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ARMY SCIENTIFIC
ADVISORY PANEL

SUB-PANEL REPORT ON
REVIEW OF ACTIVITIES & PLANS
ENGINEER TOPOGRAPHIC LABORATORY (ETL)
SEPTEMBER 1967

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REVIEW OF ACTIVITIES & PLANS
ENGINEER TOPOGRAPHIC LABORATORIES (ETL)

September 1967

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INTRODUCTION

Military map making is one of the oldest military arts. It was brought to a relatively high state of perfection generations ago. What, then, are the considerations which make it still an important area for study? Obviously, they must stem either from new map requirements by users or from new technical possibilities in map making. In ETL's actual operations both considerations are involved.

New map requirements come most obviously from the fact that the United States, as a global power, must be prepared for military assistance or operations in many parts of the world. Thus, we must have - or be able to produce very quickly - suitable maps for almost any part of the globe. If we include necessary updating, the sheer bulk of this problem becomes most impressive.

The new maps, of course, must also be suited to the needs of modern weapons. In the past, the controlling requirements generally came from the needs of tube artillery. These weapons called for very high relative accuracy, but only over comparatively short ranges, typically of the order of a few miles. With the advent of missiles and airborne vehicles of various sorts, there has come into being a new requirement for at least moderate accuracy over significantly greater distances. The intercontinental missile extends this sort of requirement to much greater ranges.

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yet. The geodetic nets of the various continents must be in register to satisfactory tolerances if the guidance problem for such weapons is to be solved satisfactorily. In addition to the question of accuracy, it is also obvious that the traditional military map when considered on the basis of modern weapons, logistics and tactics may not always carry the kind of information which would be most useful and may, in fact, include much information of no use at all.

New requirements on the military map maker for traditional tactical operations are comparatively straightforward and require no particular elucidation. They have been developing gradually ever since World War II. New requirements for limited unconventional warfare and the requirements imposed by our strategic deterrent forces are not clearly developed, and it is uncertain as to the agency primarily responsible.

The new technical possibilities in map making have arrived much more suddenly and have much more immediate impact. They consist essentially of the use of earth satellites for the acquisition of primary data and the use of the modern digital computer to do most of the hard work of actually preparing the map. As an illustration, it is clear that satellites, visible simultaneously from points thousands of miles apart, have the potential, by means akin to ordinary surveying by triangulation, to solve the problem of interconnecting geodetic networks between continents. The high speed computer similarly has the potential to eliminate much of the hand calculation and hand drawing which in the past has made the production of new maps such a tedious and backbreaking process.

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The Assistant Secretary of the Army (R&D) and the Chief of R&D recognized that these changing requirements and techniques probably would result in major modifications to ETL R&D programs. This report is a summary of the activities of an Ad Hoc Group* appointed by the ASA(R&D) to review ETL programs and plans. The report contains the conclusions and recommendations of the Ad Hoc group and includes comments on Laboratory relationships with the users, a discussion of how systems analysis and engineering could be utilized, a limited evaluation of the technical resources available and finally some suggestions on program priorities.

It was abundantly apparent that the members of the Laboratory, and those in the AMS and the Army Staff who support them, are all dedicated to serving the Department of Defense in the most profitable manner. The presentations showed a high degree of technical capability, and the willingness to consider changes or explore alternatives was outstanding.

* Members of the group are listed in Appendix 1.
Objectives of the review are outlined in Appendix 2.

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USER RELATIONSHIPS

The committee's principal reaction to the programs presented by ETL and the Army Map Service (AMS) amounted to a feeling that neither the problem of new requirements nor new tools has been quite adequately addressed. In the case of the new needs, it appears that the blame can probably not be laid entirely at ETL's door. Certainly the men we talked to seemed alert enough to the question of user needs and were enterprising in trying to respond to them. However, the generation of requirements, at least for Army operations, is primarily a function of the Combat Development Command. There was no indication in the presentations we received that there is an active focus in CDC really concerned with the map making question.

It is important to notice that the generation of requirements for maps is not a trivial matter. Accuracy requirements beyond real need, for example, may greatly affect the complication and expense involved in producing a given map. Unneeded detail may actually injure the usefulness of a map by destroying the ease and clarity with which it is read. One cannot go far in this line of thought without asking also whether all users of a given map should be content with the same article or whether there should be essentially different maps for different purposes. Obviously, CDC is the proper organization to answer all such questions.

For some purposes, the DIA as well as CDC is the official source of requirements for ETL. This is particularly true where a global

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network may be involved. Here, too, it appears that ETL may be unduly handicapped by lack of suitable focus in the generation of requirements by the responsible agency. In this case, the situation might possibly be remedied if DIA were to delegate responsibility in this area to another agency within one of the services.

In the face of this lack of definition of requirements goals, it is obvious that ETL has attempted to develop requirements itself or to develop hardware based on obsolete or ill-defined objectives. A great number of their proposed analytical efforts, involving operational systems analysis, were caused by their desire to create viable requirements. This is obviously not a laboratory function. The Review Group supports ETL in its desire to enhance systems analysis and the use of operations research personnel, but it is suggested that these people, probably grouped together in an important laboratory organization, should spend their time trying to define useful systems with minimum complexity rather than to create requirements which should have been defined by CDC or DIA.

Restraining ETL in its efforts to define requirements will, of course, not fill the vacuum and, although the group did not investigate directly the activities of CDC and DIA, there is obviously much to be done in these two organizations. Our suggestions are as follows:

1. There should be a permanent element and a central consistent core of effort within CDC to derive up-to-date tactical requirements. It is possible that such an organization could work directly with ETL to match new techniques and evolving requirements. The CDC-AMC efforts

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to create a New Concept Organization would seem to be a useful pattern and it is possible that members of ETL and CDC should join together to evolve new requirements and concept solutions in such a way that development time-spans are reduced and laboratory resources are used in the most profitable areas. The Army should be able to make progress in this area without involving outside agency approval.

2. With respect to strategic requirements, the suggestion is made that ASA(R&D) initiate conversations with DIA for the purpose of creating a tri-service requirements board whose sole purpose is to see that "other service" requirements are defined and distributed to a doing agency, whether it be ETL, AMS, or another service laboratory. This board could bring added consistency in the statement of strategic requirements and it could serve to check for duplication of effort or loss of an important concept due to lack of effort by the supporting agencies.

