Sensing Workshop, 1)0-3)	0	1		11

Table 10: Comparison of Curricula, Current and Projected.

Point of Comparison	Current*	Projected**
Weeks duration	15	11/12***
Lecture duration	130 min	50 min
Laboratory duration	130 min	165 min
Field problems	8 days	6 days
Total number lectures	99	59
Total lecture time	127.8 hrs	82.5 hrs
Total number lab sessions	48	33
Total indoor lab time	104 hrs	90.8 hrs
Total effective field work time****	76 hrs	40 hrs
Number of subject categories covered	10*****	
Number courses initially proposed		5

* Based on analysis of five terms under old program

** Projected to begin under AIT pattern September 1986

*** Effective time is only 11 weeks if one full week is cancelled out for mid-term exams plus the partial last week for finals.

**** This reduces standard 8-hr day by 8 hrs in each case as allowance for travel time

***** This number is subject to interpretation; but when one compares time devoted to categories covered now as compared to the new program syllabuses, it is obvious that some topics must be touched only superficially in the new plan, if covered at all.

With the hope of being constructively helpful, the following recommendations with respect to each course outline are presented:

Course RS.01, Introduction to Remote Sensing: Since, in the new pattern, some students will take only this course, it is essential to impart to them what they are most likely to need in elementary and initial applications as well as to provide a good grounding in those facts and principles essential in preparation for a resource assessment or monitoring project. The student who stops at this point needs especially to appreciate how to get effective help from the experts. He does not need to know much, or even anything, about sophisticated technologies he is unlikely to find helpful as a beginning user. There are viable options to reduce scope and intensify in some critically important areas.

RECOMMENDATION 27A): Either at the outset or under caption 11, the beginning student needs a strong orientation to problem analysis, objective setting and the specification of information needs so his remote sensing results will address these specific and real needs.

IMPLEMENTATION: This is one of the frequently overlooked or shortchanged items in project planning and design. The user of the technology must be made aware of the importance of proceeding from knowing the real problem to be addressed, the kinds of decisions to be made, whether the opportunity will exist to fine-tune or alter a decision once made (or is it set in concrete?). Do the decisions concern policy and objective setting, resource allocation, development/management planning and implementation; or does the application involve monitoring the effectiveness of the planning and implementation process with the goal of refining the management or implementation plan. Even when the expert plans a project, these are some of the first quesition he must ask. The answers are the real determinant of specific information needs.

In the experience of this Consultant, the remote sensing project planner often has to help or guide the client or agency decision maker in perceiving what his exact information needs are. Guidance will often be needed as well in the scale of treatment and especially in the amount of detail needed to meet objectives. It is also not uncommon to find, on probing for specification of exact information needs in relation to objectives and decisions, that the client has not really done a problem analysis, defined kinds of decisions, causes of perceived or real problems or set goals and objectives for what he is doing. This kind of person is not uncommonly found in developing nations and in large bureaucracies in the industrial world where management has tended to be "by the seat of the pants in an information vacuum" or by "a 12-foot shelf of procedural manuals". In these instances the remote sensing technician/planner will have to walk the client through the maise by the hand if he expects to end up with a satisfied client.

It is also not an uncommon tendency for the client to ask for information types that a particular remote sensing technology cannot provide or which simple aerial photography interpretation can provide more quickly and cost effectively than sophisticated methods. In other instances it is not necessary, given appropriate sampling techniques, to actually survey an entire contiguous area in order to provide a client with what he needs to know. Proportional probability sampling is a very powerful tool in consort with multistage or multisystem remote sensing. Such approaches provide, as well, valid means and confidence limits on derived statistics.

RECOMMENDATION 28B): Most logically in the beginning course with reinforcement in the Image Interpretation and Mapping course, RS.02, all students need training in how to make an ecologically integrated analysis of landscapes for the purpose of developing mapping legends and understanding better how to convert image characteristics and/or spectral data into information.

IMPLEMENTATION: Because students come into remote sensing from many disciplines, the ARRSTC student body being even more diverse than normal, many lack the experience needed to perceive the specific vegetations that comprise the land cover or to grasp the vegetation-geological-landform-soil relationships that determine the character istics of the images or of the spectral data with which they work. This kind of knowledge and ability is in the purview of the plant ecologist, the plant geographer, the soil genesis expert and the geobotanist. In the past, good treatment has been given at ARRSTC to soils and geology, but an ecologically integrated treatment has been lacking. If this could be achieved, even by a visiting lecturer, it would be highly desirable and greatly enhance the ability of ARRSTC graduates. This information area is directly involved in developing skill in the first principle of image interpretation -- namely, "know fully what to expect on each and every landscape being analyzed." Without this kind of ground knowledge, an analyst is not equipped to push digital capability to the limit and still recognize when the output is "garbage".

RECOMMENDATION 29A): Course RS.01 should cover "Line-Scan Imagery Characteristics" in sufficient detail in Topic 4 that all other courses can move ahead without repeating lectures on the basics (see item 2.A. under course RS.02).

RECOMMENDATION 30AA): Much greater emphasis must be directed to making students fully aware of the importance of verification of final results as a critical part of an applications project and also imparting the knowledge of how to preceed and how to present results.

IMPLEMENTATION: This instructional unit or module can be logically covered as an extension of the topic of how to do ground truthing in the pre- and post-analysis stages of a project and while developing and testing the interpretive legends that will be used. A laboratory or homework problem dealing specifically with verification should be a part of every course.

The staff feels they do not have time to get to the field with the students for a verification exercise. This is not the determining constraint. Now that the program is settling down to a permanent study location, the staff should be able to develop a reasonably good digital map and a good visual interpretive map of the project area. They can then select and ground check a number of small windows across the range of mapping unit types so the students can perform a laboratory exercise in verification and generate an error matrix table. Students could work entirely from staff-provided materials, ground photos and a few aerial stereo models.

The exercise should then call for an interpretation of the consequences of the kinds of errors displayed and the development of a plan for further refinement and correction of the mapping units where necessary. Such an exercise can be used with the beginning course as well as the advanced courses. One well done case would serve all of the lecture courses. One staff member told me that an Error Matrix exercise was in the curriculum at one time but was eliminated for unknown reasons. **It must be restored.**

In advanced courses the students could probably use the same staffderived data to verify their own analytical and interpretive work.

The remote sensing profession cannot afford to have students going out without the knowledge and ability to insure the highest attainable quality of work and to convey measured accuracies to their clients. Without the ground and background study that enables the analyst to "know what to expect" in the beginning and to perform a good verification check with data summary in the end this essential goal cannot be achieved and everyone in remote sensing work suffers the consequences.

Course RS.02, Image Interpretation and Mapping:

RECOMMENDATION 31B): This course should concentrate on the principles and practices in visual interpretation of both aerial photography and top quality FCC satellite imagery (both Landsat and SPOT if available). Its goal should be to lay the groundwork for complete proficiency so each student can progressively build skill from this beginning.

IMPLEMENTATION: This is an exceedingly important course because many of the students will go back to a situation of visual interpretation as their only option for at least another 5 to 10 years.

Doubly important is equipping the students to effectively use visual interpretation in active support of digital analysis. They should learn in this course how to use visual interpretation both pre- and post-field work in the identification and compositing of multispectral signatures into information classes. In the laboratories, the working photos and images should be located so as to build ground familiarity from this course that will speed progress within the digital analysis course, RS.03.

Additionally, through both lecture and laboratory the students should come to appreciate that in an operational survey there are many kinds of delineations that can be most cost effectively made by a capable visual interpreter, shifting to digital analysis for the difficult discriminations or where it is necessary to extract the kind of higher detail that can be achieved from looking at each pixel.

It is suggested to start in both lecture and laboratory with good quality aerial stereo models, then move to SPOT if available (consider the possibility of stereo-SPOT) and finally to state-of- the-art FCC's of Landsat MSS. This is a logical progression that leads naturally into the next course on digital analysis.

RECOMMENDATION 32A): Delete topic 2.A., Line-Scan Imagery Characteristics, from this course as a detailed, full lecture presentation.

IMPLEMENTATION: As above, rely on RS.01 for this treatment with expansion as needed in the digital course, RS.03. In a visual interpretation course it is only necessary for students to appreciate how the images are created so they understand the importance of geometric correction, destriping, density equalization, edge enhancement, color balance and color matching as technological steps in preparing a quality image for visual interpretation. They do not need to know how this is done but that the capability exists and how each of these preprocessing steps makes the image more useful.

RECOMMENDATION 33B): Add a lecture on black and white photo quality and color image quality so the student is in a position to judge when and how he can work with the photo lab technician in producing the quality he must have as an image interpreter.

IMPLEMENTATION: The interpreter does not need to know how the photolab controls density and contrast and color balance although it is helpful in communicating ones quality needs to the photo lab technician. He does need to realize that the photo laboratory can go a long way to bring out contrast in the bright areas as well as to bring out large amounts of detail from many under exposed aerial B&W negatives. A good way to illustrate this is to have a range of contrasts and densities printed out from a single aerial photo negative, better yet if a thin and a normal negative is processed in this way. This drives the point home with impact.

If one doesn't tell the photo lab what one wants, even to sending along a sample with the order, they will generally give you a batch print that lacks essential detail in most of the bright areas. Accepting such is not necessary but most users of B&W aerial photography think they have to accept what comes from the lab on the first try. Not true!

Essentially the same kind of problem exists in color and false color prints/enlargements. The color lab can go a long way toward giving the user contrast and detail in bright areas without loss of detail in the darker areas, even when working from the same color separa tion positives. If one works with the photo laboratory when the technician is deciding on filter combinations, it is often possible to select a color balance more useful to the interpreter than the technician can do if he works alone.

In addition to these purely photographic control and manipulation measures, the trainees also need to appreciate that many sophisticated things can be done between the CCT and the film product that goes to the photo lab that will enhance interpretability. They need to know enough from this course to ask for the best, to recognize it when they see it and to reject substandard products that make their job difficult or impossible.

RECOMMENDATION 34A): Delete laboratory practice on the interpretation of B&W landsat imagery; but if a sample of the 10-meter SPOT can be obtained, it would be desirasble to build one laboratory or homework exercise around visual interpretation of this imagery.

IMPLEMENTATION: This recommendation is made in view of the severe time crunch in droping to 11 effective weeks of instruction. It is much better to have one or two very good laboratory problems on interpretation of top quality False Color Landsat and/or SPOT images. The goal is to help trainees learn what they can extract from state-of-the-art visual interpretation of satellite imagery. This cannot be done with B&W except in some geological applications and even there, anything a geologist can do with a B&W image he can do as well or better from a state of the art FCC because he has the added dimension of color to work with.

RECOMMENDATION 35A): Delete coverage of Thermography and Radar from this course. Use the time to strengthen essential areas.

IMPLEMENTATION: This will provide time to do a much better job of visual interpretation and practice. Both these are specialized topics, particularly expensive in application for developing countries, although radar has been very effectively used in tropical environments.

A much better way to cover these topics is in a seminar or special studies course (yet to be added to the curriculum). This would gain 6 category "A" lectures that could be directed to greater depth in understanding and in skill development.

A lecture with stereogram illustrations and practice in how to relate the detailed image characteristics to a variety of particular subjects of interest would be most helpful. A lecture on legend concepts and procedures would be desirable. A lecture on how to develop "surface truth" awareness, how to relate this to image features and how to do a final verification seem missing in lecture although treated in one "Field Trip." A lecture (possibly by visiting professor) on landscape ecology, the interrelationships of vegetation communities, geology, landforms, soils and drainage patterns would be valuable background before the first field trip.

RECOMMENDATION 36A): In working up the legend for the land use interpretation exercises, it should be developed at least to a tertiary level, in some cases possibly quaternary levels.

IMPLEMENTATION: Rather than emphasizing "extensive land uses" per Course Outline, Footnote 2, encourage the trainees to look for and identify the maximum possible detail. The point is that the students should be encouraged to push image interpretation to the limit of the imagery or photography rather than the limit of an overly generalized legend. Otherwise they will not learn what can be done with quality imagery and where the thresholds of discrimination lie.

It is also important in this exercise to have the students attempt separations within some of the natural vegetations, e.g., different kinds of marsh and emergent vegetation, floating pond weeds, different kinds of grasslands and different forest types or density classes.

This approach will lead to a greater appreciation of the potentials and limitations of visual analysis; but in reaching such decisions or impressions, students should be alerted to the fact that what each can achieve is a function of the level of detail in their own personal ground knowledge -- how well they know what to expect.

RECOMMENDATION 37A): Design the laboratory exercise also to demonstrate the mutually supportive realtionship between visual and digital analysis.

IMPLEMENTATION: The digital part of this laboratory exercise should be held for the digital laboratory of RS.03; but for students who will not be taking RS.03, the professor should work up a demonstration to illustrate the point -- building on the student's visual interpretations from the RS.02 laboratory.

Students should come to realize that, even given digital analytical equipment, there are still some kinds of interpretations that can be more cost effectively made by visual interpretation and that digital analysis, becasuse it looks at each and every pixel, should be brought into play when visual analysis alone cannot make the dis criminations or when one needs to extract the maximum amount of information from the data.

Course RS.03, Digital Analysis: Because of the now unavoidable way ARRSTC has acquired its hardware and software for digital analysis, they have a serious problem of unnecessary equipment diversity. This adversely impacts their ability efficiently to teach the principles and skills of the procedure. It is understood, however, that additional ERDAS units are on order so the situation should improve by teaching this course with one system.

This situation is further addressed in recommendations under Facilities and Equipment.

RECOMMENDATION 38C): In so far as available equipment allows, students should be introduced to and trained on the analytical system having the largest number of work stations. One should not attempt to make the beginning student operationally familiar with all of the analytical equipment available.

IMPLEMENTATION: It is inefficient and confusing for both students and staff to learn and to teach fundamentals on a diverse array of systems. The students should have the opportunity to learn the principles of digital analysis not the techniques of "what buttons to punch".

One approach could be to work up some hard copy materials from the main frame in the form of small window printouts of grayscale maps of the various bands, histograms, training statistics and classification results with two-dimensional plots of the scattergrams for each class.

Given these kinds of data for each window, it is then very effective to design laboratory exercises to familiarize students with the basic procedures, what the data look like, how thresholds are set, how the discriminations are made and how spectral classes are combined into information classes. They can even beneficially learn what the actual multiband reflectance values look like for different subjects. If each of these windows is related to a hard-copy image so they can be precisely located in the image or on an aerial stereo model, verification exercises can even be carried out and the training in principles becomes very effective.

The sequence of exercises can even be designed so the students decide what to do next by working batch-produced print outs. This can then be done, in batch mode over night, and the results presented to the students for further evaluation at the next session. The advantage to the student is that concentration is on what is happening in data analysis rather than how do you punch the buttons to make it happen.

For three years at NASA-Ames we successfully trained hundreds of people from state and local government agencies in western United States in digital analysis with exactly this approach. They went from the above hard copy training laboratories to a single-console minicomputer where they already knew what to expect and what was going on. Button punching was very quickly learned and their interaction with the system was highly effective, progress rapid! We worked out a scheme to rotate small groups of trainees back and forth between the hard-copy, batch-mode approach and the miniconsole so that every trainee got hands-on experience in interactive data processing. He learned how to control and direct batch-mode processing as well as to do his own interactive processing.

RECOMMENDATION 39A): Structure course sequence so topic 3 in RS.03 does not repeat, but builds on the same subject introduction in RS.01. Make this a truly advanced treatment to increase under standing of the nature of MSS data and what a good cross section of spectral signatures look like.

RECOMMENDATION 40C): Until the diverse hardware problem can be rectified, concentrate training in this course on the smallest possible number of systems. Leave the learning of other available systems to RS.05 or to student initiative on an extra time basis.

Course RS.05, Field Work:

Situation: This is perhaps the single most important course in the curriculum because it is the one that determines whether or not all the rest of the training is properly and effectively used, whether a good or a bad reputation is established for both remote sensing and the analysit involved.

RECOMMENDATION 41A): Make sure that topic 2 includes emphasis on importance of problem analysis and determination of information needs so that remote sensing project planning does match needs of the client.

IMPLEMENTATION: See notes and recommendation under RS.01. This course, RS.05, is where the topic should be most thoroughly developed and students given homework assignments to reinforce importance and appreciation of the key points.

RECOMMENDATION 42A): The importance of budgeting adequate time and money for ground truthing and verification must be strongly emphasized.

IMPLEMENTATION: In an operational project, funds for two ground expeditions is never enough. Under the best of working conditions where analysts are already familiar with the region, three is an absolute minimum. Also build an awareness of the extremely highvalue of low-elevation aerial overflights both in initial familiarization (with imagery in hand) and for verification.

In little-known or poorly known regions, an initial comprehensive ground trip plus an overflight for general, and specific, familiarization should be the starting point (obviously with 1:250,000 FCC's in hand). Another ground trip for legend class development and verification is usually needed. An intermediate ground verification trip after considerable classifications and mapping have been done is highly desirable. A final comprehensive ground, or ground and air, verification trip is absolutely essential to insuring quality performance and should never be ommited.

RECOMMENDATION 43A): Students should also be reminded of the option of a sampling approach rather than a complete survey.

IMPLEMENTATION: In many respects the concept of multistage (multiscale) and/or multisystem remote sensing applications in a sampling approach are very attractive for providing statistical data where complete map coverage already exists or is not required for the intended applications.

Proportional probability sampling is a very powerful statistical tool to use in conjunction with remote sensing applications. Foresters have made these combined approaches pay big dividends for many years.

RECOMMENDATION 44B): Systematic Aerial Reconnaissance as an approach to verification, as well as obtaining supporting statistical data, should be thoroughly explained in project planning.

IMPLEMENTATION: This technique, developed to a very high degree by Michael Gwynne, Harvey Cruz and colleagues in East Africa and applied extensively in East, West and Central Africa, should be brought to the awareness of all students because few developing nations restrict aerial overflight to the extent that Thailand does. The technique should be exploited wherever it is technologically feasible.

RECOMMENDATION 45A): Move the subject matter for week 10 to either week 6 or 7 so that verification and the statistical treatment of results and classifications is seen as an integral part of the process and that the procedure flows directly from field data col lection into interpretation/classification and then into the all important verification function.

RECOMMENDATION 46D): GIS and Information Management are important topics, but it would be better to focus on a separate course in Information Management, including GIS. In the short term, it may be more effective in RS.04 to cut GIS to one week and expand topics 10, 11 and 12 in the course outline.

RECOMMENDATION 47A): Work up a tutorial exercise from which all students can learn to use "Wordstar" and "Mailmerge" on their own and devote the time in the workshop to something more critical.

IMPLEMENTATION: If the logical geometry of placement of the primary control keys in "Wordstar" is explained to students, anyone, who can type at all, can quickly learn to use the package while working on documents they have to do for the course, or just using it to write a couple of letters home.

An important adjunct to the self-learning is a one or two page summary of all control keys and what they do. The Consultant provided one such copy to the ARRSTC Secretary. In addition, because of its worldwide popularity, there are many good but short reference books available on "Wordstar". These are much superior to the long tutorial manuals because looking up instructions when needed is both fast and easy, faster in many cases than using the "help" menu.

It would also be worthwhile to include instructions for creating a simple merge control file under "Mailmerge" because this is a tremendously useful facility for any writer. It enables one to draft ideas as they come without regard to their order in the document. File names follow a numbering system from an outline of the report, etc. These are easily merged into a finished document regardless of the order in which they are stored on one or even multiple diskettes.

RECOMMENDATION 48A): Make sure that topic 6 includes information on what the student needs to know about the ecology and resources of the area before he goes to the field.

