CSEP:

A timely solution to tactical C-E problems

"There is an urgent need to take positive action to upgrade the current communications posture in Europe. Field exercises, after action reports, critiques, and commander's notes confirm the unsatisfactory nature of our tactical communications systems. While there are numerous developmental actions underway to enhance various phases of the communications systems, these actions must be unified into a single program, which bears the responsibility and the authority to effect resolution of the European communications problems in the near term..."

—Lt. Gen. H. Dickinson
March 1978

by Capt. Geoffrey B. Charest

There are numerous actions being taken to correct communications difficulties in the tactical Army. However, there had been no central focal point for coordination of the management of these actions. The Communications Systems Engineering Program is the attempt to unify the fragmented management for development and improvement of tactical comm systems into a single program which has the responsibility and authority for effecting resolution of problems in an effective, timely way. The scope has rapidly broadened since Dickinson first articulated the need to address not only the European theater, but the tactical communications needs of the Army as a whole.

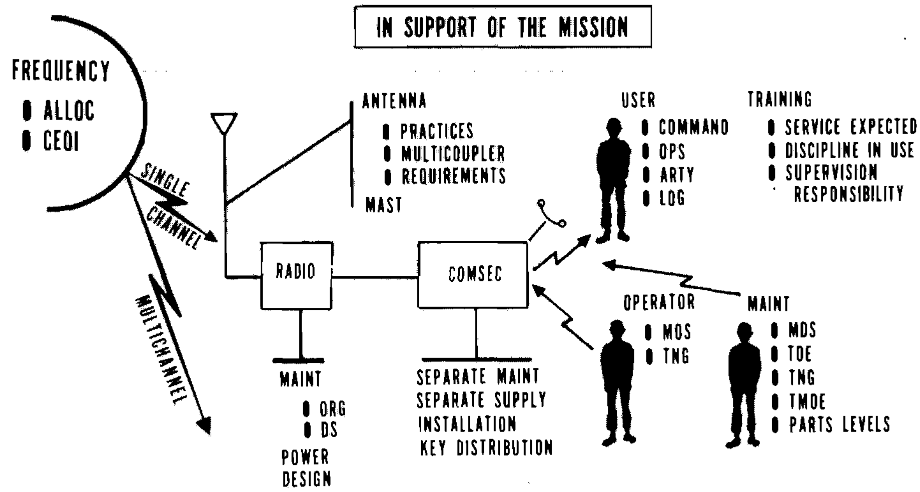
The objectives of the Communications Systems Engineering Program (CSEP) are two fold. First, it aims at providing near term assistance in the form of quick reaction projects through military adaptation of commercial items, product improvements, accelerated development within existing technology, and development of new procedures and recommendations for commanders' consideration. A second objective is to obtain long term benefits by providing a vehicle for action on user problems and requirements in the communications arena and by modification of performance specifications for those systems presently under development.

CSEP was formed in early 1978 under a Memorandum of Understanding between the US Army Communications Research and Development Command (CORADCOM), The US Army Communications and Electronics Materiel Readiness Command (CERCOM), the US Army Signal Center and The US Army Field Artillery School (CORADCOM and CERCOM have since merged to form CECOM). The purpose of CSEP is to present a forum for cooperative efforts in the conduct of their respective programs and missions to achieve significant improvements in the area of tactical communications support.

Management coordination of the program is performed by a Senior Review Board consisting of one O-6 from each of the commands. Meeting quarterly, the Senior Review Board conducts a review and analysis of ongoing projects and tasks continually striving for rapid, aggressive, dynamic action towards near term tactical communications improvement. Key to accomplishment of the Senior Review Board management is the active participation and support, with appropriate representation during the Senior Review Board meetings, of elements of DARCOM, TRADOC, FORSCOM, USAREUR, DA (ACSAC, DCSOPS, DCSRDA) plus other agencies involved in specific projects such as the US Army Materiel Systems Analysis Activity (AMSAA).

The day to day responsibility for administration of the CSEP program rests in CECOM's Center for Systems Engineering and Integration (CENSEI). This assignment stems from CENSEI's responsibilities for Army tactical C^3 systems engineering. CSEP provides the insight and

THE TACTICAL COMMUNICATIONS SYSTEM



feedback generated from the field to enable CENSEI to better engineer and design the systems of the future in a realistic way. The CSEP office of CENSEI also provides the focal point for funding and coordination of almost all individual concept systems evaluation projects of a hardware and engineering nature.