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SYSTEMS ENGINEERING/SYSTEMS ANALYSIS

In attempting to understand the place of systems analysis and systems engineering in the ETL structure, the Review Committee attempted to gain an insight into the mechanism for satisfying requirements, and the intended workings of the present organizational structure. It failed to perceive a simple, efficient process for accomplishing this, although this may be the result of the short time available. Nevertheless, the following general impressions are offered.

Support and Operating Organization:

ETL in general, and the Mapping and Geographic Sciences Laboratory in particular, seem to be blessed with an abundance of overhead assistance and advice to review, guide, and allocate its 150-odd personnel. For example, we note in Memo 10-1, which was furnished us, that the Deputy Commanding Officer, the Executive Officer, and the Program and Management Offices, in addition to the Commanding Officer, all have responsibilities which reach into the operation of the M&GS Laboratory with regard to utilization of and allocation of resources, measuring progress against objectives, "setting guidelines", "maintaining quality control of ETL-wide administrative matters," providing "staff management", conducting management studies of ETL operations, implementing control programs "required for the most efficient utilization of available resources," etc. This advice, review, guidance, and direction is

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apparently in addition to the basic support provided in procurement, contracting, security, maintenance, etc.

In addition to this top-side activity, the description of which covers three and one-half pages of the twelve and one-half page description of the ETL functions, the M&GS Laboratory has both a Director and an Assistant Director, and four staff officers, who are likewise concerned with assisting in the "direction and guidance in the allocation of manpower, facilities and funds". Continuing the management chain, each of four Divisions has a Chief and Assistant Chief, and fifteen branches each have a Chief.

In further reading Memo 10-1, the Committee is left with the impression that the present organizational structure may represent the results of a series of attempts to provide detailed M&GS Laboratory management from outside the Laboratory rather than by strengthening internal Laboratory management. The Committee does not see why the Program Management Office, for example, should be outside the M&GS Laboratory, since it seems to be preempting many of the proper responsibilities of the Laboratory Director.

Comparison with Previous Organization

Comparing the organization chart of August 1967 with that of October 1965, the Committee feels that certain desirable elements of the earlier organization may have been lost in reorganization. For example, the earlier organization recognized the difference between

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program requirements and functional support, with Directors of Global and Tactical Systems, and a Divisional organization based on technical specialty areas. The new organization seems to have lost the concept of "Program Manager". (The Program Management Office is, according to its Functional Statement, not charged with Program Management in the technical sense.)

The "Systems" Approach

While it is true that any organized activity can be defined to be a "system", it is the opinion of the Committee that the term should be reserved for the highest level of integrated equipment/personnel/procedures program developed within ETL, and in this sense the systems approach should indeed receive increased emphasis in ETL operations.

During the Committee review, it appeared that the wholesale designation of ETL programs as systems within themselves tended to dampen proper consideration of their interactions with the other inhabitants of their operational environment. The Committee felt that there was a tendency to be somewhat provincial in ETL briefings. This, of course, cannot be considered as a proper application of the systems approach to Laboratory programs. The director of any laboratory effort must be cognizant of how his program fits with others. This is certainly as important as efficient budgetary program management.

Operational Evaluation and Equipment-User Interrelationships

The Committee heard very little about "operations research" during

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its meetings. Yet the interrelationships among field operations, requirements, equipment service performance, and contribution of the equipment (and maps) to force effectiveness is the keystone to ETL success. We believe that some work of this kind is being done. For example, in March 1964 Col L. L. Haseman, Deputy Assistant Director, DIA for Mapping, Charting and Geodesy, presented an open paper on "Rapid Military Mapping" in which he described a planned program of test as follows:

"Our present plan is to photograph a portion of the maneuver area in advance, then at the start of the maneuver this photography will be provided to a unit at its home base. We will monitor each of the successive processing stages and will fly the resultant graphics back to the maneuver area. Here they will be furnished to selected troop elements in lieu of conventional maps and the combat efficiency of these units will be assessed, using these expedient graphics."

The Committee was not told of these experiments, or whether the effect of available graphics on the combat efficiency of the troops was determinable. However, noting that the experiment was reported by a DIA officer, the Committee is uncertain as to the degree to which ETL is allowed or encouraged to participate in research and analysis on the operational requirements, implications, and effectiveness of its products. Certainly no modern system development (or even subsystem development) can be carried out with maximum efficiency without such considerations. The Committee feels that this is the kind of activity in which ETL should actively participate and, in fact, originate.

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ETL is in need of top management planning. The committee is inclined to lay the blame upon the top management (top management probably extends beyond the immediate ETL Laboratory) for the fact that the ETL programs appear poorly organized. Management apparently hasn't been able to solve today's problems while simultaneously planning for the future. As a result of the lack of top level planning, each little subgroup seems to be trying to plan not only for themselves but for the whole laboratory, and even for the whole D.O.D. Many project managers seem compelled to justify their work by building it into a complete system that extends all the way from data acquisition to finished product. The laboratory seems to be responding too much to a wide variety of demands without adequately sorting them out and picking and choosing their efforts to advance their field. (It would be interesting to know whether the Laboratory has ever refused to work on a project because they felt it would divert them from their major objectives.)

Some Suggested Organizational Objectives

The Committee recommends that the ETL organization be restructured and simplified to clarify line responsibility for planning, staffing, direction, and review, and that the structure be based on a balance between the continuity and technical capability of civilian personnel and the operational knowledge obtained by the rotation of military personnel.

The present military personnel assigned impressed the Committee most favorably, but we find that civilian continuity is dispersed among

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many lower level organizations. The Committee suggests that overall management may best be strengthened over the long term by addition of a civilian technical director who will act as Deputy Director of Laboratories.

As a long-term objective, the Committee feels that the proliferation of chiefs, associates, and assistants should be carefully considered and professional advancement be keyed to technical stature rather than management title. This implies a substantial responsibility on the part of the CO and Technical Director to secure adequate professional recognition for "non-management" experts.

To clarify its recommendation, the Committee offers the attached organization chart. It recognizes that to accomplish a reorganization effectively, considerations of personnel capabilities, existing functions and responsibilities, and many other factors with which the Committee is unfamiliar must be given careful consideration. The chart illuminates certain concepts, however, which the Committee proposes for consideration. These include:

- (1) The installation of a Technical Director, as discussed above.
- (2) The establishment of a Development Planning Office (may be as small as two men) to prepare and maintain the Laboratories long-range plan.
- (3) Establishment of administrative and technical program management for major programs as an activity which draws on all resources of the Laboratories laterally, assembling teams for major

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programs, directing their work, and returning the teams to their home Divisions on completion of projects.