IMPLEMENTATION: This has to do with the subject of "knowing what to expect" that is discussed elsewhere. It is also a good idea to provide the students with a simple form on which to record specific observations on vegetation and other features of the ground surface which affect reflectivity or energy absorption. Keep in mind that it is better to have a little information on a larger number of widely dispersed examples of image types than to have large amounts of detailed information on only a few locations. Location error (or variation) is the more important source of variation with which one must deal.

Curriculum Planning for Future

RECOMMENDATION 49B): After the experience of the January 1987 term, initiate the full sequence of AIT 90's series courses: RS.96, Seminar; RS.97, Research Studies; RS.98, Selected Topics; and RS.99, Special Studies.

IMPLEMENTATION: Of these, RS.96 and RS.98 would be most useful to initiate, but all should be available in the next 2 to 5 years.

Additional Course Possibilites:

RS.98 would be a variable credit course as arranged with each student. Students would be allowed to pursue individual interests on their own initiative but under staff guidance. They should be allowed to enroll for such a course at any time providing their background is commensurate with the requirements of the study they undertake. Students should be actively encouraged to move in this direction.

This is a good way to build graduate level strength and depth of knowledge without trying to cover it all in lectures. It places more responsibility on the student. It would enhance value of the remote sensing offerings to the various AIT Divisions.

Studies could involve intensive library work, information organization and reporting on a carefully selected topic particularly relevant to the interests and future work of the student. Labor atory work in RS.97 or RS.99 on a well defined problem or project should be acceptable provided the student developed his own work plan subject to faculty approval. Simple research projects in the student's area of interest and level of expertise would also be appropriate under the same guidelines.

An RS.96 Seminar course of 1 credit would be useful to cover special current topics, to reinforce principles or to organize a program of guest lecturers. A GIS Problem organized under RS.99 and based on Dangermond's "Integrated Parametric Mapping and Editing" procedures could be a good way to initially cover Geobased Information Systems.

This is probably the most efficient and effective way to make the training relevant to individual student needs and to meet the repeated request of both graduating students and national agencies to provide more discipline-oriented training. This is a far better solution, under the AIT course pattern, than to offer separate courses focused on disciplinary needs. After all, principles are principles and they can be taught to all alike.

An Approach to Resource Ecology as a Basis for Remote Sensing Applications:

An excellent approach to explaining the resource ecology of Thailand would be to start with an explanation of the Physiographic Regions of the country and then within these regions talk about the geology, rock types, and structural geology, geomorphological variation with in each, natural vegetation cover types, soils and vegetation-soil- landforms variation, landuse patterns and recent trends, human settlement, industrialization, recognized problems and conflicts in forestry, agriculture, range, watershed, fisheries, urban/industrial development and extractive industries (mining). One commonly used organization of physiographic regions provides a reasonable frame work for this organization:

Central Plain
Central Highlands
Northeast Plateau
Southeast Coast
North & West Continental Highland
Peninsular Thailand

Of all the elements needing discussion as a background for legend development and for properly handling surface truth and verification functions, vegetation is the most difficult. This is because of the general lack of agreement on vegetational classification criteria and approaches. Unlike soils, geological rock types and geomorphology, there is no universally accepted scheme. The closest is that of the plant geographers (UNESCO's world vegetation classification scheme) but these have the universal disadvantage of using many primary class criteria that cannot be discerned by photo or image interpretation.

There is a little-known, hierarchical scheme developed by this Consultant with NASA support during the Apollo days of the space program which the Consultant and a few of his associates have used on operational projects around the world. It is published in the 8th ERIM Symposium on Remote Sensing of the Environment and has been found reasonably suited to remote sensing applications, at least its criteria are consistent so far as vegetation and land use categories are concerned.

The Anderson scheme of Land Cover and Land Use classification (USGS) leaves a lot to be desired because it treats vegetation from a land use bias and its classes inherently cause confusion among those vegetation types that are potentially suited to multiple uses.

By all means the Australian Land Systems approach, very widely used around the world in remote sensing applications should be included in any fully adequate presentation. If this Consultant were to recommend any single, already developed and widely accepted system to use in the ARRSTC training program, the Australian Land Systems approach would be it!! It certainly would not be the USGS Land Cover and Land Use System that was developed by a committee working around a table and not adequately field tested before publication.

These problems leave ARRSTC in a dilemma because they have not had staff qualified to handle this difficult area. It is not likely that they will be able easily to recruit a qualified person who has sufficient familiarity with both tropical vegetation and remote sensing.

RECOMMENDATION 50B/C): A viable option would be to recruit a well qualified plant ecologist or plant geographer to organize and line up contributors to a one or two week seminar and workshop on Tropical Plant Ecology. Conduct this seminar at AIT and then abstract out of the proceedings the material that would provide the specific conceptual and factual basis for a proper treatment of tropical vegetation ecology as it relates to remote sensing legend design and applications.

IMPLEMENTATION: An early attempt should be made to determine from the Thai foresters the depth of their knowledge of tropical forest and related vegetation composition and structure. Tropical grass lands and savannas are another subject needing a similar treatment.

When one gets down to the vegetation types to use in the training program at ARRSTC, if nothing better were done than to test the types generally used in topographic mapping, this might prove superior to what they are doing now. This would have the advantage of facilitating accuracy checking by the students - even recognizing the topo sheets are not up to date and not always accurate as to vegetation and land cover indications. The classes used in Thailand are:

Dense Forest - >75% canopy cover
Open Forest - 25-75% canopy cover
Marsh/Swamp
Nipa Palm
Hardwood Forest
Bamboo Forest
Orchard Plantations
Forest Plantations
Scrub
Tropical Grassland
Rice Field
Mangrove
Land Subject to Flooding

A good test project for students to work out would be to determine the suitability of these classes and accuracy levels at which each type is photo identifiable, working with aerial stereo models. With this completed, they could then make the same determinations from a very careful digital analysis for which the aerial photo interpretation and ground work would have established an excellent information base from which to develop, test and cluster the spectral signatures, the work obviously followed by full error matrix analysis.

Interrelationships, ARRSTC and NRDM Staff:

The effectiveness and speed with which AIT can move into a Natural Resources Development and Management Program will depend on the qualifications and background of the people who restaff the Remote Sensing Program. It is possible to make this restaffing contribute in substantial measure to a personnel base from which to move into the NRDM Program. This merely requires that ARRSTC be restaffed dominantly with people who are primarily natural resources professionals and secondarily remote sensing specialists. This is possible and consistent with the building of the strongest possible program for training, extension and applications project work in natural resources assessment and monitoring. This is the exact pattern followed by the more successful remote sensing training centers in the United States.

RECOMMENDATION 51B): That in restaffing ARRSTC a conserted effort be made to recruit people from the natural resource management and development disciplines who have an adequate background in remote sensing applications to their disciplinary area. Further that a serious attempt be made to locate and recruit, among these individuals, one person who could lead the maturation and implementation of a Natural Resources Program and a second individual who could rotate, under existing Administrative-Management policies, into leadership of a new AIT Center for Training in Natural Resources Assessment and Monitoring.

IMPLEMENTATION: This is a big order and it will not be easy to find the two specific individuals identified in the recommendation. They do exist but is small numbers. The second position should be relatively easy to fill with high natural resources qualifications, imaginative and dynamic leadership and managerial capability as well as experience in successful remote sensing applications projects. In fact, the Consultant has four names in mind at the moment for the second position.

The first position, on the other hand will be more difficult. In the Consultant's judgement, the field is quickly narrowed to North America and Australia where the liklihood is greater of finding the unique experience, philosophies and attitudes about natural resources development that the position will require. In filling this first position, the requirements for developing and leading the Natural Resources Program should not be in any way compromised to get a person who could also serve as a remote sensing staff member. It is vitally important to find the right person and hire him for the primary job alone rather than to compromise qualifications in any way.

People who know some area of natural resources well are the most capable in applying remote sensing technology to their own fields. People who lack this background often are unable to determine what the numbers mean or when the analytical system is giving correct resource information vs. unnatural clusters of spectral numbers unrealted to information need or informationally meaningless variations in tone or color in a hard copy image.

The most difficult problem is in obtaining the required balance of disciplines in a limited number of staff positions and where at least half or more are likely to be obtained through secondment and with less than optimal control by AIT. The solution may be found in the job and qualification descriptions used in recruitment and the way candidates are evaluated in relation to those qualifications.

Guidelines for Job and Qualification Descriptions:

In recent years the presumed professional area of Environmental Management has emerged in many univesity degree programs and even in designated functional units of many agencies. If AIT's goal is to recruit as much as possible for supportive capability in the staff of ARRSTC and the eventual needs in a Natural Resources Program, then people with this kind of background generally will not qualify. Their training tends to be too generalized, disproportionate emphasis on environmental concerns, too shallow in its science base and with too little knowledge of how actually to remove or mitigate an envornmental concern through scientific application of sound management principles.

Two other areas in which to exercise caution are generalized Geography and Professional Planning as degree areas. Again both of these tend often to lack depth in either the natural science base and/or in the principles and practices of sound resource management, i.e., they may know too little about what actually to do on the land, what kinds of decisions are really involved or the skills and knowledge required to correct a natural resources problem situation even though they may be capable at recognizing the problems.

If people from the above disciplines should apply and their CV's look good otherwise, they should certainly be carefully interviewed before employment to determine the degree to which their philosophy and viewpoint is compatible with what AIT intends to accomplish, to what extent job experience may have compensated for education and training deficiencies and whether the common risk of superficiality has been corrected in their individual cases.

The above are important cautions only if AIT follows the policy of combined benefit from recruitment. If their goal is only to restaff ARRSTC in the tradition under which it was conceived, then one can find capable remote sensing specialists in the above ranks.

RECOMMENDATION 52A): For restaffing of remote sensing alone, new hires must have in-depth strength in one earth resource related discipline, preferably with a development or management orientation.

IMPLEMENTATION: This is essential because from here on out the program of the remote sensing training unit should swing strongly to the demonstration project, extension and technical assistance areas while maintaining instructional involvement about at its present level. Success here requires senior people who can relate to specific resource development and management needs.

Past staffing of ARRSTC has been very weak in botanically related disciplines (agronomy, forestry, range, marsh/coastal zone management). A strong effort should be made to correct this situation and emphasis should be toward these kinds of people who also have experience in the tropics even though this makes them harder to find. If a compromise has to be made it should be to give on the side of tropical experience if a candidate is otherwise the stronger. The Consultant would prioritize these options in this order: Forester, Coastal Zone/Marshlands, Range, Agronomy/Horticulture.

Criteria for Job Descriptions:

The teaching and project leadership staff should meet the following minimum qualifications:

1. Competent in visual image analysis as well as digital analysis.

   The performance of the program is adversely constrained by persons who have a philosophical problem with the essential and mutually supporting role of both methods of analysis and who know from experience that sometimes visual analysis is more cost effective than digital.

   The only possible exception to this might be in a senior systems analyst to manage and oversee maintenance of the digital labs. In future years, the Program should not need its own electronic maintenance person (contract with RCC instead) nor a high powered programmer. The Program's senior systems analyst merely needs to know what to tell these kinds of people to do and when they have produced the desired result. Hiring or paying for these specialists on an as needed basis is a much wiser staffing decision at this stage of development.

2. Minimum of a BSc/MSc degree in a natural resources field, preferably with a management rather than a research emphasis plus 5-years on-the-job experience.

   Even though this is a minimum, a successful applicant should hold the PhD or DSc degree (which might be in a complementary non-resources area) in order that he can hold full and respected academic status on the AIT staff.

   While quite a few persons without this kind of background have contributed importantly to the Program in the past, the high computer and physical science background is not essential to future success of the remote sensing program. Such persons would add little or no complementarity to the NRDM program. They do not even have the resource knowledge to lead students in getting a maximum of information out of analytical procedures. Today's information needs are beyond just looking at broad forest, grassland, water, barren land, urban/industrial and agricultural classes and this is about as far as most non-resource people can push the system.

3. Past performance and experience should establish capability as a teacher or conveyor of information and appropriate enthusiasm. This need not be from classroom or academic teaching. There are many other ways to display instructional capability. The first requisite is knowing one's subject; but beyond that, there are a few other qualities that must be evaluated.

4. Applicants should have worked on, or better yet, managed one or more successful remote sensing applications projects in their discipline or have collaborated as a specialist on interdisciplinary applications.

5. To the extent it is possible to determine, each individual should be a good team worker, not a primadonna or lone-wolf and should have no personality quirks that will be disruptive of group morale.

RECOMMENDATION 53A): Starting immediately all staff members, regardless of their administrative-management duties, must be actively involved in teaching, demonstration or R&D projects and extension.

IMPLEMENTATION: With a small staff, exclusive administrators are a luxury AIT cannot afford. The new thrust with greater emphasis on applications projects and direct contributions to resource development and management decision making in the region will require each staff person to be 50 to 70 percent involved in one or more of the "outreach" functions.

Staff Size and Discipline Coverage:

AIT administration must realize, as pointed out above, that 1) facilities in laboratory courses and field work will not allow more than about 25 students per term with a maximum of 30; 2) these students must work in groups of not more than 5, preferably 4, and that each group needs an instructor (staff or technician) in the initial phases of training and on field work; 3) student/staff ratios are not a measure of teaching load or need in this kind of curriculum; and 4) had the previous staff made use of their discretionary time in extension/project work, the teaching load was about right for high levels of accomplishment in all areas.

For full professional-level teaching staff this translates into an absolute minimum teaching-projects staff of five and preferably seven. Added to this must be the Photographic Scientist/Manager to run the Photographic Laboratory and a Systems Analyst which is presently being well handled by Khun Korapin Srisuksawadi. Taking the administrative organization as it now is, one of the five/seven should have the additional capability of functioning as Assistant Director and another as Curriculum Coordinator.

Recognizing the AIT policy of rotating Chairmanships, this picture changes so that recruiting should be done with the idea that each staff person is a potential program leader. With a staff of this size, with the hardware all essentially in place, a Liaison Officer on board, and given that the Chairman is an energetic and dynamic person, the Consultant does not believe an Assistant administrator is necessary, certainly not an Associate level.

Addressing the support staff, with the multiple word processing facilities available, two secretaries seems about right. Given that some staff will personally use word processing for their writing and correspondence the secretarial typing load should not be excessive for present staff. They should be able to meet the full office support needs of the entire staff when up to strength.

It seems that the employment of a Liaison Officer is a worthwhile thing, especially if his authority is clearly defined in relation to the higher liaison obligations of the Director/Chairman and the normal outside contact responsibilities of the staff. This seems to be an important facilitator position and should be treated as such. It would become particularly important if an expatriate were leader of the group.

As discussed above, the Information Officer is and can perform important functions for the unit. His position and role should, however, be thoroughly reviewed, and perhaps redefined, as a part of the NRDM planning yet to be accomplished. Under tight budget situations, the Consultant would view this position as vulnerable, expendable if need be. If the Information Officer could also perform one of the analytical technician jobs, at least in the near term, the vulnerability of his position would be substantially diminished. The Visual Analysis Lab. Technician might be a possiblity to evaluate.

AIT is caught in the bind with too diverse hardware/software systems. This requires more technician support and a heavier load on teaching staff to either learn all systems or to assign one staff person to cover each major system. This latter option which the Consultant prefers, would require four assignments in the digital sector and a fifth to the Visual Laboratory, thus adding up to the absolute minimum staff size.

Khun Korapin's position as Systems Analyst should be maintained as the supervisor and analysis expert on all systems but to be effective she should eventually have two knowledgable Technicians who can be placed in charge of each facility, keep them open after hours for student use and assist students with their work. A third technician is critically needed in the Visual Analysis Laboratory as pointed out before and eventually a fourth in the Photographic Laboratory.

These Technician positions are placed in the following priority for filling as the Consultant's recommendation:

(1) Visual Lab Technician
(2) ERDAS System Technician
(3) Roving Technician for DMAPS and the Mini-System
(4) Photographic Laboratory Technician

As long as the Mini-System is not functioning, Khun Korapin can handle position (3).

The Photo Lab position is placed in fourth priority because of the Consultants recommendation to mothball the Photographic Laboratory until a qualified Scientist/Manager can be employed and because this person, when hired, should be free to select his own Technician. There could be good justification for selecting this person from those who have done well in the Photographic Science and Graphics program at

Chulalongkorn University, a person who could potentially move into the Scientist/Manager position.

There has been thought that an Electronics/Computer Engineer position is also needed to keep the systems running. This may not be the most cost effective way for AIT to meet this need.

RECOMMENDATION 54B): Negotiate an arrangement with the Regional Computer Center to share a person and have the RCC service all of the ARRSTC hardware, even though it might mean hiring an additional person in RCC, the likelihood of efficient use of the individual's time is much greater.

As regards seconded or contract staff, the Consultant has the following recommendations:

RECOMMENDATION 55A): Stagger the termination dates of all seconded and contract hire personnel so that whole groups do not leave at the same time and even though implementation will require an initial one-year contract for one person.

IMPLEMENTATION: Except for the reason suggested above, contracts and secondments should be for a minimum period of two years. Other wise the demonstration project and outreach program will suffer. Single year appointees should, however, be required to engage in an appropriate remote sensing research project of their own choosing. Making this opportunity known could be a positive recruitment in fluence not just for the short-term appointees. Preparation and submission of a proposal under this program could be a valuable screening and evaluation device.

RECOMMENDATION 56A): AIT must insist on being brought into the loop on selection of all secondees and contract hires and that they have the full right of veto on any and all proposals.

IMPLEMENTATION: The best way to implement this is from a carefully prepared job description and qualification statement for each position. The seconding agency or donor must be made aware of these well ahead of recruitment. Some suggested statements will be found in Appendix I.

Considering recommendations on staff recruitment above, AIT would be well advised to also insist on and exercise the right of personal interview of the top one or two "qualified" applicants before any position is filled by secondment or donor contract. If this cannot be done for any reason, then the Consultant has severe doubts about the viability of the NRDM idea and would recommend termination of development activity until preemployment interviews can be assured.

Remote Sensing Diploma Program:

The Consultant agrees that a Diploma program is a significant step ahead provided high standards are maintained on performance and a combination of examinations, discussions and project evaluations are used to decide if each student has met the requirements.

A policy should be adopted at the outset which sets a minimum academic performance level. For starters, the Consultant would recommend that 75 percent average across all examinations and scores be the cutoff point below which Diplomas will not be granted, possibly dropping back to the present Certificate of Completion.

In the long run, AIT and the program will gain respect if such requirements are made known in advance and rigorously ahered to without exception.

It must be recognized also that faculties or individual instructors can relax their standards to the point of becoming meaningless, i.e., a 75 percent grade can be given whether earned or not or scoring standards can be relaxed unnecessarily. Therefore, a faculty wide system needs to be developed to monitor the quality, depth and form of examination. With a small group of students, an oral final examination before the full faculty could be a desirable control mechanism.

Remote Sensing Degree Program:

Under the AIT guidelines any degree program would have to be at Master's level. The Consultant would consider this inappropriate at this time. He is strongly opposed to the concept of Bachelor's degrees in Remote Sensing. They should instead be in a science or professional field. He considers that advanced degrees in remote sensing can be appropriate for some people; but they should be for the people who have the capability of working on the forefront to technological development. This is generally inappropriate for people in developing countries because of their greater need to use proven elements of the technology.

Master's level training in the field too frequently leads to wasted effort "reinventing the wheel," e.g., just because one knows a bit of advanced math and how to program, development of a new software package for image analysis is an attractive idea even though as good or better package could have been bought off the shelf at comparatively negligible cost. It is much better for personnel from developing nations to be trained to do something to meet a real need -- use the existing technology for the benefit of their country.

Facilities and Equipment:

Situation: A serious problem has developed from the way ARRSTC acquired its hardware. They have four different hardware systems with their attendant software packages. This is a much wider variety of systems than can be justified for instruction. The departing computer systems staff is deeply concerned about the impact on instruction, should even one system go down during the busy September 1986 term. With their departure there is no senior staff who knows the systems to sort out and correct the problem.

Obviously the students would like to learn each system and so state in their "Roundtable" discussions with the staff. If only two systems were available, the temptation would not exist. The students also complain that they don't have time to learn one system well and by the time they do, the time available for their final and major project is just about over.

The various vendors obviously like the exposure of "their system" to this broad regional audience and no mention is made, except by the person who has to keep the system running, of the expensive and complicated maintenance problem this leaves to AIT's limited budget.

RECOMMENDATION 57B): Embark on a program to gradually reduce diversity of equipment for digital processing to one microsystem with six units (one extra should one go down) and one minisystem with multiple terminals (not less than 5). Then network all these with the RCC mainframe for purposes of image storage and preprocessing, including those data manipulations that can be performed more efficiently on the mainframe than on either the mini or micros.

IMPLEMENTATION: In the case where AIT does not need the equipment and it is entirely or mainly a matter of marketing exposure for the vendor, the following Policy is suggested. Vendors would be allowed to place their hardware and software with ARRSTC only on the conditions that: a) AIT can afford the physical space in relation to all other demands and priorities, b) the vendor agrees to cover all costs of space modification to accommodate his equipment, c) the vendor agrees expeditiously to cover all maintenance of his equipment while it is installed and used at AIT, d) the vendor agrees to supply and install at no cost to AIT all model updates and software improvements made to his equipment while the agreement remains in force, e) vendor agrees to expeditiously remove and restore space to AIT specifications when contract is terminated or AIT no longer is able to make beneficial use of the equipment, f) that a highly user-friendly manual for the operation of his equipment and its software be provided AIT at the time the equipment and/or software are installed.

While some of the above costs to the vendor are substantial, they in total will represent his lowest cost advertising budget in terms of effectiveness. The costs are most reasonable in exchange for the substantial value of having his equipment displayed and used to the point of familiarity by the regional student body attracted to AIT. The cost of implementation, if taken from the company advertising budget, would be negligible indeed.

The important principles involved here, aside from efficient use of funds, are that: a) training is more efficient if done on a single good system, b) students who learn the principles and processing functions well on one system can quite easily make transition to other systems, given a good manual, and c) there is a tremendous difference in maintenance costs as one narrows or minimizes diversity.

Readers are referred to Dr. Kurt Rudahl's suggestions, Appendex F, for other suggestions regarding improvement of the computer hardware situation. There are critical problems in the Atlas Mini-system and the Optronics that must be solved.

In the visual lab the main problems to be solved are disposal of the color additive viewer, exchange of mirror stereoscopes for a good binocular magnification type and eventual acquisition of a stereo zoom transfer scope and a Richards-type light table system.

Guidelines for an Extension/Outreach Program:

The guidelines written in 1980 by the UNDP/ESCAP Mission on Regional Remote Sensing Programme are difficult to improve upon for the guidance of the ARRSTC "Outreach" program where its charter parallels that of UNDP/ESCAP in the promotion and demonstration of remote sensing applications to natural and human resource development in Asia.

This Mission, reporting in July 1980, noted that remote sensing "is strongly supported by all government and institutional representatives which the mission consulted." The Mission specifically recommended: (bracketed statements are the author's insertions)

1) Program should be based on four principles:

   a) Build self-reliance of ESCAP countries to use the technology in the development and management of natural resources.

   b) Emphasize technical cooperation among developing countries of the region and devise a technology compatible with the region rather than to "transplant" technology from dissimilar environments. Each application should be "best suited to a given application and envrionment."

   c) Should adopt a network approach and strengthen linkages between remote sensing facilities "rather than creating a new remote sensing agency."

   (This concept is particularly appropriate in guiding future expansion of the ARRSTIC program. Details should be worked out with ESCAP/RRSP)

   d) Start modestly with information exchange, training and joint pilot projects.

2) Main criterion for the formulation of program components is their contribution to the increase of remote sensing capability in the participating countries ¢and to the solution of real problems.

3) A regional remote sensing program should include (reiterated from meetings in 1977 and 1978):

   a) Information exchange, in which a "regional remote sensing documentation service" is specifically mentioned.

   b) Training, but not mentioning degree work.

(The latter at that time was not considered necessary, but now it is thought that conditions may have changed to where degree work in remote sensing is appropriate for some people.)

c) Joint pilot projects between groups of countries having common research and development needs and priorities.

(This is still urgently needed. With the intervening progress in training and facilities development in the region, ARRSTC will miss a tremendous opportunity if it does not vigorously develop this kind of outreach by working through and with its alumni.)

4) The program should be based on cooperation. They reemphasized the network idea and suggested the ptogram be guided by a coordinator and an intergovernmental consultative committee.

(Subsequently realized through the ESCAP/RRSP; but the principle of cooperation and taking advantage of networking opportunities to increase effectiveness of facilities, staff capabilities and maximize return on collective investments in institutional development is paramount. To ignore these principles of networking and cooperation in developing future programs would be tragic, especially when one important goal should be to realize maximum synergistic benefit and gain from each national, bi- or multilateral investment in the Asian Region).

5) The program is multidisciplinary and should involve renewable and non-renewable resources.

6) Recommended to locate a coordinator in ESCAP with 8 themes or activity areas suggested. (Now a realized fact.)

7) Suggested AIT as the host and developer of the remote sensing documentation service.

(This has been partially achieved by the employment by ARRSTC of an Information Scientist to lead this activity in close collaboration with the AIT Library and Documentation Center.)

8) Mentioned training programs at AIT, refering to the new Asian Regional Remote Sensing Training Center (ARRSTC) and the Indian Photo-interpretation Institute (IPI) of NRSA in Dehra Dun.

In the discussion of this topic in the Mission Report, a desirable and permanent separation is implied in the approach to training with AIT emphasizing digital and IPI visual interpretive approaches.

(While this may have been a statement of fact in 1980, it is not a viable guideline for training either at IPI or ARRSTC. The view point still persists in some quarters and was discovered in the interview process by the writer. It should be resisted or ignored in future planning. While it is possible to develop a visual interpretation program without the digital, the reverse is not advisable and to separate visual and digital training completely would be a grave mistake and an injustice to the trainees at AIT.)

Again the recommendations of the Third Asian Remote Sensing Symposium, 6-11 February 1984, in Chiang Mai, Thailand, emphasized the following points:

1) Still a need to establish a centralized system to disseminate remote sensing information and literature on applications.

2) There should be a sharing of remote sensing facilities by countries with unique capability, specifically citing India and Thailand.

3) There is need and opportunity to implement collaborative research/applications programs on a bi- or multilateral basis.

It must be recognized that, in the intervening years, the ESCAP/RRSP and Thailand's own NRC remote sensing programs have been engaged heavily in the implementation of these guidelines while ARRSTC has lagged behind, giving dominant emphasis to training. ARRSTC should first develop a close liaison with both these organizations as it moves into an expanded outreach effort. It should jointly plan its activity with these two organizations to achieve maximum effective ness of the combined efforts.

Remote Sensing Information Center:

The information center repeatedly emphasized in Regional meetings is an important concept; but near-term financing and expansion of the activity should not be undertaken by AIT out of the context of the full development plan for the remote sensing training activity and the natural resources development idea. To do so could commit funds and staff out of line with priorities. All new implementations should follow the principle of working from a carefully thought out and prioritized total plan for coordinated program development con sistent with regional need.

The presently conceived program and plan for the remote sensing information center could be substantially improved from the view point of grantsmanship. A number of suggestions along this line have been passed on to Mr. Ehsan Ullah for consideration when or if it is appropriate to resume program planning in this specific area.

In his present plan, there is a serious deficiency in that it is proposed to add five items of equipment that are duplicatory of what ARRSTC already has. The total equipment budget proposed is $172,040. Total salaries and wages budget of $133,095 is proposed. When ARRSTC is struggling for financial existence, this kind of proposal is totally out of line with reasonable near-term priorities.

Additionally, in the initial years (first three of the program as proposed) doing 1/3 of the travel outside of the region seems inappropriate as well as is the size of staff initially proposed for the activity.

The first step in development should be to build and categorize the information base (publications, reports, etc.) from which the program could function -- so that it really has a service to offer. One person should be able to make substantial progress toward this from a reasonable operating and travel budget and use of available computer capability.

Relative Priority, Information Center vs. Projects:

One might raise the question, what kind of outreach activity will buy the program the most support both in the short and the long run. In the Consultant's judgement this would be in well performed, professional quality demonstration projects expeditiously completed, preferably in joint performance with the client. Such an approach would add most significantly to the information base from which an eventual Remote Sensing Information Center could function.

SUMMARY OF RECOMMENDATIONS REGARDING NRDM

INTEGRATED NATURAL RESOURCES DEVELOPMENT AND MANAGEMENT

Situation, Justification

There is a critical need to carry formal training in integrated planning beyond the traditional planning done by disciplinary managers and scientists. Planning must be carried into the development of an operations or implementation plan with budget and a strategy (the strategy often being the more important). A further nontraditional element, usually entirely missing, is the inclusion of a monitoring plan. Through applications experience, students must be inculcated with the importance of monitoring not only the effective ness of the initial integrated plan for resource allocation or for natural resources development and management but of the implementation plan and strategy as well. The often omitted monitoring provides the information for fine tuning the entire operations process, thus insuring that the entire planning process achieves desired results as well as handling the unanticipated surprises and side effects as the work moves ahead.

Traditionally, natural resources training has been discipline oriented, and these disciplines have tended strongly to talk just to themselves. In recent years there have been notable attempts to break away from this isolationist thinking and planning, particular ly at the action agency level. Multidiscipline teams have been drawn together and instructed jointly to address resource problems. It is recognized that substantial progress has been made in a few instances to achieve team planning for integrated development and mnanagement. The successful teams have demonstrated some of the procedures and unique requirements of the new approach. The concepts, however, mainly reside at the field or working level. They have hardly been noticed by the rank and file of natural resources academicians. Most attempts to do integrated interdisciplinary planning have been on the initiative of forward looking individuals within a few action agencies that are responsible for natural resources management or for planning effective action programs to improve the renewable natural resource base and the lot of dependent society. By and large the concepts, procedures and guidelines for success in this new thinking and orientation to planning have not reached academia and the textbooks with any lasting impact.

Some of this kind of integrated planning is in fact being started by a few agencies in the Royal Thai Government. They are plowing new ground in interagency planning and even involving key university experts on occasion.

It is in this setting that leadership at the Asian Institute of Technology (AIT) began to think about and to define a potential program for Integrated Natural Resources Development and Management (NRDM) in 1984.

After defining some of the parameters and requirements of the program, the next all-important question of feasibility must be addressed as the essentials of a successful program come more clear ly into focus. Is it, in fact, feasible for AIT to undertake the further development and implementation of such a program? This is the first question addressed in some depth by the Consultant as he prepared to advise AIT on the matter.

Feasibility, Natural Resources Program at AIT

Advantages of AIT as a setting for NRDM:

1. AIT provides a neutral ground among governmental agencies and nations of Southeast Asia in which to develop such an integrated program.

2. On this neutral ground, AIT is in a strong position to draw groups together who might not otherwise, of their own initiative, join in unrestrained cooperation to achieve a common goal.

3. AIT's neutral position and lack of ties to traditional disciplinary planning can be turned into a strong advantage if they are bold enough to provide leadership in a new concept.

4. AIT has a multinational representation in its staff. This makes it possible to expose the students to a broad spectrum of experience, philosophy and approaches to problems of the developing countries -- an advantage unique in education and training.

5. Similarly, the multinational student body is an asset rarely found in other schools of natural resources management. This diversity brings a richness to the educational experience.

6. This double mix of nationalities, taken with AIT's Charter, provides an incomparable opportunity to serve the region. Each graduate becomes an envoy of a new concept and procedure of integrated, team planning for natural resources use, development and management.

7. AIT is in an outstanding position, from the standpoint of computer power and staff capability, to develop the information management part of an integrated planning program.

8. The institution has a well developed and proven training and outreach program in natural resources assessment and monitoring to provide new resource information or to update the old as well as to extend the capabilities in resource assessment and monitoring, in information management and in how to make sound decisions in natural resources developmemt and management

9. The progressive thinking of many Royal Thai Government (RTG) Departments concerned with Natural Resources as well as the depth and quality of their staff presents a significant opportunity for professional and informational support to the NRDM program. Some departments have expressed interest in such collaboration.

10. The irreplaceable advantage of collaboration with RTG agencies would be in providing field problem locations with otherwise unavailable information for planning plus a select staff of local experts to help evaluate and critique the final team planning efforts of the students.

Disadvantages of AIT as a site for NRDM:

1. Except to the limited extent found in individual staff persons, AIT lacks depth and breadth in the natural resources management disciplines. This is most critical in vegetation ecology, some areas of agriculture (agronomy, horticulture and soils), and in forestry and rangeland sciences.

2. The pattern of a two-year secondment of staff is not conducive to the continuity of philosophy and teaching concepts that would be required for a substantive and unique program.

3. Short term secondment, even with prospect of renewal, will not provide the continuity of leadership the NRDM program will require in its initial five to ten years.

4. The required leadership for such a program is not now clearly identified among present staff. The probability is high that this key positon will have to be filled from outside after a carefully planned and deligently persued recruitment and interview program.

5. The present pattern of rotating/elected Chairmanship is not compatible with the requirements, at least in the early formative years, for leadership and guidance of an integrated natural resources developement and management program.

6. The core courses around which this program is to be built do not exist as unique courses focused on the concept of achieving interdiscipline, team planning for development and management of natural resources. An outline for one such contributing course is suggested in a following section. Some existing courses at AIT have been identified as potentially contributing to the NRDM program. While this is true, none fill the bill for the re quired core that can make the program both unique and valuable to the region.

7. It has been thought that an NRDM program was partially justified as a "home for the Asian Regional Remote Sensing Training Center (ARRSTC)." This is not true even though remote sensing applications would be an important element in natural resources development and management. If the NRDM idea will not "stand on its own feet" at AIT, it should be dropped. This attempted justification may have compromised some of the inherent strengths of the remote sensing program and probably has restricted the best thinking and planning for NRDM. It has caused people to miss the greatest strength of the idea.

8. It is the Consultant's feeling that some of the regular AIT courses have been identified out of desperation as contributing to the NRDM idea. It seems to have caused AIT planners to "qualify" certain existing courses because they were "somewhat related to natural resources" rather than for the fact that they would individually and substantially contribute in a direct and essential way to the NRDM concept.

Can the Disadvantages be Mitigated?

The Consultant looked critically at the advantages to see if there were ways to maximize strengths and if disadvantages could be sufficiently minimized. This lead to the following recommendations:

Advantage 9:

RECOMMENDATION 58B): Realization of full benefit from RTG agency strengths and willingness to participate will require that AIT take the initiative to step out and invite their participation. This must be done under a policy of willingness, mutually to share the costs in proportion to the relative benefits to each cooperating agency.

IMPLEMENTATION: If the approach is made with the expectation that the cooperating agency will foot the whole bill, non-cooperation and failure will be assured.

In making the overtures, AIT must recognize and deal with the fact that some of the Thai agencies perceive AIT as overcharging for services, asking for free service when they should be paying a fair market price or charging for services when they (AIT) should be cooperating (these kinds of comments were made to the Consultant with particular reference to the Computer Center and the remote sensing unit.) One interviewee characterized the problem as AIT's "Donor's support; we need money syndrome."

The Consultant looked critically at the disdvantages to see if he could perceive ways to lessen their impact. This lead to the following recommendations to lessen impact or convert deficits into assets:

Disadvantage 1: There are two approaches to mitigation of this disadvantage: a) hire more staff in certain natural resources management areas or b) achieve disciplinary strength through trainee recruitment and screening practices in combination with the recommendation under Advantage 9 above.

RECOMMENDATION 59A): Establish high qualifications for all trainees under the NRDM program and make no exceptions. Require that all applicants: a) have a minimum of a BSc degree in one of the recognized natural resources disciplines or in anthropology/sociology, in land or resource economics/policy, in political science/law, in normal human behavioral psychology, in engineering (emphasis on systems analysis and project/program management being especially valuable); and b) with a minimum of 3 years employment experience where they have applied their professional skills in real-world (non-academic, preferably managerially oriented) situations.

IMPLEMENTATION: In applying these two criteria, AIT should strive with each class of students to achieve a balance from among as many of the above indicated disciplines as possible. Double representation of a single discipline should be deferred in favor of the breadth of included disciplines unless the alternate candidate is marginal.

Where an option exists to decide in favor of 3 to 5 years on-the-job experience, this should generally be exercised. If candidates have had some experience in problem analysis and team decision making, they may be especially valuable contributors because, in this program, participants are looked upon as contributors as well as trainees.

It is also the belief of this Consultant that a prior grade-point- average of B or better should be required during the formative years of the program. Such applicants will generally bring a superior work and performance ethic to the trainee group. It is of course recognized that some average scholastic performers blossom on the job and that what you are really recruiting for is potential lead ers. Thus scholastic record should always be evaluated against the total job performance, indications of motivation and leadership potential.

It should be apparent from the above that this kind of program has some unique requirements for drawing together the student body for an appropriate working group. It is essential that a single graduating class consist of not less than six or eight or more than 15 to 30 students. Otherwise, the principle of team planning and group interaction is hard to maintain.

Assuming a two-year Masters program, the recruitment of the incoming class must assure graduating numbers in the above range. The other option is to organize initial classes as a total immersion short course of three terms minimum duration. From such a start, as the reputation of the NRDM Program is established and demand grows, it could be shifted to a more conventional academic approach of two year (six academic terms) duration.

A Thesis or Professional Paper could consist of each participant's individually detailing and interpreting or analyzing the group plan, his summarizing all working principles and guidelines learned in the course and possibly preparing a proposal for how he/she intends to apply the new knowledge and ability upon return to full employment.

AIT must recognize that, in the formative years, they will be striving for an outstanding reputation throughout the region (if not the world) and this will not be achieved by low C and D level performers, rather by the outstanding performance of the alumni of the program when they return to their home employment.

Disadvantage 2: Unless AIT can come up with a particularly effective way to control, to the point of vetoing secondments that do not measure up to all essential qualifications specified by AIT, the program will have continuing problems in continuity of philosophy of approach and in the quality of performance as an instituion. The NRDM idea cannot be successful, in contrast to conventional Division and Center programs, unless Disadvantage 2 is fully mitigated.

RECOMMENDATION 60A): To be effective AIT must take the initiative by developing job and qualifications descriptions for all positions and then insisting in all new secondments (or direct hire contracts by donors) that the secondees or contractees meet the qualifications and job performance specifications detailed in these job descriptions originating with AIT. Personal interviews are an essential part of recruitment.

Disadvantage 3:

RECOMMENDATION 61A): At least half of the staff, and particularly the leader, should be employeed under longer contracts.

IMPLEMENTATION: In establishing personnel policy, the alternative of dismissal at the end of two years if an individual doesn't measure up should not even enter the thinking. The solution must be found in recruitment and interview policies arising from clearly stated qualifications which in turn arise from thoroughly thinking through the job descriptions and terms of reference for each position.

Disadvantage 5:

RECOMMENDATION 62A): The first leader, if not permanently posted after careful and deliberate selection with few if any compromises on qualifications - should serve for at least five to six years, possibly longer.