- (4) Establishment of an Advanced Systems Division to analyze requirements; work with CDC or DIA in defining these requirements; interpret them in terms of ETL responsibilities; develop concepts, preliminary designs, and configuration of solutions; do simulations, evaluations, and cost-effectiveness trade-offs to shake out new concepts and guide on-going developments; and do operations research on the interaction of ETL products with the user, including the measurement of effectiveness if such is possible.
- (5) Consolidation of the engineering function (system, subsystem, and component in a single division).
- (6) Consolidation of advanced technology R&D function in a single division.

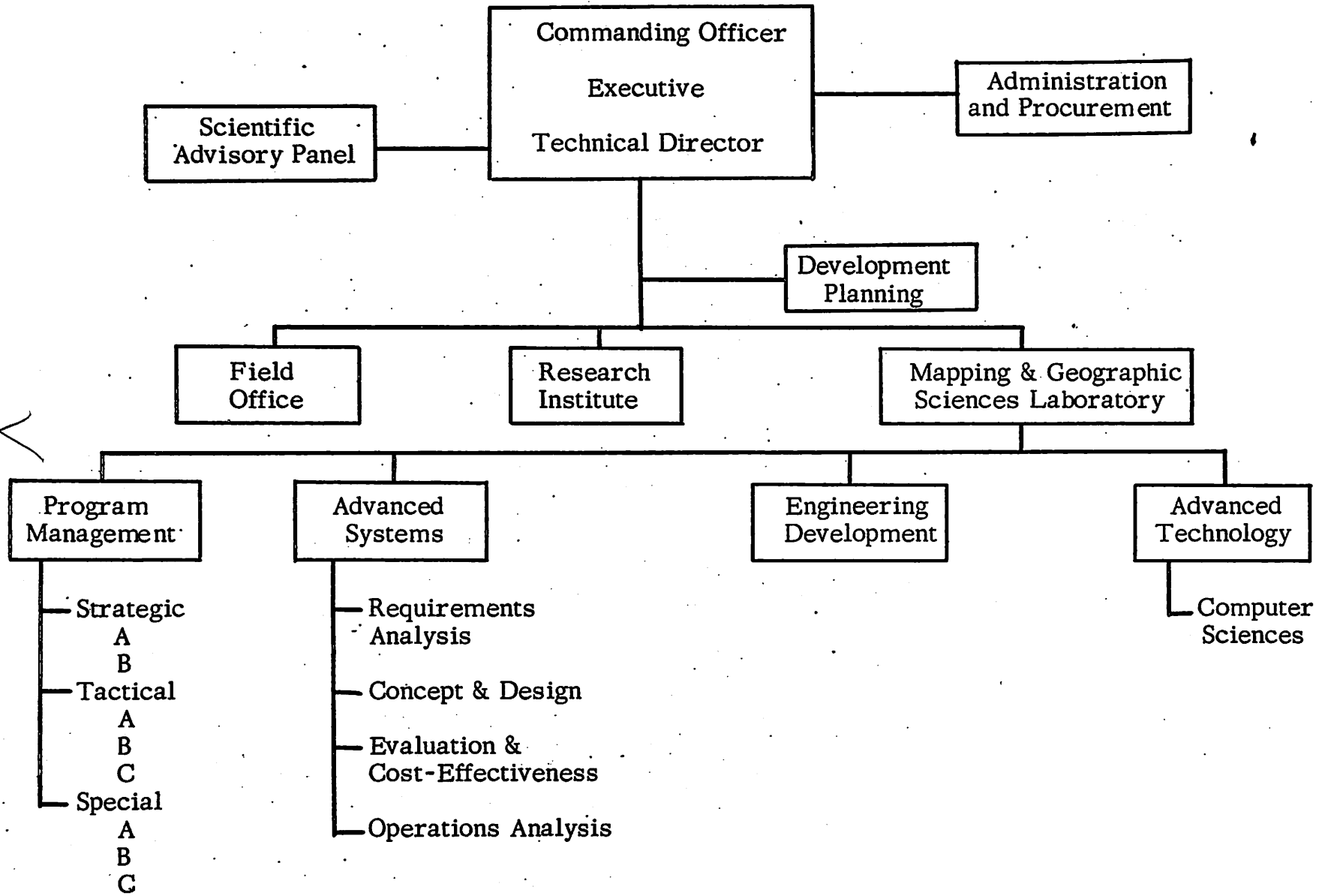
Operationally a major program using the resources of all divisions would be directed by a Program Manager, and possibly one or two members of the Program Management Division, and staffed from the other three divisions, as appropriate. The Program Manager would be responsible for the over-all program, including the system consistency and its interaction with other operational system concepts. The other Division Chiefs would be responsible for insuring technical integrity in their areas of specialty. If Division Chiefs are to be responsible for technical integrity, they must have some funds for long range support of

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their specialties which are not subject to the "ups and downs" of current systems in favor or disfavor. This arrangement is usual in industry, works well, and allows allocation of the best talent to programs by priority. It also insures the availability on call of specialists in advanced technology to all programs requiring their particular talents.

Programs involving only a single division should probably be managed and executed in that division.

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TECHNICAL RESOURCES AT ETL

Knowing that a three-day visit is too brief to serve as a satisfactory basis for evaluating the competence of members of a laboratory, the Committee spent a substantial part of its executive sessions comparing impressions about ETL's technical resources. The Committee members came to surprisingly similar conclusions about the laboratory personnel. The three main observations which were reached are:

1. The young people seemed to be good in the areas related to new technology. The all-weather mapping, the UNAMACE system and the pattern recognition groups had some particularly bright young people. The Research Institute under Professor Bjerhammar appeared to be well-staffed.

2. There are many competent "old pros" in the middle management. These people have a solid record of accomplishment in conventional mapping. The ETL has a good reputation based on many of these men's past performance. The quality of the young men attracted to the laboratories bears out the fact that ETL has a good reputation.

Some of these "old pros" may, however, be inadequately responding to the new technologies which have the potential to revolutionize mapping. These technologies are recognized but new ideas appear to have been awkwardly incorporated and some ideas have been promoted too vigorously before the total implications have been thought through. The Committee

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was unanimous in its concern over the random way in which new computer technology, as an example, has been applied.

3. The top management clearly seems to be uncertain and confused about the role of ETL. This confusion reflects itself in the momentum demonstrated by the Laboratory as a whole. The overall posture lacks the luster that this field warrants.