IMPLEMENTATION: This is a new program that, in spite of the best planning, will be expected to undergo some evolution under the guidance of vigorous, effective leadership and the work of an innovative, dedicated staff. It is a non-traditional program entirely dependent and tied to the philosophy of approach. No compromise is possible on this point.

While recommendations are toward building a small but highly qualified initial staff, AIT administration should recognize at the outset that, as the program is matured, its popularity should re quire expansion of core staff, and the hiring of instructors with strong natural resources management training and experience. If NRDM is successful, the student body should grow to the point that AIT can no longer impose on Thai agencies for support in all of the resource disciplines as suggested in the Recommendation under Advantage 9 above.

Disadvantage 6:

RECOMMENDATION 63A): The central core and theme courses of the NRDM program will be different from any of the conventional management and planning courses taught in the professional disciplinary schools that emphasize application of recognized "practices" developed under conventions of silviculture, agroforestry, agronomy, range ecology, agriculture and animal management, etc.

IMPLEMENTATION: The NRDM core and theme courses will set the philosophy and approach of the program to achieve integrated team management. They will develop a new practicum on the techniques of achieving effective human interaction in planning and for guiding a team of often divergent, sometimes antagonistic disciplines toward the compromises that remain consistent with scientific principles and proven management practices in the respective disciplines.

A planning pattern of team-derived problem analysis including derivation and assessment of development and management alternatives should lead to resource development decisions that never severely compromise scientific or disciplinary principles, except possibly those of short-term-profit economics. Such group planning will result in achievement of common goals consistent with both the potentials and inherent limitations that are imposed by the ecological nature of the resource on the allowable activities of man.

A successful NRDM program does not have to consist of a large number of traditional courses. Its essence will be in the unique character of the trainees accepted into the program and to the practical decision making laboratories, drawn from real-life situations, that are the real core of the program.

Disadvantage 7:

RECOMMENDATION 64B): The maturation of the NRDM idea and the future of remote sensing at AIT should be treated as separate, but mutually supporting issues.

IMPLEMENTATION: There are a number of alternatives for the management and future guidance of the remote sensing program.

There are options in how closely they may be tied together administratively within AIT. The decision will rest largely on staff composition within the remote sensing unit and the capability of its management. If staffing swings strongly to natural resources peoples, it could become an integral part of the larger natural resources program. This trend would, in fact, be in line with the Consultant's overall recommendations.

If the remote sensing unit is staffed substantially by non-resource people (computer types, physicists, mathematicians and engineers) then its direct contribution to the natural resources teaching program would be minimal to none. In any case, there is strong justification for administering the remote sensing program within the Integrated Natural Resources Development and Management Program once INRDM is in place (Figure 2).

After careful evaluation of all the pro's and con's the Consultant concludes that the development of a particular kind of natural resources program at AIT is feasible. The details as to the kind of program and the guidelines and constraints on deveopment are set forth elsewhere in this section of the report. The Consultant, therefore, recommends--

RECOMMENDATION 65A): That AIT move forward immediately and vigorously to complete the maturation of an integrated program in natural resources development and management, adhering to the guidelines set forth in this document.

Natural Resources Development and Management in Perspective

The philosophy and concept from which the Consultant has been guided in his thinking about a potential Natural Resources Program at AIT is graphically portrayed in Figure 1. The unique contribution of AIT to Natural Resources Development and Management will be 1) to insure that its graduates really understand the concepts of inte grated planning as revealed in this flow chart and 2) that they have the capacity to carry out interdisciplinary development and management in accord with the concepts involved therein.

To save time in preparation of this report, a redrafting job was not done. Instead, the full implication in the AIT program context is obtained if the reader translates the words "RANGE" and "RANGES" in blocks 17 and 16 into the broader context of "NATURAL RESOURCES". This diagram is taken from work of the Consultant as a coauther of a background guidance paper prepared for UN/FAO/UNEP by Winrock International, Morrilton, Arkansas, 72110, USA titled "Background Paper on Global Assessment and Monitoring of Rangeland Resoures."

Experience shows that most professionals in the natural resources fields, when they begin to plan for development and management projects, will commit three basic errors: 1) To start thinking immediately from their discipline orientation and in the context of Blocks 15, "Management" and 23, "Development" (Figure 1), 2) To omit almost completely the political, human/social, and economic considerations embodied in the decision blocks 2, "Facilitating and Guiding Decisions" and 8, "Allocation Decisions", and 3) Fail to realize that planning decisions on their own part must move progressively from left to right through this conceptual flow diagram if their development and management decisions are to result in successful projects that do not create more problems than they solve.

The first goal of AIT will be to make its graduates of the Natural Resources Program as fully knowledgable of these concepts and the required procedures for their application as careful academic planing and instruction can achieve.

The second goal will be similarly to build a high level of skill and ability in interdisciplinary team planning as an essential part of the design of development programs and management systems.

This will be done by placing trainees in situations where they must learn to progress, as contributing team members, through the sequences of Figure 1 in actually working out solutions to real-world, not hypothetical problems. In every case the planning situation will involve a specified landscape where natural resources development and/or management opportunities exist.

Interrelationships ARRSTC and NRDM:

Looking to the future the remote sensing program at AIT needs a stronger central thrust or focus to keep it oriented to truly purposeful endeavors and meaningful service to the Asian Region.

"Remote Sensing" defines a technology with extremely broad implications lacking in purpose. For example, a neurologist applies remote sensing when he performs a brain scan. An airplane pilot uses remote sensing when he looks (with radar) for the proximity of other aircraft or turbulent cloud patterns. Remote Sensing as a name fails to communicate this purpose, or reason for being, for existence.

The Asian Regional Remote Sensing Training Center has well achieved its training goal (290 graduates from a projected 300). A potentially strong Institution for applying the technology has been established at AIT the initial steps have been taken and all the administrative framework has been established for the full integration of the facility into AIT. These two achievements match the two most important goals set by USAID when they initiated the project that made the development possible.

Admitedly the implementation of the project has encountered substantial problems, a few major shortfalls and some severe disappointments in relation to initial hopes and expectations of all concern ed. But the Consultant, after very critical and in-depth evaluation, has found that dedicated staff did come through and that the two most important goals, prerequisite to regional recognition and establishment of a mechanism and home for continuted service in the Asian Region have become a reality in keeping with USAID expectations. A strategy has been developed and embodied in a series of recommendations with implementation suggestions for solving remain ing problems and placing the facility on a healthy path into the future. The potential is high for further achievement in the areas of shortfall.

The first concrete step in pointing the Center to the future is to give it a new name that establishes a specific focus of activity and a purpose consistent with AIT interests and the needs of the Asian Region.

RECOMMENDATION 66A): That the name of the remote sensing training center be changed to the "AIT Center for Natural Resources Assessment and Monitoring (CENRAM)" , and that its purposes and activity be redirected in keeping with the functions and emphases diagramed in Figure 3.

IMPLEMENTATION: This should be at the discretion of AIT leadership and appropriately timed in relation to other goals in the interest of a coordinated program to more adequately service the Natural Resources Development and Managment Needs of the Asian Region.

The only precautionary admonition from the Consultant is not to allow faculty or Senate debate on the new name of the remote sensing unit. He has devoted careful thought to a name that is consistent with and indicative of the specific contribution the activity at AIT can make to the much more important and greater goal of a training program in natural resources development and management. This should be a simple matter of Administrative Decision from the Office of the President.

Strategy for Maturation of the Natural Resources Idea at AIT:

Many elements relating to the INRDM developmental strategy are covered in the main body of this report. Certain vitally important elements are in common with the strategies to insure the future of the remote sensing program. Following are some of the key steps as seen by the Consultant as of the date of this writing:

1. Sound planning of the INRDM idea and developing it to proposal stage is still a major undertaking that will take a capable person some months to mature.

2. Planning for the Interdisciplinary Natural Resources Development and Management Program, the Natural Resources Assessment and Monitoring Program and the possibility and an Information Management and GIS element should move for ward under one leadership because of the intimate and essential interrelationships among the three.

3. The initial planning to advanced draft stage should be done by one or not more than two people rather than by a committee. Subsequent to reaching the advanced draft stage the manuscript should be subject to peer review. The authority to accept or reject suggestions in prerparing the final documents must reside with the original writer(s).

4. The work done by Dr. John Lukens, when taken with the recommendations and suggestions of this Consultant, does provide a very good point of departure; but a substantial rewrite of Luken's latest draft is in order.

5. Particularly those elements of Luken's proposal dealing with contributions of existing courses from among the AIT divisions to the program needs a much more critical investigation and analysis.

6. The solution of staffing and management problems in the remote sensing unit must be solved before the INRDM program can be fully matured. This is because of the desirable interface between the two programs and the fact that the direction restaffing takes in the remote sensing unit will have a strong impact on how staffing for the INRDM will be put together.

7. Planning for INRDM can move ahead soon, but an attempt should not be made to finalize plans and prepare a final draft proposal until the direction of solutions to present problems in the remote sensing unit are clearly evident and assured of attainment.

8. Replace the concept of a Remote Sensing Information Officer and projected Regional Remote Sensing Information Center with the much more comprehensive and useful concept of Information Management for decision making in Interdisciplinary Natural Resources Development and Management.

9. Approach donors with the idea of a training and service program that:

    a) enbodies all three of the aforementioned elements, (Figure 2) with emphasis on its being non-duplicatory of traditional natural resources training programs.

    b) goes beyond tradition by contributing to the critical training and extension needs of interdiscipliianry planning for natural resources development and management.

    c) is specifically deisgned to avoid the pitfalls and problems of monodiscipline planning and single-purpose development.

    d) is critically needed in all developing nations where the urgency of successful projects that soundly develop and manage natural resources for sustained human benefit makes the risks of poor design and failure untenable.

An Essential Core Course for NRDM:

This is not the only core course that would be a part of the INRDM instructional program but it is considered by the Consultant to embody the most important but not all of the concepts essential to performance of the interdisciplinary team analysis and planning concept.

TITLE: Human Relations in Development/Management Planning or
Interpresonal Relations in Planning and Management

NUMBER:

CREDITS: 4: 3(1)

Laboratory is exclusively a series of sessions in Team Problem Solving of real-world problems, usually drawn from the experience of the instructor or the NRDM/ARRSTC staff. This series of exercises are designed to give practice in each phase of the topics covered in lectures. Problems are designed so what is learned through application in the first lab session is used in the second, etc., and the final laboratory problem provides an opportunity again to use all of the principles learned as does the carrying out of the "Student Project" at the conclusion of the full course of training.

Key Points in Design of Problems:

(1) Emphasize confrontational types of problems in part of the laboratories.

(2) One good exercise in Idea Generation, Conferencing and Idea Evaluation. Build experience in the concept of "plusing (adding to) ideas followed by evaluation, selection and application of the best of the ideas developed.

(3) Emphasize Problem Definition, Development of Alternatives and Decision Making Procedures in reaching a solution through a Team Problem Solving approach in all laboratories.

(4) Emphasize interdisciplinary team planning for Integrated Resources Management (Not single-discipline management). Build a long field exercise around this phase where students acquire essential information, analyze, plan and decide among alternatives and then develop a strategy and plan for implementation.

Lecture topics covered in this course are what makes it unique among university courses and the approach to Team Planning in Integrated Resource Management. Most people would have to essentially major in human relations and take a long series of courses to glean what the team planner in resource development and management needs to know and apply from this complex area of knowledge to be optimally successful. Most people learn the subjects in the "school of hard knocks" or go through life without the knowledge and many of the skills. The subject matter is carefully selected, heavily distilled to bare-bones principles and purposefully organized to form the basis of the concurrent laboratory experiences.

Following are most of the lecture topics covered:

(1) Goal and Objective Setting, the role of Enthusiasm and Motivation in interpresonal relationships. The Characteristics and Role of a Leader.

(2) Principles of Human Relations, the Levels of Interpresonal Relationships, how to open an closed mind and move to confidence and belief.

(3) Techniques of idea generation, building or expansion and evaluation or testing.

(4) Techniques of Discussion Leading and Participation, Team Analysis and Planning, Development of a Strategy and Tactics.

(5) Principles of Negotiation and Persuasion, determinants and definition of a Point of No Compromise.

(6) Principles of Problem Analysis, Problem Solving and Decision Making.

(8) Essential Principles of Administrative-Management, how applied in project implementation and management.

In the business world many of the above topics have become the subjects of a series of post-graduate seminars and total-imersion short courses for which people pay from $250. to $1,500. US each without hesitation. They are generally put on for business executives and middle management by well-qualified consulting firms. The development has definitely been done in response to missing elements in nearly all university programs.

It is about time some university somewhere came up to date with the business and management world by bringing the same program into the university environment, focusing it on natural resources development and management. The INRDM program is the focus for AIT to capitalize on this opportunity to be first in the Asian Region if not in the Eastern Hemisphere.

As the consultancy progressed and concentrated attention shifted to the question of a Natural Resources Development and Management Program at AIT, it became increasingly clear that AIT is in a unique position to move successfully into this field if a few critically important guidelines are followed. They have the opportunity, along with those donor agencies who choose to support the program, to provide the Asian Region with a new and critically needed training element for successful Natural Resources Development and Management.

It is a Program that, if properly planned and implemented, will contribute more to the success of natural resources and human development projects than any other single innovation that can be added to traditional procedures. The unique elements are that the approach is non-traditional and one that will train interdisciplinary groups of resource specialists in the techniques and procedures of effective team planning and design for both resource development and program implementation. Given the support, planning and staffing that will make the program successful at AIT, it will stand as a model throughout the developing countries of the world as the proper way to approach and implement resource development and management for the real benefit of human society.

A P P E N D I C E S

APPENDIX A

CEP Tasks per Statement of Work:

1.0 Review and become knowledgable about ARRSTC
1.1 Plans
1.2 Programs
1.3 Operations
1.4 Management
1.5 Curriculum
1.6 Perceived strengths and weaknesses

2.0 Investigate and become knowledgable about:
2.1 Diploma Program in Remote Sensing
2.2 Degree Program in Natural Resources Management

2.0 Investigate and become familiar with programs of other donors to support ARRSTC
2.1 France
2.2 West Germany
2.3 UN/ESCAP
2.4 Others locally represented

3.0 Investigate and become generally familiar with
3.1 Plans, operation, management and curricula of AIT
3.2 Possible expanded role for ARRSTC therein

4.0 Meet with following to keep them informed of activities and progress
4.1 President AIT (3 conferences to rev. date)
4.2 Director of ARRSTC (weekly updates being made)
4.3 Others as designated by President AIT

5.0 Prepare and revise as necessary a detailed report which:
5.1 Reviews and summarizes activities and findings
5.2 Comments on findings of Item 1.1 - 1.6 above
5.3 Makes specific recommendations on:
5.31 Future development of ARRSTC
5.32 ARRSCT operations and management
5.33 Plans
5.34 Programs
5.35 Proposed academic diploma and degree programs
5.36 Specific suggestions, guidelines and strategy on implementation of all 5.3 items

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In the accomplishment of this mission, the above tasks were prioritized by months and weeks. Weekly and daily job lists were prepared and performed according to the priorities and scheduling requirements where other individuals were involved. A running record of task progress and task completion was kept on a working copy of the list. Initial notes and findings as well as outlined ideas on recommendations and strategies were organized according to the above task designators. From these notes narrative was drafted and edited as indicated below to produce the final report. Before the end of the first month a comprehensive outline of the full report had been prepared to a secondary level. Each category in the outline was sequentially numbered with an hierarchicalcal system that also functioned as sequential file names in the word processor. This enabled progressive conversion of hand notes into text draft followed by editing to review draft status with a minimum of wated time and effort. It also facilitated preparation of both the review drafts and the final report copy with "Mailmerge" without ever retyping a single section of the report.

APPENDIX B

Donor's Expectations from the Program

(Extracted from the Following Documents)

PROJECT PAPER
ASIAN REGIONAL REMOTE SENSING TRAINING CENTER
USAID Project No. 498-0253 dated July 1979
and
USAID-AIT AGREEMENT of 30/8/79 rev. 13/8/82

The following are excerpts from the above subject documents made by Dr. Charles E. Poulton, Consultant and Advisor to President North (AIT). An essential first step is to clarify and summarize the purposes, goals and measures of attainment envisaged by USAID at the inception of the ARRSTC Project. This consolidation from the above titled documents should greatly facilitate an objective project evaluation and documentation of achievements in relation to the donor's expectations. The purpose of this exercise is to place all concerned in a position to contribute to:

1) contribute to a strong, positive evaluation statement to USAID (and other donors) about the ARRSTC Program,

2) clearly identify viable expectations and opportunities yet to be met and

3) enable the ARRSTC Staff to move therefrom to develop a Strategy, Goals and Objectives and a Program Plan that will ensure continuance of ARRSTC as a center of excellence in the transfer of remote sensing technology throughout the Asian Region.

To accomplish this composite summary editorializing has been limited and carefully done. Quotes are abundantly used to reinforce authenticity and original intent of the project's designers. In some cases two or more disconnected statements have been combined in a single quote to avoid redundnacy in the summary, but extreme care has been exercised not to change the meaning of any statement so treated. In cases where quotes are not used, the statements were merely abbreviated by leaving out phrases not critical to meaning; in some cases, careful substitution of words for phrases and careful combining of parallel statements in the USAID Project Paper and in the USAID-AIT Agreement was done.

PERCEPTION

"...an Asian Regional Project to establish the Asian Remote sensing Training Center...as an educational facility of the Asian Institute of Technology (AIT) at Bangkok Thailand, complete with laboratory, computer, and data storage facilities."

Region Served

Bangladesh, Bhutan, Burma, India, Indonesia, Maldive Islands, Malaysia, Nepal, Paua New Guinea, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Taiwan, Naura, Western Samoa, Tonga, Brunei, Cooke Islands, Fiji, Hong Kong, Gilbert Islands, Solomon Islands, Tuvalu.

PURPOSE

Establish ARRSTC, "available to the countries of the region," with "capability to: (1) provide training...(2) demonstrate the usefulness of remote sensing in development planning and resource management, (3) agencies in obtaining remote sensing information and technology transfers and (4) assist in planning, as requested by Asian user agencies, with a view toward becoming an integral part of the Asian Institute of Technology."

A "...two-phased six-year training and demonstration project to develop, with ESCAP's cooperation, the ARRSTC..." as above conceived. "The project will provide:

(a) data bank and outreach facilities to give Asian decision-makers the most sophisticated and current data available to regulate their resources and land use procedures, and

(b) a facility to train Asian technicians who will be capable of developing resource and environmental utilization plans based on sound, current, regional data..."

GOAL

"...improvement of the management of natural resources in the Asian Region."

STRATEGY

A Two-Phased program with "Disbursement of funds for Phase II contingent on the results of an external review conducted near the end of year three" (see comprehensive evaluation of USAID remote sensing projects in Thailand by Resource Development Associates, Inc. June 1983).

<u>During Phase I,</u> the project will (a) establish an institutional base, (b) all equipment will be installed, (c) staff in place, (d) relations with internal institutions will be established, (e) services of US advisors contracted, (f) curricula developed and tested, (g) short-term training courses completed, (h) "a library of professional papers, aerial photographs, and relevant text books will

be set up at AIT and historical CCT and image data acquired from the EROS Data Center." (i) "These data will be digested, enhanced, and utilized for instruction and problem solving; and the data products most needed by the countries in the Region will be distributed by the outreach activity." and (j) "provide other services, and outreach, that will assist agencies concerned with the utilization of satellite imagery and computer technology to solve development problems." Initial time frame 1979-81.