The Use of Computer Technology

Laboratory management has apparently not organized a really strong computer sciences group, although they have developed many special purpose computers. The result of this premature application is that many of the small, specialized computers which have been developed are obsolete, and they are finding that the problem for which the computers were conceived is really much more profound. One specific example of this is in the character recognition area. Many of the basic studies could have been simulated on a large general purpose computer, but ETL overall planning failed to provide for such a facility and the specialized computers cannot cope with the fundamental problems. Since many of these basic problems are extremely complex, one can only conclude that ETL technical leaders failed to comprehend the magnitude of the problem and the capability inherent in the technology. In another instance, ETL is developing a special flying spot scanner for a system so advanced in concept that scanners may be completely different before the system is brought to fruition. Scanning is not the core of the problem for

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this system. It is suggested that the system idea could be simulated in a general purpose computer before mechanization. A strong computer sciences group would help think these programs through before money and time is spent to build hardware.

The committee was impressed with the fact that mapping information is first obtained in the form of a picture. It is then scanned and digitized, corrected and reassembled as a picture. The process is a complicated procedure for reassembling information to suit the human observer's well-known ability to use picture detail. This process made a great deal of sense when it was completely photographic, but if the picture has to be scanned and digitized then one should ask the following questions.

a. Should the digitized data necessarily be reassembled into a picture?

Perhaps it can be presented in many different ways for a wide variety of users.

b. Maybe the data should be gathered in a different way? Serial strips, parallel strips, pulsed light with range data. Perhaps the use of synthetic apertures could be exploited.

The responses to questioning along these lines indicated lack of deep consideration. A few standard responses were given, but no one had attempted to think through a few systems, pinpoint problem areas, and suggest solutions. One answer given was that film is an efficient

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medium for storing information. This may be true, but the information could be stored equally well in digitized form. Another response was that digitized mapping has been tried and has been a failure. However, one wonders if maybe it has failed because of this tendency to push complicated hardware too soon. Thoroughly studying the problems has two advantages: The hardware is better when the time comes to use it, and fewer false starts are made.

In any case, the role of the computer in semi-automatic map-making is not clearly articulated. There seems to be a tendency to have the data bouncing in and out of the computer, whereas when the whole procedure is looked at as a system, numerical data should stay in the computer, the various desired visual outputs provided as by-products, not items in the line. It would seem that the data flow and use of computers in the various programs could be profitably reviewed by ETL. This is where a systems analysis would be appropriate. But it must be done by someone who has first-hand experience with computers.

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Relationship with AMS

The committee detected rivalry between AMS and ETL. In many respects the AMS group were more imaginative in their thinking than ETL. Their young people appeared to be even sharper.

The AMS group have collected a group of software specialists who have helped in the advanced planning. ETL on the other hand has been so busy developing hardware and struggling with endless engineering problems that they have neglected the software aspects of the mapping business or have delegated it piecemeal to contractors.

AMS has had an advantage in having clear-cut objectives and rigorous requirements which have forced them to extend themselves. ETL on the other hand is torn between fundamental new research and mundane engineering, making it more difficult to plan a program.

The relationship between these two organizations should be cleared up. If ETL is to be the think organization for AMS, then ETL should be developing a computer-oriented software analysis group with less emphasis on development of hardware.

Recommendations for Improving Technical Resources

ETL needs help from someone who has been successful in high-level research and development planning. A person of this type will be difficult to come by, so realistically ETL may for the time being have to seek an alternative. There are several procedures which should be carefully considered. The Committee makes the following suggestions:

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1. ETL could establish a civilian advisory board. The board should consist of a balance between industry and university people. A dedicated board of 5 to 6 members would be invaluable to ETL. The board should be used to review all of the ETL projects and to critically scrutinize ETL's research and planning. Consideration should be given to compensating consultants who would qualify as board members in order to obtain adequate talent. The board should be charged with the task of assisting in the upgrading of the quality of the ETL laboratory personnel. An attempt should be made to attract advisors who are genuinely devoted to the field and to the concept of high-quality government laboratories. It might be well to emphasize that, in addition, the advisory board could help reduce the amount of ill-advised or premature outside contracting for large systems.

2. ETL could sponsor a summer study on mapping and geodesy. The National Academy would probably help organize a summer study of the field and make recommendations for participants. The summer study could pin-point problem areas, research needs and alert more people in the scientific community to the challenges of this exciting field.

3. ETL could initiate a program to develop a high-level association with universities. This might be done in the following ways:

- a. Appoint one or two university people to the ETL advisory board.
- b. Emphasize the reeducation program for ETL personnel.

Colonel Anderson seems to feel he is limited in this

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area by formal regulations. This matter should be looked into.

- c. Set up summer research jobs at ETL for students.
- d. Let out a few research contracts to universities and monitor them in a broadminded way. The monitors of university contracts should be ETL's very best people, who thoroughly understand research and who do research themselves. Contract monitors who "direct" the research will do more damage than good. The contract monitor should be able to infuse the workers with the excitement of the project thereby motivating young university members to follow the field.

There is a note of caution relating to university departments: there are now several schools that offer course work in photogrammetry¹. It may not be advisable to automatically support these schools. They apparently emphasize the conventional mapping procedures and are primarily interested in analytical triangulation methods. ETL should look to activities of much broader significance. One might obtain better long-range perspective from departments that appear quite unrelated to mapping. A few examples which should be explored are departments of

1. Geology
2. Geography
3. Computer sciences

¹Photogrammetric Engineering, Volume XXXII, March 1966, page 307 et sequi.

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4. Statistical analysis
5. Systems analysis
6. Mathematics
7. Physics

4. The Research Institute now under Professor Bjerhammar should be brought back into ETL. Both ETL and the Institute need closer ties than now seem apparent. Professor Bjerhammar will be a serious loss to ETL. He should be asked to suggest a replacement. It is also recommended that Secretary O'Neal have a private talk with Professor Bjerhammar before he leaves. It would be of value to know the history of the Institute to determine if the reasons for its separate location are still valid. It would also be of value to obtain Professor Bjerhammar's reaction to some of the criticisms of this committee.

Professor Bjerhammar might also be excellent help in identifying promising young people within the organization, and if an Advisory Board is formed he should be invited to join for his help in areas where security permits.