Phase II (FY '82 - FY '85) will evolve a project strategy that will emphasize (a) "accelerated training, research and demonstrations of the Center's capabilities." (b) "...may include establishment of a Master's Degree Program." and (c) "...hoped that by the end of Phase II, the Center will be an integral part of AIT's program." and "The Data Bank of the Center will be integrated with the AIT Library..."

GUIDELINES

Training: (a) Maximize flexibility to respond to varying individual requirements and recognize that most Asian countries do not possess sufficient depth of technical personnel to insure optimum use of satellite data. (b) Both optical and computer-based problem solving will be demonstrated with hands-on instruction. (c) Students will be encouraged to bring imagery and local problems ...to the Center for solution during the training. (d) Arrange air photo coverage and imagery of test areas in Thailand. (e) "The Center will have trained 200 to 300 technicians to form the nucleus of an Asian community of remote sensing specialists" by the conclusion of the second phase. (f) "They will have available the imagery and other products of the Thai ground station...to assist...in solving development problems."

Problem Solving and Research: (a) U.S. and Asian instructors will assist in carrying out remote-sensing research to establish this subsidiary of AIT as a center of excellence, insure Asian acceptance of remote sensing technology in national development planning. (b) The door is open to contractual research on specific problems.

Outreach: (a) The U.S. Project Leader, and later the Asian Director of ARRSTC, will have to be dynamic and innovative in their communication with Asian Governments, institutions, and interested individuals to make known their capabilities and receive feedback on requirements of the client countries. (b) A Newsletter will be circulated. (c) The satellite data products processed by the Center and most needed by the countries in the Region will be distributed by the outreach activity." (d) The Center will collaborate on symposia and other meetings to increase Asian awareness of the Center and its capabilities.

Technology Transfer: Project envisages technology transfer on six levels as follows:

(1) Direct transfer of skills through short-term training.

(2) Transfer of new techniques through reports, seminars, symposia, etc.

(3) Transfer and interchange of students, full-time instructors, and part-time lecturers throughout the area.

(4) Outreach activities resulting in the transfer of information via communication, newsletter, document dissemination, etc.

(5) Transfer of knowledge through continuing education of university professors and government officials.

(6) Transfer of benefits to Asian populations through implementation of programs applying the technology.

PROJECT MONITORING AND EVALUATION

Equipment Planning: Immediately after execution of the Grant Letter of Agreement between USAID and AIT, USAID will provide two consultants (a Computer and a Remote Sensing and Ground Truth Spcialist) to finalize details of equipment to be purchased, including spare parts. Estimate 2 months each, cost about $40K.

Equipment Maintenance: It is estimated that about $400K will be required to maintain computer peripherals and software during the life of the project. USAID will finance this requirement from the grant.

Consulting Assistance and Guidance: Contractor will be required to arrange for up to ten person-months of specialized expert consulting services during the six-year period of the contract for solving special problems and giving special advice and lectures.

Management and Progress Monitoring: The contract calls for quarterly Status and Progress Reports along with reimbursement billings from AIT and six (6) copies of the ARRSTC Annual Report to go to USAID.

Measures of Accomplishment: The following criteria of successful implementation are stated or implied in the two key project documents:

(1) Attainment of the higher goal (p.2) will be evident in the continuing use actually made of data available through remote sensing technology in planning for real development and management projects throughout the Asian Region.

This measure essentially excludes pilot and demonstration projects unless their results are beneficially used in the real-world decision process or they lead to a follow-on operational project.

(2) Numbers and trends in student enrollment and student applications in relation to acceptances.

(3) Trends in scholarship support; consistent supporters, sporadic supporters, drop-out supporters (why disconcontinued) and new supporters (why they initiated support).

Criteria for classifying support:

Consistent:	Missed no more than one year since first participation.
Inconsistent:	Support greater than 2 yrs, one of which is in the last two years.
Drop Outs:	No support in the last 2 years.

(4) Percent of countries inside Region who have sent students. Number of countries outside region who have sent students. Numbers sent, by years.

(5) Feedback from students: a) while enrolled; b) after return home, volunteer response and staff contact.

(6) Professional performance and progress of students after returning home, continued use of the technology.

Qualifies for continued use if regularly uses technology in own work or has proposed projects that were accepted and results used in decision process.

(7) Workshops held or participated in; list by date and name so trends in this activity are evident.

(8) Research or Demonstration Projects undertaken by ARRSTC staff or under their direction. List by year of initiation, titles, financial support level and status.

(9) Agency requests for assistance and advice on sensing applications.

(10) Staff or student contribution to non ARRSTC seminars, professional meetings; special recognition for invitational papers.

Mid-term Evaluations: During the final year of Phase I, an external evaluation of the project will be conducted (done by Resource Development Associates, fourman team in May 1983) to determine whether the project is achieving its objectives. This was set up as a determinant for moving into Phase II.

Final Evaluation: Project plan calls for a second indepth evaluation near the end of Phase II.

COOPERATIVE RELATIONSHIPS

The Project Paper envisaged many contributions by ESCAP and NRC. These have been left out of the summary because neither USAID nor ARRSTC has positive control over these expectations.

However, an attempt to assess the awareness and acceptance of the ARRSTC Program by ESCAP, UNDP, NRC and Thai universities having similar programs could be particularly relevant as another measure of the success and present stature of the program.

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APPENDIX C

Findings and Recommendations, 1983 Program Review

Extractions from RDA, Inc.'s Report of June 1983 -- Specific ARRSTC Related Implications. SUMMARY by Dr. Charles E. Poulton, Consultant and Advisor to President North. (1986)

(1) The 1983 review team pointed out that "arrangements for administrative support for the teaching staff had not been made [early enough in the program]." and "the relationships between teaching staff [at ARRSTC] and AIT...were not delineated clearly enough to avoid confusion on the part of the teaching staff."

(2) Each faculty member is responsible for about nine (9) contact classroom hours per week...in keeping with customary university scheduling.

(3) With this kind of training program and considering the language diversity, large amounts of time must be spent directing students on a personal basis. With sophisticated equipment and a goal to provide "hands-on" experience, personal staff supervision for small groups of students and demonstrations are essential. These requirements justify the low student/faculty ratio.

(4) In the initial developmental stages, a large amount of time had to go into a) developing the digital processing phase, b) developing and modifying software, c) preparing exercises and d) "shake down" of newly installed equipment.

(5) The review team was particularly complementary when they said, "the course is probably the only one given in the world that provides the time to go into a fine level of detail in virtually every known technique in the field of remote sensing." The Consultant would not go quite that strong and recommended dropping some littleused systems in favor of better coverage of visual methods and verification.

(6) The length of time available provides for fully integrated labortory and field experience to support the teaching of techniques. Thus the course approaches the ideal balance in providing both education and training.

(7) "All the usual techniques are taught for analysis of visual imagery. Acquisition of these skills is vital both to program graduates from the countries lacking digital analysis capabilities, and those who will use visual imagery in support of digital analysis." The reviewers felt that a good balance was achieved between the visual and the digital approaches to image analysis.

(8) Full awareness is taught of the importance of field investigations, supporting information and maps, etc., in the remote sensing interpretation process as a part of a spatial information system.

(9) "The science of photography is inextricably bound with the techniques and tools of remote sensing. A common omission in remote sensing training is the development of an understanding of photographic theory and how that knowledge can be applied to select methods for acquisition of remotely sensed information."

(10) The role and techniques of Geobased Information Systems in information management and use is an integral part of the program.

(11) The course is structured to provide an education broad enough for graduates to grow into leadership positions in their respective countries. The course is conceptually sound.

(12) "Graduates from the program need time to rise to positions of influence in their home countries before any final assessment can be made [of program's effectiveness]."

(13) Adequate visual support data for instruction is in short supply.

(14) The team commented that ARRSTC had not, at the mid-point, fulfilled two of its original purposes: a) demonstration projects of the usefulness of the technology in development planning and b) movements toward becoming an integral part of AIT. They concurred especially that research and applications projects should be a part of the ARRSTC Program. They recommended an increase of staff activity along this line and that students be encouraged to conduct projects on problems from their own countries.

(15) Two additional areas of concern were identified by the 1983 review team: a) inappropriate emphasis in relation to student backgrounds; and b) limitation of class sizes to match well the complex nature of the subject and the unique requirements for effective instruction. The reviewers noted that a 30-student class is too large to be effective.

(16) The review team recommended "changing the fundamental structure of the program from...a single training course to a comprehensive, traditional, university-like program of related courses.

(17) The team suggested a program of 9 courses of 4-hour/week duration with students taking 3 courses per term over 3 terms with successful graduates being awarded a graduate diploma in remote sensing and/or credits toward a discipline-based Masters degree with 36 trimester or 24 semester hours.

(18) Suggested adding case studies of discipline applications to the formal curriculum plus "Directed Study" and a Thesis or Project.

(19) The program should remain an autonomous unit at AIT, one that would be recognized in the region in accord with original specified design.

(20) The team made a number of recommendations about digital analysis software which have now largely been met by the diligent work of the present ARRSTC staff.

APPENDIX D

Individuals Interviewed

Asian Institute of Technology:

Mr. Yian Kwan Ang
System Analyst
ARRSTC

Dr. Buddy H. Atwell
Associate Director
ARRSTC

Dr. Janos J. Bogardi
Associate Professor
Water Resources Engineering

Dr. Denis Borel
Associate Professor
ARRSTC

Mr. M. C. Brown
Assistant Professor
English Language Center

Dr. Harry R. Clarke
Associate Professor
Industrial Eng. & Mgt

Dr. Apisit Eiumnoh
Assistant Professor
ARRSTC

Dr. Robert H. B. Exell
Professor
Chairman Curriculum Committee
Energy Technology

Mr. Roland Gachet
Research Associate
ARRSTC

Dr. Joe A. Gartner
Associate Professor
Agric. & Food Eng.

Dr. David Gee-Clough
Chairman & Associate Professor
Agric. & Food Eng.

Dr. Sarah E. Goldin
Assistant Professor
ARRSTC

Mrs. Emilie Ketudat
Academic Secretary

Mr. Georges Kozminski
Instructor
ARRSTC

Dr. John E. Lukens
Associate Professor
ARRSTC

Dr. Milton J. Marcus
Director
Regional Computer Center

Mr. Nipon Masavisut
Director
Administrative Services

Prof. Alastair M. North
President of AIT

Dr. Kaew Nualchawee
Director of ARRSTC

Prof. Prinya Nutalaya
Professor & Chairman
Geotech. & Transp. Eng

Prof. Ricardo P. Pama
Vice President for Development

Dr. Chongrak Polprasert
Chairman & Assoc. Professor
Environmental Engineering

Dr. Amphon Pitanilabut
Project Architect

Mr. Kurt T. Rudhal
Assistant Professor
ARRSTC

Mr. Narong Sa-iam
Financial Accountant
Accounts & Control

Mr. Sadequzzaman
Research Associate
ARRSTC

Prof. Gajendra Singh
Vice President Academic Affairs

Mr. Samut Siriburi
Liaison Officer
ARRSTC

Ms. On-anong Suraniranat
Sr. Info. Scientist
RERIC

Mr. Xua Surathep
Assistant Director
Regional Computer Center

Mr. Prida Thimakorn
Associate Professor
Water Resources Engineering

Dr. Tawatchai Tingsanchali
Chairman & Assoc. Professor
Water Resources Engineering

Mr. Md. E. Ullah
Info. Scientist
ARRSTC

Dr. Pongsagdi A. Vejjajiva
Director of Finance
Accounts & Control

Dr. H. A. Vespry
Director
Library & Regional Doc Ctr

Dr. B. K. Worcester
Assoc. Professor
ARRSTC

Dr. H. D. Dias
Director
Division of Human Settlements

Chulalongkorn University:

Mr. Yongyuth Chanyarak
Botany Department

Dr. Prasit Prapinmongkolkarn
Assoc. Dean for Plan & Devel.
Electrical Engineering Dept.

Mr. Sakda Siripant
Head
Photographic Science Dept.

Prof. Thiva Supajanya
Geology Department

Dr. Narong Tiramongkol
Geology Department

Mrs. Rajanee Virabalin
Botany Department

Kasetsart University:

Dr. Kasem Chunkao
Chairman Dept. Conservation
Faculty of Forestry

Dr. Sathit Wacharakitti
Associate Dean
Proj. Leader Remote Sensing

Royal Thailand Government:

Prayong Angsuwatana
Dept. of Mineral Resources

Khun Thong Chai
Assistant in Forestry
Department of Forestry

Khun Prasopchai Namlabhuda
Tech. Forest Officer
Department of Forestry

Dr. Manu Omakupt
Land Development Dept.

Dr. Suwit Ongsomwang
Tech. Forest Officer
Forest Management Division

Dr. Sinboon
Meteorological Department

Dr. Suvit Vibulsresth
Director
Remote Sensing Division, NRC

United Nations Agencies:

Pieter J. Bakker
Chief Mineral Res. Sect.
ESCAP

Mr. M. U. Chaudbury
Expert Remote Sensing
ESCAP/RRSP

Dr. Nay Htun
Director & Regional Rep.
UNEP

Dr. David M. Thorup
Associate Director
UNDP

Dr. Heng L. Thung
Manager/Coordinator
ESCAP/RRSP

USAID / Washington, D.C.:

Dr. Neil Brady

Mr. Steve Lintner

Dr. Chuck Paul

Mrs. Carol Peasley

Dr. Jack Sullivan

USAID / Thailand:

Mr. Willy D. Baum
Health, Population & Nutrition

Dr. John R. Eriksson
Mission Director

Mr. William E. Knowland
Environment & Nat. Resources

Khun Narintr Tima
Program Specialist/Health

Mr. Lee Twentyman
Deputy Mission Director

ERIM / Ann Arbor, Michigan (Contributors to Report):

Dr. James Cooper
Photographic Scientist

Dr. Thomas W. Wagner
Regional Coordinator

World Bank / Washington, D.C.:

Dr. B. Wayne Luscombe
Environment & Sci. Affairs

Dr. Glenn Morgan
Environment & Sci. Affairs

Winrock International / Bangkok:

Dr. Robert K. Dixon
F/FRED Project

Dr. James E. Nickum
Economist

Consultants:

Prof. Donald Bewley
Massey University
New Zealand

Dr. Frank H. Bollman
Agric. Ind. Inc.
Sacramento, CA

Dr. David Runnalls
Director
IIED
Washington, D. C.

Appendix E: Evaluation of Coverage of Curriculum Subjects as Indicated by Lecture and Laboratory Hours of Contact.

Subject Matter Covered	1984 A	1984 B	1985 A	1985 B	1985 C	1986 A	1986 B
	Class Contact Hours on Topic — Lecture/Laboratory						
Orientation	6/	3/	3/	3/	3/	18/	3/
Basics/Background	33/	15/	24/	24/	15/	18/	12/
Visual	18/	6/	6/3	3/	2/	3/	3/
Digital	21/	30/	27/	42/	42/	39/	30/
Radar	9/	12/6	3/6	3/6	6/3	3/6	6/3
Thermography		3/	3/	3/	3/	3/	3/
Cartography & Mapping	6/3	6/6	12/	9/	6/3	12/	6/3
Photogrammetry			3/	3/	3/3	3/	3/3
Legend Concepts and Proced.	3/						
The Resource			3/				
Land Cover/Vegetation			6/				
Soils	4/		6/	6/			
Landforms	5/		6/3	3/			
Visual Interpretation Methods					3/3		
Photography	/3	6/6	3/3	6/8	3/18	6/15	6/15
Imagery	6/75	15/9				3/	
B & W	/6	3/	3/2	/3	/3	/6	
FCC		3/	/6	/6	/6	/3	
Digital Interp. Methods	192/72	39/57	15/33	27/57	33/27	30/33	57/18
Managing an IPS					3/	3/	3/
Project Planning & Management	3/	9/	9/	12/	12/	9/	6/
Student Project Plan			/27	/11	/18	/24	/39
Student Project Execution	9/81	/36	/69	6/57	21/42	15/57	12/75
Info. Verification		18/	12/	9/	12/	9/	6/
GIS Principles & Practice	6/	/6	3/3	6/6	15/12	9/6	15/6
Applications/Case Studies	3/	18/	27/	36/	12/	24/	18/
Library, Free Time			/9	/9	/9	/6	/3
Future of R S, Roundtable		/6	/6	/6	/6	/6	/6

APPENDIX F

Goldin and Rudahl Statements

ARRSTC Staff members, Goldin and Rudahl prepared a paper, "Any Size, Any Color: Digital Image Processing Facilities at the Asian Institute of Technology" that sets forth the full capability of the systems for digital image analysis at AIT. Rudahl also prepared a memorandum under date of 11 June 1986 that addresses the then operational status of all the sytems and made some recommendations for the future.

For the concerned reader, these are both included on the following pages:

ANY SIZE, ANY COLOR: DIGITAL IMAGE PROCESSING FACILITIES AT THE ASIAN INSTITUTE OF TECHNOLOGY **

S.E. Goldin and K.T. Rudahl
Asian Regional Remote Sensing Training Center
Asian Institute of Technology
Bangkok, Thailand

INTRODUCTION

Remote Sensing provides effective tools to tackle many of Asia's most serious economic and social problems. Unfortunately, appropriate use of remote sensing techniques requires substantial specialized knowledge, as well as relatively sophisticated equipment. The Asian Regional Remote Sensing Training Center (ARRSTC) was established within the Asian Institute of Technology (AIT) to acquaint developiong countries in the Asia-Pacific region with both the theoretical and practical aspects of remote sensing technology.

ARRSTC's primary activity is teaching Asian scientists and decision-markers about remote sensing principles, techniques, and applications. It offers broad training programs covering all aspects of remote sensing at a fundamental level as well as more specialized instruction focusing on particular, advanced topics. ARRSTC faculty also conduct remote sensing research and supervise research projects conducted by AIT students. Finally, ARRSTC provides professional assistance and facilities on a contract basis to other agencies and organizations wishing to use remote sensing research and supervise research projects conducted by AIT students. Finally, ARRSTC provides professional assistance and facilities on a contract basis to other agencies and organizations wishing to use remote sensing techniques.

The Center possesses the various facilities necessary to support its teaching and research activities: imagery and map collections, visual analysis equipment, drafting and cartographic aids, photoprocessing facilities, and finally, computer facilities. Because digital image analysis and geographic information processing represent emerging technologies with already-demonstrated power, ARRSTC has devoted considerable effort to developing its digital capabilities. This paper describes the various digital image and map processing systems currently available at ARRSTC.

** Revision of paper presented at the ESCAP Conference on Recent Developments in Remote Sensing Equipment and Technology, 10-14 June 1985, National University of Singapore.

ARRSTC's computer facilities cover a wide range in sophistication, power and price. This is appropriate, given the range of activities pursued by the Center. For faculty, contract, and advanced student research, the Center can offer state-of-the-art image processing facilities with extremely high resolution and processing speed, which can be used to implement new, experimental analyses. For intermediate levels of training, microcomputers augmented with special hardware provide moderate image quality and an excellent cost/benefits ratio, allowing students to perform standard analyses using affordable equipment. For introductory level training, simple image processing software used with an unaugmented microcomputer can demonstrate the basic concepts of image processing. ARRSTC trainees and clients have the opportunity to compare the various alternatives within the power-price spectrum and to evaluate which type of system will best serve their needs and those of their countries.

OLDER SYSTEMS

Mainframe DIMAPS System

Until recently, the bulk of ARRSTC image processing training and research was performed using the DIMAPS (Digital Image Manipulation and Processing System) software package, running on AIT's IBM 3083 mainframe computer. This package requires a specially-equipped workstation, including a graphics processor, 512x512 color graphics monitor, and vector graphics monitor (Table 1). ARRSTC possesses two fully-equipped DIMAPS workstations. Two color film recorders, and a large scale electrostatic plotter provide input/output capabilities for the main frame system. A stand-alone, very high resolution scanner-plotter by Optronics will support mainframe image processing activities and also be used with ARRSTC's newer systems, when ARRSTC's new photographic laboratory becomes operational.

Although DIMAPS is a relatively old software system, it provides most basic image enhancement and classification functions (Table 2), including one and two dimensional Fourier transform analysis, principal components analysis, and unsupervised classification. The only supervised classification algorithm available in the basic system is a variant of the parallelepiped algorithm that allows adjustment of training set boundaries to exclude outliers. However, ARRSTC personnel have developed a maximum likelihood classification module for DIMAPS as part of an ongoing reserach project. Other DIMAPS extensions developed at ARRSTC include modules for geometric correction and for quantitative and spatial comparison of classified images.

The DIMAPS system gives ARRSTC trainees experience using a mainframe-based image processing system, with the typical advantages and disadvantages associated with such a system. The advantages include high data storage capacity, large amounts of memory for calculations, magnetic tape devices to allow direct input from satellite image CCT's and the availability of experienced system support personnel to assist with problems and new development efforts. The main disadvantages are the high cost for equipment acquisition and ongoing support, the complexity of the hardware, which tends to lead to maintenance problems, and the relatively slow response associated with a time-sharing system. The DIMAPS system has an additional disadvantage, from the train- ing point of view; it is not a well-known system and is used at no more than a handful of sites throughout the world. However, the training program encourages students to learn general image processing concepts and skills rather than the details of a specific system. The mainframe image processing facilities at ARRSTC play an important role in our training efforts.

Microcomputer-based Pericolor System

The Numelec Pericolor 1000 is a microcomputer-based sytem dedicated to image processing. (Table 3) The system is built in France and was supplied by a grant from the French Government. Its main processor is the 8-bit Intel 8080 microprocessor. It also includes a specialized arithmetic processor to speed numerical calculations. The current configuration at ARRSTC has sufficient video memory to hold eight 256x256 pixel images with 8 bits resolution per pixel (possibility of 256 colors or gray scale levels). This is the maximum number of image planes that the Pericolor can support; smaller configurations are possible.

The Pericolor 1000 can take its input either from its two 8 inch floppy disk drives or from 800/1600 bpi magnetic tapes. It includes software to read a wide variety of CCT data formats. Currently, the Pericolor produces image output on a dot matrix line printer, with up to eight gray levels. Processed images can also be transferred to the mainframe via floppy disks or tape and output using the high-resolution electrostatic plotter described above.

The standard Pericolor software is menu-driven and provides a variety of image processing functions: density slicing, arithmatic combinations of bands, filtering, etc. (Table 4) The software allows excellent control over the image display, offering zoom, recentering and color map change options. Graphical histogram and contouring operations are also available. In addition to the standard Pericolor software, ARRSTC's installation includes several specialized software modules written by CNES (Centre Nationale d'Etudes Spatiales) for use with SPOT simula- tion data. These modules provide a variety of capabilities including supervised and unsupervised classification and geome- tric correction. Finally, although the Pericolor is a specialized rather than general purpose microcomputer system, it does allow the user to do a limited amount of custom programming, in BASIC.

The Pericolor system has been used by students since the January 1985 term and is quite popular. Its strengths include its quick response, its flexible image displays, and its excellent color capabilities. It is a highly interactive system much better suited to exploration and experimentation than the mainframe image processing system. Although it uses an older, slower microprocessor and has less memory than current microcomputers, it can use these resources effectively because it is a dedicated system, designed to perform only image analysis functions. It sacrifices generality for a higher level of performance. The specialized nature of the Pericolor makes it cost somewhat more than a general microcomputer-based system. However, unlike a mainframe-based system, maintenance and support costs are relatively low. Also, in response to competition from other microcomputer-based systems, the price of a Pericolor 1000 system has recently been reduced.

The Tutorial Image Processing System

A third resource for image processing training at ARRSTc is the Tutorial Image Processing System (TIPS), a program written by ARRSTC faculty to introduce students to the logic of basic image processing operations. TIPS runs on IBM-PC, Fujitsu Micro16S and Sanyo MBC-555 microcomputers, under the MS-DOS operating system. No special hardware is required. Either color or monochrome monitors can be used with the IBM-PC.

TIPS is not an image processing program, in the usual sense. "Images" in TIPS are 9x9 matrices of integers between 0 and 7. Matrix positions represent pixels; values represent gray scale levels. TIPS provides options to display images using different colors, patterns, or characters to represent different gray scale values, making it easier to see simple patterns (such as letters of the alphabet) that can be embeded in the images. TIPS can also display image histograms. Images in TIPS can be scaled, averaged, added, differenced, ratioed, filtered and classified. Images displayed on the screen are updated automatically in response to any changes in input values or operations.

The TIPS program provides an excellent supplement to introductory lectures on image enhancement and classification. It allows students to experiment with the mechanisms of convolution, ratioing, etc., in a simple environment that still preserves the essential features of an image processing system. Using TIPS also increases the trainees' comfort and familiarity with computers, facilitating the transition to more complex hardware and software systems.

NEWLY-INSTALLED SYSTEMS

High-Performance Minicomputer System

ARRSTC has recently installed equipment that constitutes its most sophisticated and powerful image processing facility. This high-performance system centers on a very fast superiminicomputer with dual processors, augmented with array processing hardware. (Table 5). The system is configured to support two image process- ing workstations, one of which can display images up to 1024x1024 pixels at 8 bits-per-color (plus a one-bit overlay), the other providing a resolution of 512x512 pixels (with four overlays). Each workstation can thus display more than 16 million colors. Six alphanumeric terminals provide facilities for custom software development. Input/output devices for the system include a video scanner/digitizer and a color printer, as well as a standard lineprinter. The system has three removable hard disks with capacities of 300 Megabytes each and a 800/1600/6250 bpi tape drive for image storage. The tape subsystem will allow use of CCT image tapes and transfer of image data to the Optronics printer for high resolution output.

The software accompanying this system is Delta Data Systems ATLAS. It provides a wide range of image and geographic information procesing functions (Table 6). In particular, it supports such computationally-intensive operations as iterative clustering, Fourier analysis, principal components, geometric correction. ARRSTC has acquired the source code for the software, which is written in FORTRAN, and an extensive library of subroutines relevant to image processing, so that it can expand the capabilities of the system as needed.

The high resolution, speed and processing capacity of this minicomputer system will best suit it for use in research and applications work by faculty, advanced students, and outside organizations. It will provide the power necessary to process data from new high-resolution satellites such as SPOT. The hard disk and tape facilities will also be used to store and reformat data for ARRSTC's microcomputer-based systems. ARRSTC plans to connect the minicomputer to the microcoputers in a medium speed network, allowing a microcomputer user to save or retrieve large data files as needed. Having his powerful minicomputer system avilable for demonstrations will also be a powerful stimulus to the development of remote sensing in the region. Students, visitors and clients can be introduced to equipment at the current frontiers of technology.

ERDAS Microcomputer-based Systems

The ready availability of inexpensive personal computers creates a constant temptation to utilize them in image processing systems. However, there are serious difficulties in using an unaugmented personal computer for this purpose (Rudahl 1985). The two ERDAS systems that ARRSTC has just installed demonstrate how much can be gained by relatively modest additions to massproduced computers.

Each ERDAS is essentially an IBM-PC/XT plus a high resolution graphics processor and display, and a comprehensive set of software modules. The graphics equipment provides a display resolution of 512 by 512 by 24 bits per pixel, plus two 512 by 512 by 4 bit overlay planes (Table 7). This basic hardware configuration is supplemented by an ink-jet color printer and a 24 by 36-inch digitizing tablet which are shared by the two systems. The standard software includes an image processing package (image display and enhancement, geometric correction, interactive training field selection, numerous classification options, and provision for merging classifications into a GIS), utilities and menu creating facilities, and a toolkit with macros and libraries for creating user-developed functions. Additional software options acquired by ARRSTC include a geographic information system (GIS) module and a polygon digitizing package (Table 8).

The configuration of all of the new computer systems installed at ARRSTC includes provision for sharing as many of the peripherals as possible among various systems. In particular, when the proposed network is installed, the ERDAS equipment will depend on either the IBM mainframe or the minicomputer system for tape reading and translating. Connections to both these systems will permit image data files to be transferred from the larger systems to ERDAS and back. The scanners and printers will likewise be shared among the various systems where possible.

The ERDAS installations are being used for the first time by students from September 1985 term, and have already demonstrated their effectiveness. Their flexibility and ease of use, as well as their low cost, make them very interesting and attractive to trainees. Although the ERDAS systems are constrained by limited data storage capacity and a relatively weak processor, they provide results comparable in quality to many larger systems, at a considerably lower cost. It is expected that these machines will support many student projects and new development efforts in the near future.

MAPS Geographic Information System Software

Another software package recently installed at ARRSTC is the Map Analysis Package System (MAPS). This GIS software runs on the IBM mainframe. It does not require any specialized hardward; its outputs are character-coded maps printed on the lineprinter. Despite its rather crude output, MAPS is a quite powerful system that provides a wide range of GIS operations. Versions of MAPS are available for a variety of different hardware configurations other than the IBM mainframe. In fact, a version for the IBM-PC microcomputer is currently under development. Thus, training using MAPS may be generalized to other hardware environments.

FUTURE DEVELOPMENTS

As new products continue to reduce the price and increase the quality of image processing, ARRSTC will face a continuing need to update its facilities and its training programs. The effects of technological development should be most apparent in the low-end equipment: the microcomputer and personal computer based systems. The following discussion reflects ARRSTC's current plans for ongoing development of its image processing facilities. It should be recognized that these plans will inevitably change in response to new technologies as they become available.

SPOT Data Processing System

The Government of France has promised ARRSTC a new image processing system to replace the Pericolor 1000 before the end of 1987. Technical details of this system are not yet available; it will probably be microcomputer-based and will certainly be faster and more powerful than the Pericolor.

This new French system will include software specially designed to process data from the SPOT satellite, due to be launched this fall. The system will most likely be used for reserach projects involving SPOT and for training students to interpret and use high-resolution satellite imagery.

Image Processing Software for Personal Computers

One major gap in available digital image processing resources is any reasonable image processing software that will run on an off-the-shelf personal computer, without any additional hardware. Such software would be invaluable for training and might have utility for some modest real world applications as well.

The only software of this sort currently available is the Apple-PIPS program. ApplePIPS is weak and difficult to use even for training because of the Apple II's limited memory, display, and disk capacity; nevertheless it remains popular. The current generation of personal computers, however, offer 4 to 16 times as much memory, 2 to 100 times greater disk capacity and significantly improved display resolution over the Apple II. Software designed to take advantage of these capabilities would be a great improvement over ApplePIPS.

ARRSTC has taken some steps in this direction. Center personnel have written IBM-PC assembly language routines to display sub-images, zoom, create image windows, and calculate and plot image histograms. Development along these lines will continue, although it will probably go slowly due to more pressing demands on staff and faculty time. In addition, it has been arranged for ARRSTC to receive a test version of a new commercial

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image processing software package that will run on IBM-PC compatible machines without extra hardware. This new software, currently under development, should be available early next year.

CONCLUSION

ARRSTC's primary function is to provide remote sensing resources to the Asia-Pacific region: expertise, instruction and equipment. A variety of different digital image processing faci- lities are available at ARRSTC, to meet a variety of needs: basic training, advanced training, student projects, faculty and con- tract research. This paper has described, in some detail, the capabilities, strengths and weaknesses of these various image processing systems. Hopefully, it will help governments and agencies with the region to determine how they can best make use of the resources at AIT/ARRSTC.

References

RUDAHL, K.T., 1985, Image processing using personal computers. ARRSTC Newsletter, Vol. 3, No. 2.

Table 1

DIMAPS Hardware Specifications

MAIN PROCESSOR:	IBM 3083 (time-shared)
IMAGE PROCESSING WORKSTATIONS (2) :	Ramtek Graphics Controller and Color Monitor 512 x 512 pixel resolution 9 bits per pixel (512 colors)
	Tektronix Vector Graphics Display (storage type)
	Tektronix Thermal Printer
	Matrix Color Film Recorder (35 mm and large format)
	Trackball, Joystick
OTHER PERIPHERALS:	Versatec Electrostatic Plotter (200 dots per inch resolution, 22" wide)
	Optronics scanner/printers (not currently in use)

Table 2

DIMAPS Software Specifications

ENHANCEMENT FUNCTIONS:	Arithmetic operations - sum, difference, - ratio Contrast manipulation - Gaussian - linear - manual Filtering - general 5x5 filter - edge enhancement (Laplacian) - smoothing Fourier analysis - one-dimensional with filtering - two-dimensional with filtering Principal components analysis
CLASSIFICATION FUNCTIONS:	Biscatterplot display and unsupervised classification based on clusters Parallelepiped classification - Histograms of training sets - Training set boundary adjustment - Deletion of classes - Mixed pixel designation
ANALYSIS FUNCTIONS:	Histogram display - full scene, sub-scene - polygon, training sets Brightness profile display (along line) Image coordinates display
DISPLAY FUNCTIONS:	Single band false color, B&W Three band false color Stored image display - single or side by side Grid lines and annotations Enlargement - pixel duplication - interpolation Reduction - pixel elimination
UTILITY FUNCTIONS:	Image store and recall Sub-image selection Display of image inventory Versatec output module

Table 2(Cont'd)

USER INTERFACE STYLE:	Main menu plus extensive queries; numeric responses Trackball/joystick for selection of image areas and other graphic interactions

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Table 3

Pericolor Hardware Specifications

MAIN PROCESSOR:	Intel 8080
AUXILIARY ARITHMETIC PROCESSOR:	9511A
MAIN PROGRAM MEMORY:	64 Kbytes
DISPLAY CHARACTERISTICS:	256x256x8 pixel image planes 8 image planes plus 8 one-bit marker planes; can also be used as one 512x512 image planes with 16-bit color resolution (can only view 256x256 pixel window at one time)
PERIPHERALS:	Trackball Dual 8-inch floppy disk drives 800/1600 bpi 9-track magnetic tape drive Epson dot matrix printer (8 gray levels)

Table 4

Pericolor Software Specifications

ENHANCEMENT FUNCTIONS:	Arithmetic operations - sum, difference, - ratio - vegetation index Contrast manipulation - linear - manual Filtering - general 3x3 filter Principal components analysis Geometric corrrections - linear
CLASSIFICATION FUNCTIONS:	Biscatterplot display Supervised and unsupervised classification based on clusters
ANALYSIS FUNCTIONS:	Histogram display Image statistics display Contouring
DISPLAY FUNCTIONS:	Single band false color, B&W Two or three band false color composite Grid lines and annotations Zooming (magnification) Recentering of image Dynamic color assignment
UTILITY FUNCTIONS:	Tape reading/writing utilities - all common CCT formats - up to 16 bands Output to printer routine
USER INTERFACE STYLE:	Extensive, hierarchical menus (in French) Graphical interactions, icons as well as verbal options Menu window on same screen as images Trackball and keyboard used for responses

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Table 5

Minicomputer System Hardware Specifications

MAIN PROCESSOR:		Gould 32/6780
IMAGE PROCESSING WORKSTATIONS	(1) :	Comtal Graphics Controller and Color Monitor 1024x1024 pixel resolution 24 bits per pixel (16 million colors) 1 bit-plane overlay
	(2) :	Comtal Graphics Controller and Color Monitor 512x512 pixel resolution 24 bits per pixel (16 million colors) 4 bit-plane overlay
OTHER PERIPHERALS:		Eikonix scanning digitizer 2048x2048 resolution
		Analogic AP-500 array processor
		800/1600/6250 bpi 9-track tape subsystem
		Floppy disk (8-inch) subsystem
		Color ink-jet plotter
		Line printer

Table 6

Minicomputer ATLAS Software Specifications

ENHANCEMENT FUNCTIONS:	Arithmetic operations - sum, difference, - ratio Contrast manipulation - standard - customized Filtering - general n x n filter Principal components analysis Fourier analysis KAUTH transforms
CLASSIFICATION FUNCTIONS:	Biscatterplot display & unsupervised classification based on clusters Automated training field selection Polygon clustering Maximum likelihood
GEOMETRIC CORRECTION:	Landsat to Mercator Coordinate conversion Multitemporal registration
ANALYSIS FUNCTIONS:	Histogram display - full scene, sub-scene - polygon, training sets Brightness profile display Image coordinates display Multivariate/multiple linear regression Analysis of variance
DISPLAY FUNCTIONS:	Single band false color, B&W Three band false color Stored image display - up to 16 subimages simultaneously Grid lines and annotations Enlargement - pixel duplication - interpolation Reduction - pixel elimination

Table 6 (Cont'd)

GEOGRAPHIC INFORMATION SYSTEM PACKAGE

UTILITY FUNCTIONS:	Image store and recall Sub-image selection Display of image inventory Destriping and reformatting Polygon manipulation package Table editor
USER INTERFACE STYLE:	Menu-driven Trackball/joystick for selection of image areas and other graphics interactions

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Table 7

ERDAS Hardware Specifications

MAIN PROCESSOR:	IBM-XT personal computer (8088) with 10 mbyte Winchester disk 8087 arithmetic coprocessor
IMAGE PROCESSOR:	Number 9 Revolution graphics processor and display subsystem 512x512 pixel resolution 24 bits per pixel (16 million colors) Two 4 bit overlays Full lookup table on all outputs 7220 graphics processor
OTHER PERIPHERALS:	Tektronix 8-color ink-jet printer 24" x 36" digitizing table Joysticks Black and white dot-matrix printer

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Table 8

ERDAS Software Specifications

ENHANCEMENT FUNCTIONS:	Arithmetic operations - sum, difference - general linear combinations - ratio Contrast manipulation - histogram equalization - linear stretch - non-linear stretch Filtering - general convolution - edge enhancement Principal components analysis
CLASSIFICATION FUNCTIONS:	Interactive training field selection Supervised classification - maximum likelihood - parallelepiped - minimum distance Unsupervised clustering Thresholding by probability Manipulate signatures - display - store - combine
GEOMETRIC CORRECTION:	Coordinate transformations - UTM - State Plan Rectification - nearest neighbor - bilinear interpolation - cubic convolution
ANALYSIS FUNCTIONS:	Histogram display Signature statistics display Image coordinate display Polygon digitizing, storing, editing
DISPLAY FUNCTIONS:	Single band B&W Three band false color Annotations, legends Enlargement and reduction Interactive color selection Map output functions
GEOGRAPHIC INFORMATION SYSTEM FUNCTIONS	
USER INTERFACE STYLE:	Hierarchical menus or commands (user's choice) Queries within menu options Graphics interaction with joystick or keys

11 June, 1986

MEMORANDUM

TO: John Lukens

FROM: Kurt Rudahl

SUBJECT: NRDM Digital PID

OBJECTIVES

ARRSTC presently owns or has available a large variety of image processing systems which can most accurately be described as fragmentary. My intention is to outline the material, personnel, and financial circumstances which would permit transforming this collection into a unified image processing environment capable of supporting continuous use at varying levels by students and contract researchers. The philosophy described should permit the integration of future major equipment acquisitions into this environment.

CAVEATS

The following discussion assumes that the equipment, both present and future, is of reasonable durability (meaning that it is at least potentially capable of being maintained in the field with normal instrumentation and a reasonable inventory of spares and supplies), and that the personnel employed are competent to accomplish their jobs. A further assumption is that neither the equipment nor personnel needs will be filled blindly, but only with care and diligent examination. A cynic might consider these conditions to be unattainable; however they are necessary assumptions.