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AREAS OF SUGGESTED TECHNICAL CONCENTRATION

Need for Re-Orientation

In the environment of earth satellites as a source of data, and of proven ability of computers to aid in map-making and geodesy, ETL should completely revise and reorient its technical program. Before addressing the revision of the technical program however, the ETL Commander should work out detailed plans to implement the program within the constraints of the various security directives governing such activity.

Geodesy

The creation of a world-wide geodetic network linking all the datums of national and continental surveys is essential for new DOD weapons systems, and to the Army itself. The responsibility for this apparently lies with DIA, who in turn assigns tasks to various agencies, including the Engineering Topographical Laboratories and the Army Map Service. ETL could respond by creating and maintaining a group with the necessary skills available to assist DIA in analyzing requirements and suggesting solutions. SECOR and related systems from the other services will be improved, and data from all of them correlated to provide the accuracies needed by new weapons systems. Apparently, there is no requirement for a specific new earth satellite to provide adequate geodetic data. ETL's present position would be greatly strengthened by research emphasizing improvements within this basic scheme of operations rather than suggesting new total systems.

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Inherent in the analysis of future geodetic improvements is the willingness to consider alternates and to search for an analytical base upon which to build the requirement for changes to present systems.

The position of ETL in these matters should be one of high technical understanding and confidence, but also one derived from a total systems analysis, including trade-offs of ultimate accuracy and simplified data handling as compared to any compromise with other system functions. To take a position of this sort will require the services of a very senior scientist or engineer who has a knowledge of the whole DOD strategy.

Preparation of Maps from Special Data Sources

A second major program which should receive priority is the ability to make maps adequate for a large part of the Army's tactical requirements from special data sources. Additional comments on this subject are available in a separate document which is available at the Engineer Activities Office, OACSI, DA.

Pattern Recognition

The automatic preparation of overlays, for color printing of roads, waterways, etc., is dependent in the long run on new ideas of pattern recognition, an area in which many laboratories are doing research. The Army's interest, as far as mapmaking is concerned, is very special, so it is in order for ETL to engage in such investigations. However, in view of the present state of the art the hardware aspects of the investigation could be reduced, and procedural investigations by means of a standard computer emphasized. At the present stage of understanding, real time analysis and, therefore, an on-line computer is not needed.

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Needed Review of Map Requirements

In this connection, a review of Combat Development Command of the realism of requirements of individual features (such as color, local names, boundaries) on Army maps is warranted at this time when large expenditures are made in attempts at automation. For example, it is customary to select churches as one of the few types of buildings to be marked on a map. This has its origin in military campaigns in Europe, where churches have steeples advantageous to artillery observers. This is not the situation in South East Asia, and presumably the efforts to identify churches, or equivalent, could be curtailed. The requirements on maps, and their general usefulness could be evaluated by paying attention to their use during real and simulated war games.

Although Combat Development Command has made studies of map requirements, it seems as if they were oriented to artillery. It is our contention that the Army has a use for maps, especially the kinds amenable to semi-automatic preparation, which are not necessarily suitable for the artillery.

Conversely, it may be that today the artillery does not need a conventional topographical map. A "digital" map, consisting of coordinates, elevations and coded descriptions of control points in digital form, for use in field computers, might be more appropriate, time-saving and accurate. Digital maps could be easily transmitted on standard communication systems. Indeed, there are probably other customers of

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digital maps, whose needs are now met by manual reading of conventional maps. It is recommended that the Combat Development Command should review these needs. It is worth noting that the data now handled by UPDRAMS could probably form the basis for many digital map products.

Review of Individual Programs

In view of the revolutionary approach to map making due to the advent of satellites and computers, the current conventional programs should be critically reviewed. It would appear that there is no longer a clear distinction between tactical and strategic levies on the Army Map Service. The principle of a bank of data to be made into maps on short notice, provides the Army with most of its tactical needs. This brings into question the validity of some of the current individual programs at ETL.

All-Weather Radar Mapping

ETL is devoting a substantial amount of effort to an "all-weather" mapping system exploiting side-looking synthetic aperture radar. While it is appreciated that such a capability is useful to the Army in a few selected areas where cloud cover obscures the terrain all year, it hardly seems necessary for the Army to procure complete operating systems for this task. One or a few research and development systems built and maintained by ETL should be sufficient to provide all the data the Army is likely to need. By maintaining this equipment in a research and development environment the design would not be frozen, and timely improvements could be quickly made as they become available.

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RACOMS

It does not seem that RACOMS is now needed, or at least would be useful, at most, only in a few selected instances. The jeep and helicopter inertial reference system likewise seems inappropriate and outmoded. The long range survey ("hero") system is another one which seems to be archaic, and unrealistic in today's battlefields.

The personnel involved in some of these projects seems to be highly qualified and motivated and could be readily converted to more urgent ETL missions.

Geographical Research.

A fairly sizeable item of expenditure by ETL is geographical research. Part of this is necessary to properly label maps, and as an aid in identifying cultural features for indication on maps. However, the whole activity appears to be more intimately connected with a larger intelligence operation and it should receive special support from the intelligence agencies. The Committee questions the location of this activity within ETL. Further review of Army documents makes it clear that ETL was assigned a specific task in doing geographical research in support of tactical intelligence requirements so legally, at least, the work should be done at ETL. This, then, implies that someone (ACSI, CDC ?) should help in outlining the priorities of geographical information actually necessary. The approximately \$500,000 per year budget is hardly adequate if research is required covering almost all of the geographical

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features being considered by the several government agencies involved. Clearly some simplification of the requirements is indicated.

Recommendations

It is recommended that the technical effort of ETL be concentrated along three lines.

- (1) A strong, clear technical group be available to accept assigned tasks from DIA in the field of geodesy for advanced weapons systems. The skills involved should be essentially those now available, but should be clearly identified and defined to clarify the Army's support role to DIA in these programs.
- (2) In collaboration with the Army Map Service, the system for generating maps (or a spectrum of maps of varying degrees of quality) from various sources accumulated in a data bank should be given a thorough systems analysis, for the purpose of simplifying the process and identifying critical items to be given priority effort in research and development.
- (3) In collaboration with CDC, the requirements for maps for a modern Army should be delineated. Questions concerning the type of topographical information, color format, etc., should be resolved to meet various user requirements not necessarily on the same map.

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Further, the value of digital "maps" should be seriously studied. Following such studies to define real needs, intensive efforts should be instigated to provide such products from photography or other sources by automatic or semi-automatic means, with speed of delivery as the prime criterion.