CURRENT STATUS OF COMPUTER LABS AND EQUIPMENT

1. DIMAPS Mainframe System. This is an old system which has been substantially augmented during the past year: in software by the water resources team, in hardware by the conversion to a new, faster, and more reliable mainframe processor. Because we are using RCC equipment for the processing, operating costs can be extremely high. Our intention was, and contiues to be, to phase out this system for computation-intensive (and therefore costly) image processing functions, while retaining and even increasing its use as an inter-system communications hub.

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Because it is RCC equipment, RCC is responsible for maintenance on all except the special image-processing equipment. This includes three film recorders (one of which is soon to be moved to the microcomputer lab), several thermal printers, two digitizing tables of dubious utility and quality, and the two RAMTEK graphics workstations. Except for the digitizing tables, all is presetnly in working order; however, the two color monitors are of low quality and probably should be replaced.

2. ATLAS Minicomputer System. The software appears excellent although it probably will be difficult to use for training purposes. It is very powerful hardware and includes a high-resolution flat-bed scanner, a tape drive, a line printer, 900 mbyte of disk drives, and an ink-jet plotter. It can accommodate upto about a dozen terminals; however we feel that it should not be used as a multi-user general purpose computer.

   There are four major maintenance problems with this system as of this moment. The tape drive is not functional for unknown reasons. The array processor is not installed nor tested. The Eikonix scanning digitizer has a defective (although perhaps useable) scanning element which will cost about $4000 to replace. And, finally, the CPU itself is showing signs of becoming flaky. The prognosis for these problems (except for the digitizer) is very uncertain: they may all stem from one cause (which in turn may be major or minor) or they may be indications of a general fragility of the system.

3. PERICOLOR. I am probably not aware of the latest information on this subject. At the moment, I believe Pericolor is fully operational as a limited, but evidently reasonably reliable system. The French Government is planning to replace it by the end of this year with a newer and larger system. I believe we should exercise great care I assuring that it will be maintainable and capable of being integrated into our overall needs.

4. ERDAS Microcomputer Systems. We have two almost identical systems based on the IBM-PC/XT: each equipped with a graphics workstation, computer with 10 MB hard disk, and dot-matrix printer. They share a single Calcomp digitizer and a Tektronix ink-jet plotter. We also plan to connect one of the Matrix film recorders to one of these systems.

These systems have been quite good from a reliability point of view: only the ink-jet plotter is presently not working and that is only because we cannot get supplies for it. There are also some pieces missing from the software which we have been unable to obtain from ERDAS. However, there are two upgrade questions which need to be considered: data communication and storage (which I discuss below under OVERALL EQUIPMENT CONSIDERATIONS) and provision for the new version of the software. Erdas has promised us a free copy of the new version (7.2) of the software. Presumably this will be improved in some way from the current version. More importantly for us, and the factor which makes it necessary for us to upgrade, is that the missing elements in the software system will be supplied. However, the upgrade is not without cost even though the software itself will be free. The new version requires both more memory and larger hard disks. The extra memory is now being acquired. The larger hard disks would be desirable in any case, but no action is presently under way to acquire them. Depending on the details, probably about $1000-1500 per system should be assumed for 28 or 33 MByte external drives.

5. OPTRONICS Scanner and Plotter. These units form a very high quality input and output pair necessary for research and contract work. They presently are working, but require frequent repair. Also, each unit uses a very obsolete and no longer available computer for control. These computers present a potential problem if and when they decide to stop working. Their functionality could be replaced by (for example) a PC but this would involve some interface engineering that I could do but most technicians could not.

6. Other Microcomputer Facilities. In addition to the two ERDAS systems, we have two IBM-PC's, one IBM-PC/XT, and one Fujitsu (which is equipped with a large memory and 28 MByte hard disk. Each of these has a printer, although one printer has a bad print head (replacement cost: may be $200). I have been told we also have a letter-quality printer on order.

   Obviously we have an on-going need for general office use of microcomputers. However, I think that the Fujitsu is wasted in that capacity and we should consider integrating it (as discussed further below) into the image-processing facility. In addition, it may be necessary to use one of the PC's for communication.

7. Other AIT Facilities. The new Computer Science department's Norsk Data minicomputer is supposed to be equipped with cartographic and image processing hardware and software before the end of this year. Also, RCC's 5080 CAD/CAM network is claimed to be capable of image processing although evidently no software is available for this.

OVERALL EQUIPMENT CONSIDERATIONS

An examination of the above facts shows that we are blessed with some of the most modern and powerful computer facilities available, but that essentially all of our systems are seriously afflicted by a major data flow or maintenance bottleneck of some sort. Probably some 90 to 95 per cent of our equipment is in working order (which is not too bad a figure, considering the complexity) but that effectively we are working at less than 50 per cent of capacity. The problem is that when one component of a system decides to take a vacation there is no effective way to replicate the missing functionality: the productivity of that entire system is reduced, in some cases even to zero.

This is a problem which should be solved, not by trying to insist that all equipment be working at all times (since this probably cannot be achieved in practice), but by providing means for sharing resources among the different systems. Image processing is particularly characterized by needing a wide variety of specialized and sensitive I/O devices. Storage and communication of large amounts of data is also typical. I believe we will never have a robust and effective facility here, capable of making full use of the available resources, until we have a means of electronic communication of data among the various systems. In this way, no single piece of equipment (other than the computer itself) can be a critical bottleneck for any of the systems.

We have some US$ 1 million worth of equipment here. For perhaps 1% of that figure we can acquire any of numerous commercially available products to provide high-speed communications among at least the majority of our equipment (the Optronics and Pericolor pose special although not insuperable problems). This is not a trivial task; it must be planned and implemented with care. We have tried to initiate acquisition of these facilities during the past two years (and written several memos discussing the issue). If these plans germinate, it may be desirable for me to return to AIT to implement them; alternatively, when I am back in the U.S. I would be in a much better position for completing a detailed design than I have been here (where manufacturers' information is so hard to acquire).

PERSONNEL

I cannot even try to calculate the cost of personnel; instead I have identified certain job functions which need to be filled. Overall I discern a minimum of three full-time technical staff of which two must be highly qualified and motivated.

1. The microcomputer lab needs someone there at all times when it is open for student use. At least during the daytime, the person there should be generally aware about software, microcomputer use, and ethical issues. This position cannot be combined with any other position.

2. The minicomputer lab needs someone similarly, although the details are different. This position could probably be combined (as it is at present) with position 3.

3. A System Analyst is needed who will be responsible (subject to the oversight and needs of the faculty) for the operations of the computer facilities. This position will not be a maintenance one, but the holder will be responsible for being aware of present software capabilities and future needs, and advising users. When necessary, some software development may be involved.

   3A. Other systems analysts and/or programmers may be required but they would not have the management responsibilities except perhaps as deputies.

4. An Equipment Maintenance Engineer is needed who will be trained (perhaps at the manufacturers' sites in the U.S.) in maintaining our equipment. This will be this person's ONLY responsibility: he/she cannot be watchdog over any lab or anything like that because their duties may require full-time attention to a specific project for an extended time.

SUPPLIES

I'll consider separately the categories of supplies which are consumed at a regular and more or less predictable rate during teaching activities, and supplies which are needed for preventive maintenance or for replacing components with predictably short lives.

Consumable supplies consists mainly of paper, diskettes (which will decrease considerably after we acquire good mass storage and communication), ribbons, ink cartridges, and the like. As a guess, I would feel comfortable suggesting a $500 budget per term for class use. The cost is probably less

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important than the fact that some of these items have long lead times and/or large order requirements. Many cannot be obtained locally.

Maintenance and operational supplies include things like disk drive cleaning supplies, disk packs, mag. tapes (which we have a big stock of, I believe), and replacement disk heads and printer print heads. At a guess, less than $1000 per year once our initial needs are met. At this moment, we urgently need new 300M disk packs and probably much of the microcomputer equipment is showing considerable wear. An immediate expenditure of perhaps $2000 is indicated.

MAINTAINING SYSTEMS FUNCTIONAL : REPAIRS

I have given considerable thought recently to the general problem of how to plan for maintainable systems in an Asian environment. I have come to the conclusion that, for complex systems such as advanced computers made by companies which have no adequate depot-level repair facilities in Thailand, there is only one workable approach: to purchase systems which are inexpensive enough to permit buying several (a minimum of, say, three). This would permit one of them to be designated as an spare, a source of repair parts and, even more important, swapping parts. When not in use in this way, the spare system could be used for program development or whatever. By taking this approach, I believe it would be reasonable to guarantee operability for the remaining systems at a level of, perhaps, no more than one day per month of down time. There are possible teaching advantages as well.

However, the only one of our present systems which is even close to this status is Erdas: for a modest expenditure (perhaps $5000) it would be possible to upgrade one of our IBM-PC's to full hardware duplication of an Erdas. Presumably no additional software licence would be required since the third system would never be operated as an Erdas.

In the absence of the above circumstances, it must be understood that every significant breakdown of the equipment will result in a battle between the skills and training of the technical staff, and the intransigence of the equipment: a battle whose duration and even outcome are uppredictable. There are several categories of help that can be provided, however:

1. Locally-available maintenance personnel.

2. Complete documentation.

3. Selected spare parts, obtained in advance from the manufacturer.

4. Selected specialized test equipment, obtained usually from the manufacturer of the system in question.

5. General-purpose test equipment.

Items 1 through 3 are unique to each situation. The specialized test equipment referred to in item 4 is frequently available covering all aspects of a system's functionality, but typically equals or exceeds to cost of the equipment itself. A few selected items may be worthwhile, however, such as disk-drive alignment equipment. In the category of general-purpose test equipment, I would recommended at least the following:

A. A good logic analyzer

B. A serial communications analyzer.

CURRENT PROCUREMENT

There are two procurement efforts under way at the moment which impact the above.

We have requested, and expect to receive momentarily, the additional memory necessary for the Erdas software upgrade. Also, the Erdas software itself is presumably on its way here.

At the beginning of this year, we requested from USAID money for a large purchase of miscellanesous items, generally referred to as spares and maintenance items. This request, totalling some US$70,000, included as much of the above listed items as we could think of at that time. Specifically, it included a large selection of spares etc. for the Gould and Erdas, a variety of consumable supplies such as ink-jet cartridges and disk packs, and full communications equipment for the PC's, the Gould, and the mainframe. Extras were requested which hopefully could be used to extend communications to the Optronics, Fujitsu, and Pericolor. Additionally, optical write-once-read-many (WORM) disks for the two Erdas systems were requested.

We believe that USAID approved this request in principle, but are completely unable to determine the present status. If all that was requested were to be received, it would statisfy almost all of the above equipment needs. Exceptions are: larger hard disks for the two Erdas systems, and the general-purpose test equipment.

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Appendix G: A Listing of Countries Represented among Recipients of the ARRSTC News Letter.

COUNTRY	RATE (B)	QUANTITY	TOTAL (B)
Thailand (Local)	1.50	136	204.00
(South-east Asian Peninsula)			
Burma	9.70	3	29.10
Laos (PDR)	9.70	1	9.70
Malaysia	9.70	60	582.00
Singapore	9.70	4	38.80
Vietnam	9.70	13	126.10
(Asian Zone)			
Afghanistan	11.70	3	35.10
Bangladesh	11.70	13	152.10
Bhutan	11.70	1	11.70
Brunei	11.70	2	23.40
China (PR)	11.70	26	304.20
Hong Kong	11.70	7	81.90
India	11.70	40	468.00
Indonesia	11.70	47	549.90
Iran	11.70	5	58.50
Japan	11.70	10	117.00
Jordan	11.70	1	11.70
Korea (DPR)	11.70	1	11.70
Korea (Rep)	11.70	17	198.90
Mongolia (PR)	11.70	4	46.80
Nepal	11.70	6	70.20
Pakistan	11.70	10	117.00
Philippines	11.70	38	444.60
Saudi Arabia	11.70	1	11.70
Sri Lanka	11.70	22	257.40
Taiwan (R.O.C.)	11.70	9	105.30
Yemen Arab Republic	11.70	1	11.70
(Oceanic Zone)			
Australia	14.40	12	172.80
New Caledonia	14.40	1	14.40
Papua New Guinea	14.40	3	43.20
Western Samoa	14.40	2	28.80
(European Zone)			
France	14.40	11	158.40
Germany (FR)	14.40	5	72.00
U.K.	14.40	11	158.40
Italy	14.40	7	100.80
Netherlands	14.40	6	86.40
Sweden	14.40	1	14.40
(African Zone)			
Kenya	15.70	1	15.70
Nigeria	15.70	1	15.70
Upper Volta	15.70	1	15.70
(North-American Zone)			
Canada	17.00	12	204.00
U.S.A.	17.00	108	1836.00
(South-American Zone)			
Brazil	18.40	2	36.80
Suriname	18.40	1	18.40
TOTAL:		666	Baht: 7070.40

APPENDIX H

Notes made in Review of Course and Lecture Outlines

Jan 1985 and '86 terms included lots of math again. Considering time would be better to treat computer as black box. Image analysts don't really need to know how the computer works. Computer logic and languages was definitely an "overkill"in both years. Had a lecture on Pascal language contrasted with Basic. This is a waste of time in relation to the purposes of this training program.

The ground documentation exercise may be too detailed with single location measurements. What the trainee needs on the first time out is to see many locations representing the same or similar ground cover conditions so he develops a feel for similarities and differences in relation to variations in the image. The big variable that throws the interpreter is the location error. Too much time spent in one place on the first time out prevents building this perception.

The students need field experience in the perception of a "divisive approach" (working from the broad to the refined classes) in the development of legends, particularly so far as vegetations are concerned.

Heavy on Radar, Bryan participating. This is too much in view of time available.

Was very detailed on color theory. This is ok re understanding FCC images and what happens when you do various enhancements. Also in understanding color balance.

Good publications bibliography was provided.

Gave a written exam. This is good. On short courses students sometimes tend to ride through and not really work or learn. As working groups grow in size this becomes more of a problem. In small work groups everyone has to produce; their peers tend to enforce performance.

With a course pattern in the academic context of AIT students will be unable to ride through because all will be subject to measured performance.

Questionnaire reveals that students from January '85 think Remote Sensing dealt with satellite imagery only. They were concerned about low resolution.

Of the -- students 14 expected to have hard copy images to work on when got home

5 to have CCT's
19 stereo aerial photography
9 a micro
6 a mini
3 a mainframe

Lukens Air photo interpretation exercise #1 very good. Asked questions about marked images on the stereo model, 22 image areas in all. Had students determine grey scale values on B&W band 5 and 7 to get idea of spectral reflectance values. Good idea.

Not sure how well photo geometry was covered. Hard to tell from outlines. Gachet gave a good lecture on photo geometry and stereo plotting. Also need to get into paralax and height measurement which may have been missing. Cartography was well covered.

Worcester covered verification of accuracy and told typical ranges of accuracy in interpretation of some features, BUT students need to experience doing this.

Certainly can't criticize the Jan '85 course for not being detailed or sufficiently in depth. If students absorb most of it they will be well grounded in the theory. May be a snow job for some and miss the point of training for practical capability in image analysis. More elements could have been treated as a Black Box and what it does rather than how it works. Nothing would have been lost. These guys aren't going to know enough to get inside the black box anyway. Are not training designers of new systems or software. The course is supposed to be training analysts.

In neither 1985 nor 1986 did the program provide treatment of the concepts of resource ecology as they relate to photography/imagery interpretation or of the structure or classification of vegetation.

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APPENDIX I

Job Descriptions

The Consultant asked all members of the staff, both departing and continuing to prepare Job Descriptions as they each perceived their positions with ARRSTC. The specific request was for (a) A description of their present job as they had been performing it; (b) A description of the job as, from their experience, they feel it should be modified for the good of the program; and (c) A list of qualifications for the job in the latter instance. It was the Consultant's intention to then edit and possibly add to these from his experience. Response from the staff was very poor. Those descriptions received are appended for the information of whom ever develops the integrated plan for the future Remote Sensing and the Natural Resources Programs at AIT.

Good job description and qualification statements are not only essential for effective personnel recruitment and management but offer an effective means of controlling qualifications of secondees in relation to AIT needs.

Job Title:

Coordinator
Natural Resources Development and Management (NRDM) Program

Objectives:

Create NRDM Program at the Masters' level at AIT

Guidelines:

1. The program will be interdisciplinary, drawing as much as possible on the exisiting resources at AIT, using courses offered by the various Divisions and Centers (President's Memorandum: January 1984)

2. The coursework will cover three broad areas:

   (a) core courses in resources policy, planning, economics, administration, law, and ecology

   (b) core courses in data collection and processing for natural resources project planning and management

   (c) specialization courses in development technology (project planning, design, and management) (Dr. Kaew's Committee Report: 16th May 1985)

3. The program should not begin until all of the funding (resources) has been secured. (Academic Senate Resolution: AS85.46, 18th September, 1985)

4. The program should be self-supporting through tuition and fees after five years.

Description:

Responsible to the Vice President for Academic Affairs (VPAA) to create the NRDM program. The Coordinator will develop and present funding proposals, and will promote the program agressively after funding is received. The Coordinator will establish the program as an independent administrative unit, with a budget and authority to spend the money. The Coordinator will recruit, select, and make recommendations* for hiring and firing NRDM staff and faculty. The Coordinator will work with his NRDM faculty, the Division Chairmen, and the Center Directors to develop a program that is academically sound and responsive to the needs of the region. The Coordinator will administer the program for the initial five years.

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* Under present AIT regulations; I would be reluctant to try to run the first five years of a program when I didn't have this authority.

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Qualifications:

The Coordinator should be highly capable in a technical aspect of natural resources development, and highly competent as an administrator. The Coordinator should have a Ph.D. and fifteen years' experience teaching in natural resources development or related fields. Five of those years should have been as a program administrator. Fifteen years' experience as a technical consultant to resources development project in both the developed and developing countries. Experience working in Asia and Pacific region desirable. A native of the region is also desirable. In addition, experience in one or more of the following is helpful: remote sensing, environmental impact assessment, or regional planning.

Note As AIT is not likely to get this person until NRDM program funding is assured, an Acting Coordinator should be approved over the next two years to set up as many of the elements of the NRDM program as possible in anticipation of funding. These elements consist of workshops, certificate and diploma programs, etc. through which courses that would be included in the Masters' program are developed and tested. All of these small programs must be self-supporting through tuition and fees.

The Acting Coordinator will have to be someone (not a committee) presently on the AIT faculty or in the administration. (Not from remote sensing, even though remote sensing has the greatest stake in the program - see job description above.) This person would work closely with the new VPAA (hopefully more responsive than the present VPAA) and with the Director of the Continuing Education Center.

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ASIAN REGIONAL REMOTE SENSING TRAINING CENTER

ASSOCIATE PROFESSOR

JOB DESCRIPTION

Job Title: Associate Professor of Remote Sensing

Job Description: The position requires teaching the portion of the remote sensing training short course dealing with remote sensing project management. In addition, the individual may be required to occasionally assist with teaching other portions of the short course such as photointerpretation and various remote sensing applications. The individual will assist in further development of the course to be offered in certificate and MS degree programs. The individual will be required to organize and conduct field trips in Thailand for the short course. The individual will be expected to assist with curriculum and program development in the NRDM program. Knowledge of photographic laboratory procedures and operations is desireable.

Position Requirements: A Ph.D. degree with experience in project management. Major area of education and experience should be natural resource oriented with supporting experience in remote sensing applications to natural resource problems, most especially in the area of photointerpretation.