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CONCLUSIONS AND RECOMMENDATIONS

Since the prime purpose of any review activity is to identify areas of improvement, it is inevitable that any conclusions and recommendations will emphasize the negative aspects of performance or management. The Ad Hoc Review Committee found in ETL a dedicated group of capable, experienced scientists and engineers supported by young men of promising potential. The caliber of the organization and its new leadership adds urgency to the suggestions and conclusions of the Review Committee so that the full potential of the talent now available may be reached.

1. There is a definite weakness in requirements definition which forms the basis and justification for ETL programs. This void has caused ETL to attempt requirements definition for itself without adequate user dialog and study. Thus, programs are found to be based on obsolete or ill-defined requirements and they lack coherence.

Recommendation:

a. ASA(R&D) should attempt to put together a New Concept/Modernized Requirements activity utilizing ETL, AMS, and CDC personnel. This should probably result in a permanent activity within CDC to modernize its analytical approach to map requirements for tactical use.

b. ASA(R&D) should instigate an activity within DIA by suggesting a tri-service board to define strategic map requirements and to assign the fulfillment of such requirements to each of the services.

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c. The geographical intelligence activities appear to be particularly diffused by ill-defined requirements. The solution here is complicated by what appears to be an assignment to determine requirements which should not be ETL's prime responsibility. A special effort should be made to combine efforts in ACSI, CDC, and ETL in such a way that a priority list of geographic intelligence requirements is created in order to simplify the R&D program.

2. Systems Engineering and Systems Analysis have been recognized as useful tools in determining reasonable requirements and producing optimum systems. The use of the "Systems Approach" at ETL has, however, been much too impulsively applied resulting in a series of isolated "systems" which have little relationship to one another. In a related field the Committee finds that an analytical operations research activity reviewing the interaction of its products with operational units appears to be lacking.

Recommendation:

a. There should be less emphasis on creating systems for elements of the total map making process and that more emphasis be placed on optimization of the total system through review of the real requirements and the simplification of the total process.

b. A review be made of the total ETL organization under the direction of a new technical deputy (See Paragraph 3 following). It is suggested by the Ad Hoc Committee that the analysis and new concept functions (the core of the systems approach) might be more effectively

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done in a single organization served by technical specialty laboratories. A specific organization is contained in the body of the report.

3. Technical resources within ETL are being dissipated by a lack of consistent technical leadership which recognizes, on the one hand, the necessity of clarifying the goals of the organization and, on the other, the implications of technological advancements on the map making art.

Recommendation:

a. A closer relationship among AMS, M&GS, and the Research Institute must be developed. It is suggested that the Research Institute should be geographically located with the rest of ETL and, if possible, ETL and AMS be located together.

b. A technical director be sought who would be a direct deputy to Colonel Anderson and have responsibility for the technical content and organization for R&D at ETL. It is further suggested that he be a "new man" more cognizant of the advanced technology areas previously listed.

c. A technical board should be formed with members of the scientific community who understand the new technologies, some of whom are allied with educational institutions. By their participation it may be possible to put some research projects into these schools thereby broadening the base of talent and serving as a recruitment aid. This board should report to Colonel Anderson.

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4. The programs now being pursued at ETL appear to be "too many" with "too few" engaged in each. There appeared to be a tendency to try and produce hardware prematurely resulting in many specialized computers with limited capacity to expand as problems became better understood. There appeared to be too much outside contracting without clear problem definition first resulting in a contractor bound laboratory with diminishing in-house talent to direct activities.

Recommendation:

a. Programs should be reviewed probably with the help of the "Technical Board" suggested previously, in order to add emphasis to the important programs and eliminate the marginal ones.

b. The Ad Hoc Review Committee feels that added emphasis should be applied to:

(1) Revision, simplification and modernization of UPDRAMS with particular emphasis on using earth satellite data and modern computer technology to the maximum.

(2) Definitive proposal to DIA for completing a world-wide control net utilizing all techniques available in the shortest possible time.

(3) Investigation of potential customers for digital "maps" whose configuration may be far different than conventional maps.

c. The Committee feels that the following projects should be carefully reviewed to assess their ultimate usefulness:

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- (1) RACOMS
- (2) Long-range survey system
- (3) Jeep and helicopter inertial reference "point moving"
- (4) Specific pattern recognition system (NIC)
- (5) Side looking radar efforts should be aimed at more definitive requirements -- intelligence? mapping? or "real time" support of maneuvers?

The entire Committee was most impressed by the dedication and capability of everyone we were privileged to meet. The accomplishments of the men in ETL are endless and recognized by all. We hope our suggestions will help to bring to bear the influences of new technology which should, when combined with the experience at ETL, produce outstanding new systems for tactical and strategic use.

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APPENDIX 1

Army Scientific Panel
Ad Hoc Review Committee for
Engineer Topographic Laboratory
September 1967

Mr. Willis M. Hawkins, Chairman
Vice President, Science and Engineering
Lockheed Aircraft Corporation
P. O. Box 551
Burbank, California 91503
Phone: 213 847-6448

Dr. Hendrik W. Bode
Vice President
Bell Telephone Laboratories
Whippany, New Jersey 07981
Phone: 201 386-2146

Dr. Robert E. Hopkins
College of Engineering and Applied Sciences
University of Rochester
Rochester, New York 14620
Phone: 716 473-3000 Ext 468

Dr. Gilbert W. King
Associate General Manager
Laboratory Operations
Aerospace Corporation
Box 95085 Los Angeles, Calif. 90045
Phone: 213 648-6036

Mr. Herbert K. Weiss
Manager-Analysis
Litton Systems, Inc.
Data Systems Division
800 Woodley Avenue
Van Nuys, California 91406
Phone: 213 781-8211 Ext 2995

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APPENDIX 2

OBJECTIVES OF ETL AD HOC REVIEW COMMITTEE

1. Review ETL systems development for:
 - Responsiveness to user requirements
 - Need for Systems Engineering/Systems Analysis emphasis
 - Need to augment or adjust technical and management resources

2. Select two systems for follow-on pilot project study

3. Report to Assistant Secretary of the Army (R&D)
 - Preliminary verbal September 1, 1967
 - Final written September 30, 1967

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ETL MISSION

RESEARCH AND DEVELOPMENT OF

- EQUIPMENT, PROCEDURES AND TECHNIQUES

IN FIELDS OF

- GEODESY
- ENGINEER INTELLIGENCE
- MAPPING

FOR APPLICATION TO

- ARMY IN THE FIELD
- BASE PLANT OPERATIONS

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DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20310

7 September 1967

MEMORANDUM FOR RECORD

SUBJECT: ASAP Subpanel Review of Mapping and Geodesy

1. During 29 August - 1 September at the request of Dr. O'Neal and Mr. Poor, a subpanel (Incl 1) headed by Mr. Hawkins of the Army Scientific Advisory Panel (ASAP), reviewed the R&D program and organization of the US Army's Engineer Topographic Laboratories (ETL) formerly GIMRADA. Objectives of the review are listed in Incl 2, and the agenda is shown on Incl 3.

2. Mr. Hawkins and the subpanel gave a verbal report to Dr. O'Neal on 1 September; a written report is planned about 1 October. Following is a brief summary of their preliminary conclusions and recommendations:

a. General.

ETL and AMS are very adept at an old art (mapping and geodesy) but they have not yet adapted fully to two powerful new tools: digital computers and satellites. Although ETL has a singular, compact mission area, it does not have a clear feel for its role in meeting the requirements of its two major types of users: strategic and tactical military forces.

b. User Relationships.

ETL does not have a good list of either tactical or strategic R&D requirements. In the tactical area, there is a need for a clear requirements circuit to CDC, and there appears to be a gap in CDC for the continued analysis of requirements. This is manifested by the outmoded and poorly worded QMDO's and QMR's to which ETL is attempting to respond. ETL recognizes this gap and is trying to fill it. However, CDC should assign clear responsibility to one of its elements to fill this gap. Currently it appears that mapping and geodetic requirements within CDC fall in at least three areas: Engineers, artillery and others (e.g. infantry, intelligence). The subpanel felt that these areas should be tied together with a more aggressive, systems oriented effort. With regard to strategic requirements, the subpanel recommended that the Army propose to DIA the convening of a board of consultants with a view to bringing some order to the method by which DIA lays on global requirements. The Panel was impressed that AMS and ETL have the capability to do more than DIA now requires, particularly in the area of target strategic missiles. A board comprised of selected representatives from ASAP and its Air Force and Navy counterparts might be a useful means for accomplishing the needed DIA review.

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7 September 1967

SUBJECT: ASAP Subpanel Review of Mapping and Geodesy

c. Systems Engineering and Systems Analysis.

The subpanel noted that both OCE and ETL recognize the need for increased ETL systems' emphasis, and they have proposed a contractor study to this end. The subpanel feels that this effort should not be delegated to a contractor but that, at least initially, it must be done in-house. They felt that ETL has a strong need for technical leadership. They recommended setting up a civilian technical director position in ETL, to be "in the line" rather than purely advisory, and that this individual should have direct responsibility for technical management of both the Research Institute and the Mapping and Geodetic Labs of ETL. The subpanel noted that Professor Bjerhammer, Acting Director of the Research Institute on loan from Sweden, has done an excellent job in pulling together some of the global geodetic satellite work to date, and the Panel is concerned over selection of a replacement for Bjerhammer when he returns to Sweden this fall.

The Panel felt that the proposed technical director should decide what needs to be done to "systematize" ETL's efforts and they pointed out that labelling every ETL effort as a major system does not help; in fact, it compounds the problem. In passing, the Panel suggested the creation of a small systems integration group within ETL to define the systems and the sub-system interfaces for those areas which should be emphasized, but they noted that the proposed technical director should have latitude in this regard.

d. Talent.

In the area of technical talent at ETL, the Panel identified a significant gap in the use of computer technology and the implications of satellites on mapping and geodesy. With regard to computers, ETL is now using a number of special purpose computers in their various systems and subsystems, but the efforts appear to be "contractor bound." Specifically, in the complete flow of mapping data from input photography to output mapping products, several special purpose computers are used in series and in parallel. The Panel felt that a hard look at the systems flow diagram (such as that now being put together for UPDRAMS by NAA at AMS) could lead to a far more effective use of a general purpose computer in a simplified, streamlined operation.

The subpanel is concerned over the physical separation within ETL of the Research Institute in Alexandria and the MGS Laboratories at Fort Belvoir, which inhibits a continuing free flow between the research and the hardware people. They were also concerned about the physical separation between ETL and the Army Map Service which, in the Panel's view, had resulted in AMS bypassing ETL in some areas, e.g., pictomaps.

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7 September 1967

SUBJECT: ASAP Subpanel Review of Mapping and Geodesy

The subpanel urged an increased working relationship between ETL and the university community, such as Ohio State, Rochester, Syracuse, Michigan, Arizona, etc. ETL should go after university consultants who could come to ETL on a regular basis, cleared as necessary, to work on ETL problems with ETL management. Selected tasks should be assigned to universities for work by graduate students, with flexibility as to specific content and rate. The subpanel noted the challenging, sophisticated and unique nature of things to be done at ETL. The subpanel noted a gap in the areas of films and chemicals, where too great a reliance is being placed on the industrial state-of-the-art.

The subpanel noted a need for a technical program planner to infuse more vigor and forward looking technology into ETL's efforts. Currently, the Panel feels ETL gets into hardware development too soon, probably because of budgetary pressures to tie each effort to a firmly documented QMR.

The Panel noted that ETL wants to send more young engineers and scientists to school for graduate education than now appears possible under a stated 2% annual quota; the Panel encourages an increased graduate education program.

e. Areas for Concentration.

The Panel did not feel that two current ETL systems need to be used as "pilot projects" for systems analysis contractual studies but rather that two major areas should be selected for increased emphasis within the ETL/AMS program:

- (1) A definitive proposal should be made to DIA to "put the world together" as a real base for strategic targeting, utilizing both advanced geodetic Secor-like systems and remote observation systems for cantilevering or bridging between points of known ground control.
- (2) An intensive review of the UPDRAMS flow chart in an effort to streamline and simplify the operation. The Panel was encouraged by the NAA effort but felt that ETL should be doing this in-house and should be gearing their thinking to technology five-years hence.
- (3) In passing, the Panel suggested a review of the current necessity for some of the technical systems that ETL is engaged in; for example, RACOMS might be simplified in light of future technology; LRSS might be combined with target location systems now being developed by others (e.g., VATLS at ECOM); and the jeep-helicopter division artillery survey system may be obsolescent in light of AAFSS and RACOMS. The Panel noted that competent ETL people are working these problems well, but they might better be applied to other, more urgently required systems. The Panel was particularly impressed

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SUBJECT: ASAP Subpanel Review of Mapping and Geodesy

7 September 1967

with Mr. Kent Yoritomo, who presented the ETL radar mapping effort. The Panel was impressed with the technical soundness and significant results in this area but questioned the high priority need for a fully operational system of this type.