Comments: This is a general description of the position which I presently hold. It is not necessarily the position for which I interviewed, but rather the position which has evolved. As you can see, it is rather limited and has not included any committment to research and outreach activities beyond meeting the general needs for the good of the AIT and ARRSTC.

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NATURAL RESOURCES DEVELOPMENT AND MANGEMENT PROGRAM

ASSOCIATE PROFESSOR

JOB DESCRIPTION

Job Title: Associate Professor of Natural Resources

Job Description: The individual will be expected to develop and teach a course in Project Management to include, but not be limited to, project planning and scheduling, project control procedures, personnel management, decision making procedures. In addition, the individual will assist teaching case studies courses on applications of remote sensing to natural resource problems. Organization and conduct of field trips will be part of the job responsibilities. It is expected that the individual will develop and direct research and outreach programs relevant to thier academic background and the needs of AIT and the region. The individual will be responsible to the Directer, NRDM.

Job Requirements: The individual must have a Ph.D. degree in an area of natural resources plus experience in application of remote sensing to natural resource projects and project management, preferably in developing countries. Familiarity with techniques of photointerpretation is essential. Acquaintence with digital analytical techniques is desireable.

Period of Employment: Minimum of two years.

Comments: The primary responsibility should be in the development of the management course for the degree program and to initiate and conduct research projects which will demonstrate the competence of the NRDM unit. An individual is required who can go into the region and present the programs to the various national centers and agencies who are potential users. This requires an agressive person who will accept a comittment to the program and represent it positively in all public formats available. The minimum period could very well be three years renewable because it will take that long to develop a program and find funding. Locating and employing qualified students will depend on the timing of the student intakes for the NRDM at AIT.

SALLY GOLDIN & KURT RUDAHL

JOB DESCRIPTIONS

August 21, 1986

Introduction

During our two years at ARRSTC, we have divided between us the responsibilities for three quite different jobs: instructor in digital image processing, digital systems engineering, computer facilities manager. Ordinarily, different individuals would handle these two quite different positions. Thus we deal with them separately here.

Instructor in Digital Image Processing

In this role we designed and presented lectures on the following general topics:

1) Computer hardware and software principles

2) Digital image fundamentals; data representation

3) Image enhancement techniques and theory; image classification techniques and theory

4) Specifying, evaluating and managing image processing equipment and facilities.

We also designed and supervised laboratory exercises on the use of microcomputers and mainframes and the operation of various image processing systems available at ARRSTC. On occasion we have also taught basic word processing; guidelines for oral presentation; hardware and software for digital GIS.

Outreach and Systems Engineering

1. System Development

   a. Evaluated bids for new minicomputer system

   b. Planned physical layout for microcomputer lab and minicomputer facilities; worked with architect to specify and monitor remodelling for new labs.

   c. Developed recommendations for acquisition of new peripherals and other hardware

   d. Developed specifications for communications network linking ARRSTC systems.

   e. Developed microcomputer software for demonstrating digital image enhancement and classification principles

2. Public Relations/Communications Functions

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a. Presented numerous demonstrations of image processing systems to visitors from many agencies and countries.

b. Represented ARRSTC at conferences within the region, describing ARRSTC's digital facilities and teaching program.

c. Wrote papers for conferences, newsletters, etc. describing ARRSTC's digital facilities and teaching program.

Facilities Manager:

At least 50% of our time was spent on various activities related to the organization and maintenance of ARRSTC's digital image processing and general computer facilities. Many of these activities could and should have been performed by staff persons with more restricted ranges of responsibility. Our recommendations for computer staff functions that need to be filled at ARRSTC are included in the attached excerpt from our memorandum of 6/11/86.

Our activities in the area of facilities management included the following:

1. Security and Data Integrity Functions

   a. Maintained keys to facilities; established and attempted to enforce access policies

   b. Maintained microcomputer software library; created backup copies of software, important data files for micro-based image processing system

   c. Maintained hardware and software documentation and controlled access; wrote additional software manuals where necessary

   d. Scheduled system use by students, researchers and outside groups.

Note that mainframe data integrity functions were performed by Khun Korapin.

2. System Maintenance

   a. Supervised routine and catastrophic maintenance of mainframe and minicomputer image processing systems

   b. Performed routine maintenance of microcomputer systems: disk cleaning, installation of new hardware components, etc.

   c. Configured microcomputer systems; hard disk formatting and set up, configuration of Wordstar for new printer, etc.

   d. Monitored consumable supplies; supervised supplies orders; attempted (unsuccessfully) to establish ongoing supplies acquisition procedures.

POSITION (Job Title): INFORMATION SCIENTIST

OFFICE: ARRSTC

REPORTS TO: DIRECTOR, ARRSTC

Job Descriptions:

The purpose of this position is to acquire, organize and monitor the diverse and extensive body of knowledge concerning remote sensing. The person holding this position will be concerned with information on all aspects of remote sensing including the design of instrumentation and the application to resource inventory needs in the Asian region. The following specific duties are required:

1. To acquire significant information in remote sensing through:

   a. Correspondence with initiators of reports and studies on remote sensing including Government Agencies, International Groups and the authors themselves.

   b. Initiation of computer searches of remote sensing literature with organizations providing this type of service.

   c. Travel to centers known to possess significant quantities of remote sensing literature.

   d. Coordination with acquisition activities of the Library of the Asian Institute of Technology (AIT).

2. To maintain and organize a collection of remote sensing information at the Asian Regional Remote Sensing Training Center.

3. To assist and coordinate with the Institute Librarian to maintain an inventory and guide to the remote sensing literature held by the AIT library. This to include an extensive search of the diverse holdings on remote sensing, listed under several key words.

4. To aid the faculty of the Remote Sensing Training Center in literature reviews when necessary.

5. Other duties as deemed necessary and important to the Center, which are assigned by supervisor.

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Qualifications:

The person holding this position should possess an M.S. or its equivalent Degree in some aspect of the earth sciences or related fields. Experience and/or education in remote sensing and literature research methods is preferred. For degree lower than M.S., one must have at least 3 years of experience on the job. The information scientist must be able to work well with people, organize the various activities and promote friendly cooperation among the appropriate agencies involved.

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IMMEDIATE OPENING

LIAISON OFFICER

Functions: To assist the Asian Regional Remote Sensing Training Center (ARRSTC) and the National Research Council (NRC) of Thailand in accomplishing the common-goal of promoting the acceptance of remote sensing technology in Thailand and throughout Southeast Asia.

Responsibilities:

- Assist in obtaining supporting data for use in the ARRSTC training,
- Determine areas and ways for close and continued cooperation in carrying out remote sensing activities,
- Assist in the training program as a field coordinator,
- Assist in other duty necessary to accomplish the stated functions or as otherwise assigned.

Qualifications:

- Thai national
- At least 5 years experience with remote sensing method and products and the acquisition of map and photo data.
- Extensive experience in interacting at middle and upper levels with agencies of the Royal Thai Government.
- A master's degree or its equivalent in the fields of natural resources or related disciplines.
- Recognition within the Royal Thai Government as a knowledgeable individual in his/her field of specialization.
- A very good working knowledge of written and spoken English.

Please send inquiries or resume and necessary supporting documentation, by February 28th, 1983, to:

Director
AIT-ARRSTC
G.P.O. 2754
Bangkok 10501, Thailand
Tel: 5239300-13

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F I G U R E S

FIGURE 1: FLOW CHART OF THE DECISION SEQUENCE IN NATURAL RESOURCES DEVELOPMENT AND MANAGEMENT

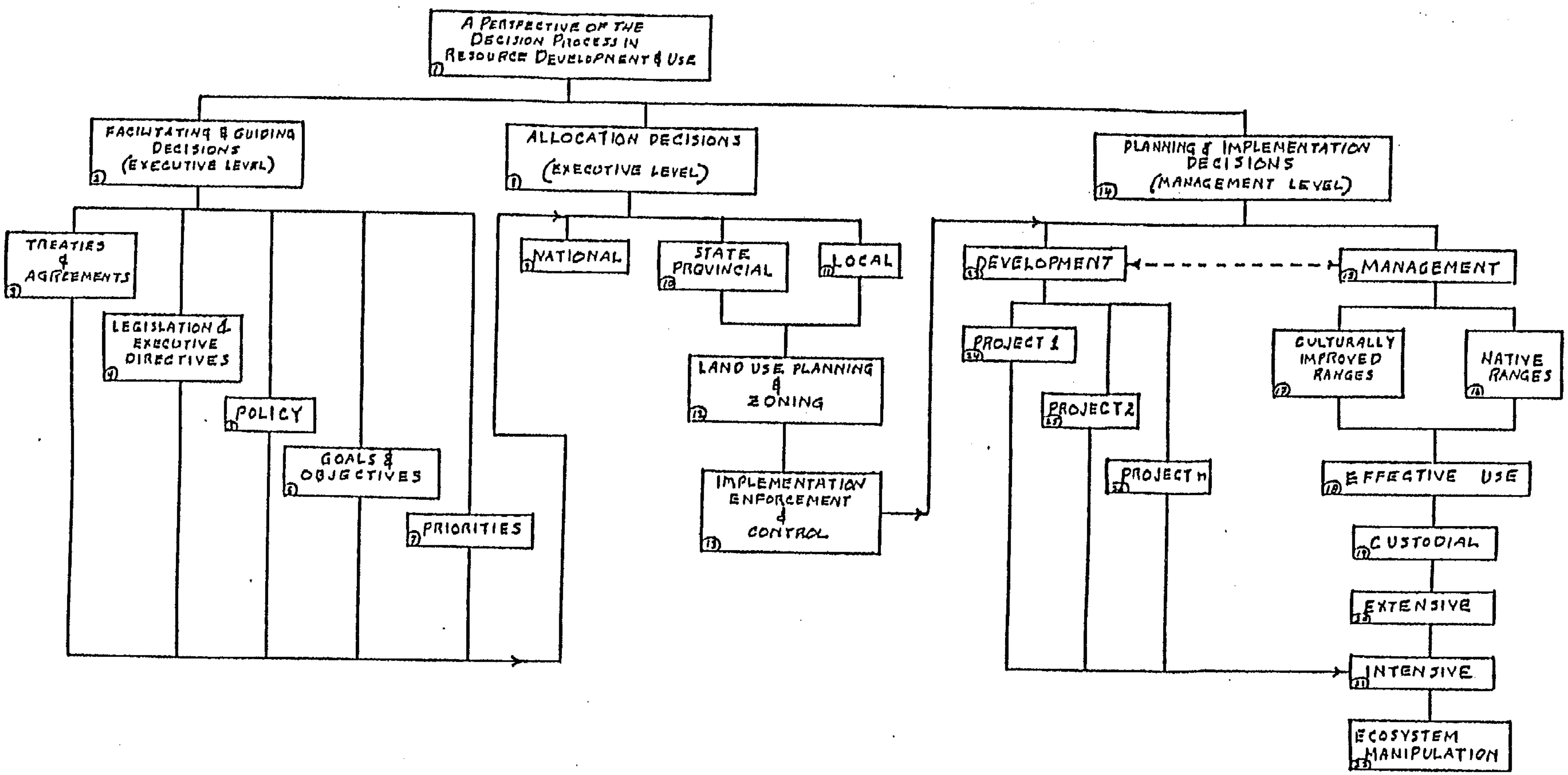

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Figure 2: Organization and Function Chart for AIT's "Interdisciplinary Natural Resources Development and Management" Program (INRDM)

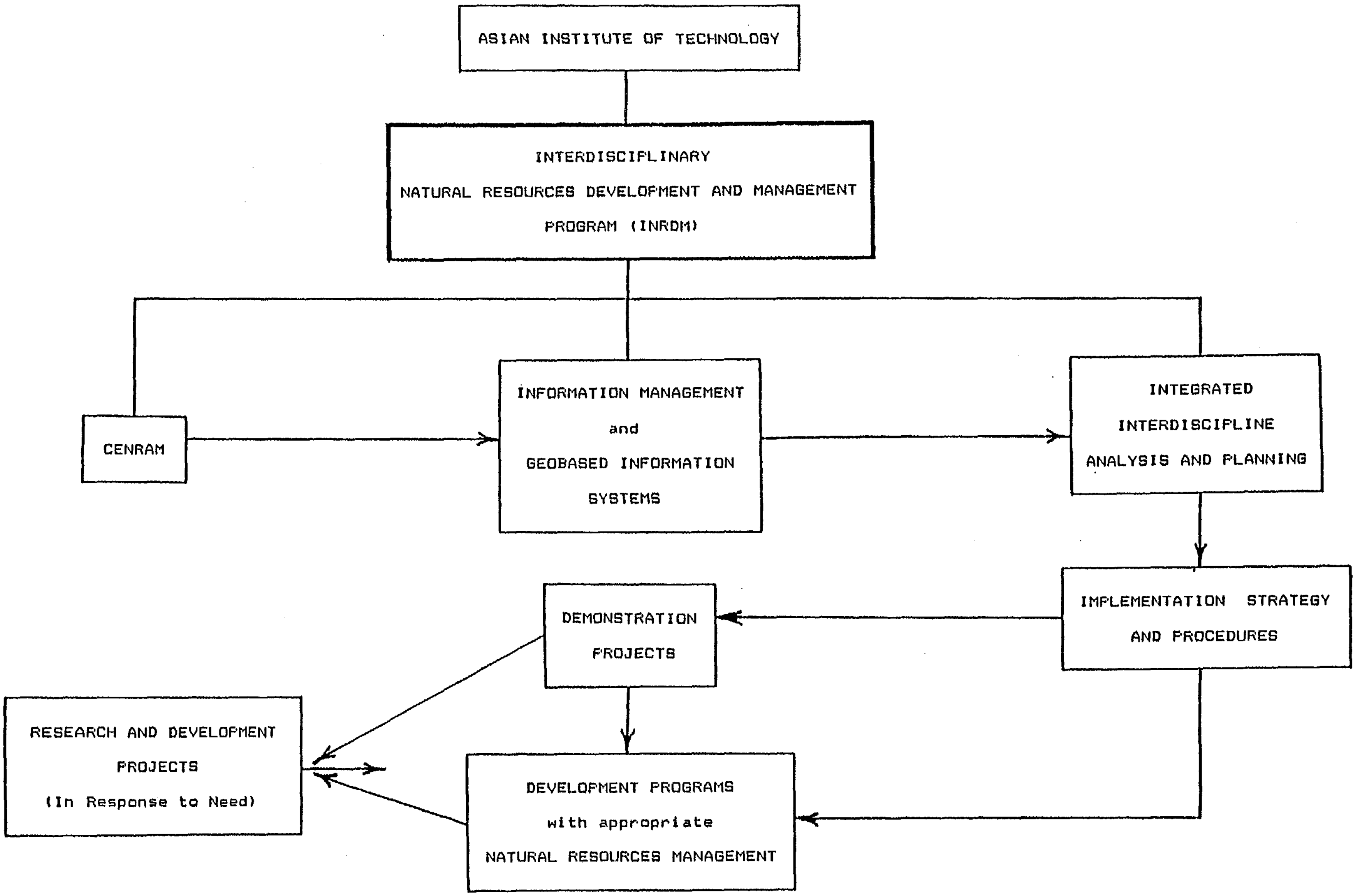
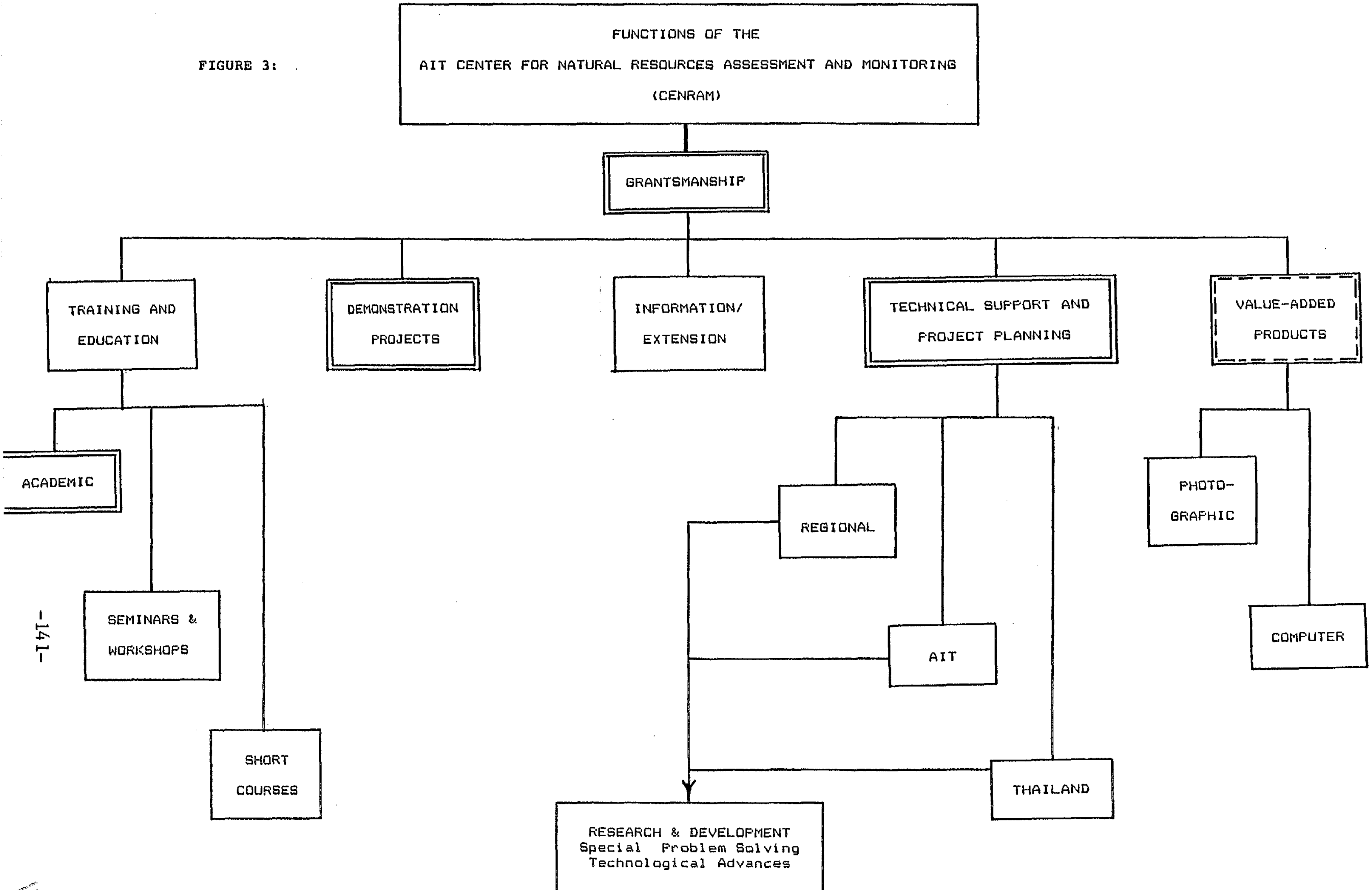


FIGURE 3:


FUNCTIONS OF THE
AIT CENTER FOR NATURAL RESOURCES ASSESSMENT AND MONITORING
(CENRAM)
GRANTSMANSHIP
TRAINING AND EDUCATION
DEMONSTRATION PROJECTS
INFORMATION/ EXTENSION
TECHNICAL SUPPORT AND PROJECT PLANNING
VALUE-ADDED PRODUCTS
ACADEMIC
SEMINARS & WORKSHOPS
SHORT COURSES
REGIONAL
AIT
THAILAND
PHOTO- GRAPHIC
COMPUTER
RESEARCH & DEVELOPMENT
Special Problem Solving
Technological Advances