(4) The Panel was unclear on the status of the Army's and the Corps of Engineers' responsibilities in the geographic intelligence area and, if these responsibilities are not now clearly assigned to the Army's Corps of Engineers, the panel felt ETL should not be working in this area. They noted, however, that the pattern recognition work at ETL could be important if it could be made to work, although the current mechanization seems awkward, premature and hardware oriented.

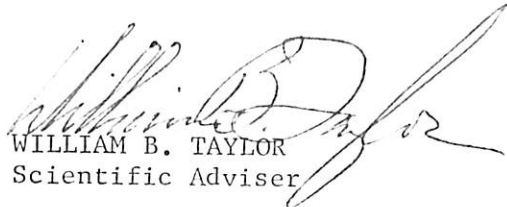
3. Dr. O'Neal asked the Panel to include in its written report to him some specific nominations or approaches to acquiring a suitable technical director for ETL and some specific recommendations for the increased university tie. On the former point, the Panel agreed to provide specific names but suggested that suitable talent may already exist within the Army; they were particularly impressed with some of the people at AMS and in previous contacts with BRL for example.

4. I reviewed the subpanel's verbal report with Mr. Poor who asked me to:

a. Review the report with OCE and ETL management and;

b. ~~To~~ Draft a memo from ASA(R&D) to Director DIA regarding the subpanel's recommendation for a DIA board to re-examine strategic requirements and task assignments to the Services.

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WILLIAM B. TAYLOR
Scientific Adviser

ASAP SUB-PANEL REVIEW
OF
U. S. ARMY ENGINEER TOPOGRAPHIC LABORATORIES (ETL)
29 AUGUST - 1 SEPTEMBER 1967

OBJECTIVES

1. REVIEW ETL SYSTEMS DEVELOPMENT FOR:
 - RESPONSIVENESS TO USER REQUIREMENTS?
 - NEED FOR SYSTEMS ENGINEERING/SYSTEMS ANALYSIS EMPHASIS?
 - NEED TO AUGMENT OR ADJUST TECHNICAL AND MANAGEMENT RESOURCES?
2. SELECT 2 SYSTEMS FOR FOLLOW-ON PILOT PROJECT STUDY?
3. REPORT TO ASA(R&D):
 - PRELIMINARY VERBAL 9/1/67
 - FINAL WRITTEN 9/30/67

AGENDA
ENGINEER TOPOGRAPHIC LABORATORY
SYSTEMS REVIEW

BY
ARMY SCIENTIFIC ADVISORY PANEL
29 AUGUST - 1 SEPTEMBER 1967

29 AUGUST 1967 - Pentagon (ASA(R&D) Conference Room - 3E389)

0900 - 1000	Orientation	Mr. Taylor, OCRD
1000 - 1020	Coffee Break (3E 364)	
1020 - 1100	Executive Session	Mr. Hawkins
1100 - 1300	Lunch (Flag Officer's Dining Room)	Mr. Taylor, OCRD
1300 - 1400	Map Concept Study (2C 472)	Mr. Wilson, OCE
1400 - 1430	R&D Program Overview	Mr. Ayers, ETL
	Classified Systems	
1430 - 1525	UPDRAMS	Mr. Griffin, ETL
1525 - 1620	Classified Automated Military Geographic System	Dr. Kothe, ETL

30 AUGUST 1967 - Fort Belvoir (USAETL) (Bldg. 312, Conference Room 108)

0800 - 0815	Welcome	COL Anderson, ETL
0815 - 0845	Research Institute Mission and Organization	Prof. Bjerhammar, ETL
0845 - 0915	M&GS Lab Mission and Organization	Mr. Gillis, ETL
0915 - 0945	ETL Systems Analysis and Weapon Systems Relationship	Dr. Baussus von Luetzow, ETL

End 3

Surveying and Geodesy

0945 - 1015	Field Army Survey System	Mr. Crowell, ETL
1015 - 1030	Coffee Break	
1030 - 1100	Position and Azimuth Determining System (PADS)	Mr. Flowe, ETL
1100 - 1130	Long Range Survey System	Mr. Friberg, ETL
1130 - 1200	Global Geodetic Positioning System	Mr. Armistead, ETL
1200 - 1300	Lunch	LTC Cordova, ETL

Mapping

1300 - 1330	Exploratory Development in Mensuration, Analytical Photogrammetry, and Compilation	Mr. Mayer, ETL
1330 - 1415	Automatic Cartographic System	Mr. Carr, ETL
1415 - 1445	Advanced Reproduction System	Mr. Gibson, ETL
1445 - 1500	Break	
1500 - 1545	All-Weather Mapping System	Mr. Yoritomo, ETL
1545 - 1700	Executive Session	Mr. Hawkins

31 AUGUST 1967 - Fort Belvoir (USAETL)

SYSTEM DESCRIPTIONS (CONTINUED)

Mapping (Continued)

0800 - 0845	Rapid Combat Mapping System (includes Tactical All-Weather System)	Mr. McComas, ETL
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Geographic Sciences

0845 - 0900	Military Geographic Intelligence Systems Concepts	Dr. Kothe, ETL
0900 - 0945	Field Automated Military Geographic System	Mr. Pearson, ETL

Geographic Sciences (Continued)

0945 - 1000

Break

1000 - 1045

Strategic Automated Military Geographic System

Mr. Lindsey, ETL

1045 - 1200

Tour of Laboratory

Mr. Gillis

1200 - 1300

Lunch

1300 - 1400

Tour of Laboratory

Mr. Gillis, ETL

1400 - 1530

Executive Session

Mr. Hawkins

1530 - 1615

Summary and Wrap-up

COL Anderson, ETL

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1 SEPTEMBER 1967 - Army Map Service

0800 - 0830

Travel to AMS

142 Holiday & Marriott.
156 175 Adams + 30 st.

0830 - 1100

Briefing on Pictomaps, UNAMACE and
Tour of AMS Facilities

Mr. Baur

1100 - 1130

Summary and Wrap-up

1130 - 1230

Lunch (AMS Dining Room)

1230 - 1300

Travel to Pentagon

291, 113

1300 - 1530

Executive Session (Room 3E 333)

Mr. Hawkins

1530 - 1630

Oral Report to ASA (R&D)
(Room 3E 390)

Mr. Hawkins

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