The eyes and ears of the Communications Systems Engineering Program are specifically tailored, technically oriented contact teams which perform initial fact finding visits to combat units, collect and evaluate data, define and articulate problems, and propose initial solutions to these problems. To date, five contact team visits have taken place, all to units in Europe. It is anticipated that the scope of these contact teams will eventually be expanded to include other tactical units in CONUS, Korea, and other parts of the world. The introduction of problems/solutions to be worked is not, however, limited to contact team generation. Self generated initiatives, initiatives developed through the Senior Review Board, and reports from field units also form integral methods for introduction of problems requiring intensively managed and systems engineered solutions.

SCOPE OF THE CSEP EFFORT

To tie the many efforts together for those factors which impact on the performance of a tactical comm system requires management and engineering on a fairly broad scope. Initially, the CSEP program has focused on the communications systems within the division and has considered problems in equipment design, operation and maintenance, the logistics support, tables of organization and equipment authorizations, training, personnel, and requirements development and documentation. The CSEP program has also begun to address selected units in tactical echelons above division.

In its efforts to improve tactical comm systems, a total systems engineering approach is used considering not only the comm system itself but all factors impacting on system performance. After being viewed as a complete system, sub tasks and objectives are established leading to upgrade of the entire system. Only through the unique organizational structuring of the program with combat developer, materiel developer, materiel readiness, and personnel and training represented and working closely towards the mutually established objective system is this possible.

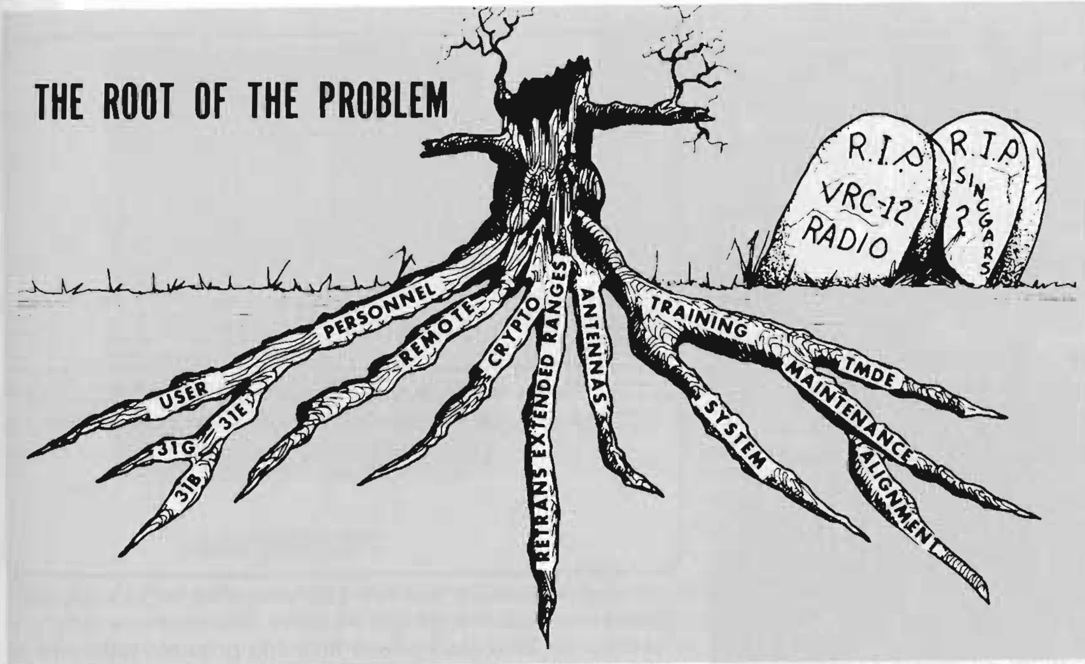
Once the CSEP Contact Team has identified and articulated comm problems for solution, initial solution developments are proposed. Efforts are then directed towards establishing/obtaining prototype in the case of equipment, and conduct of subsequent field evaluation in active tactical units. Based on these concept evaluations, requirements are refined and documented and operational concepts developed. Funding needs are established and forwarded. Materiel developments are then turned over for management through appropriate, existing project management offices. Every effort is made to expedite solutions to the field as rapidly as possible.

CSEP IS IMPERATIVE

That this program really is needed and insight into the viability of the CSEP program and approach can be seen in the slice of the program which has dealt with the tactical VHF FM comm system, the AN/VRC-12 series and related radios. This radio system is chosen because it is the major communications means for all the front line soldiers in the Army. Yet this tactical comm system suffers a wide variety of weaknesses which can be eliminated with properly engineered improvements.

The FM tactical comm system is not new. It has been in use in field units for over 15 years, yet a variety of indicators persist and vividly demonstrate a previous lack of total systems engineering. It is also clear that engineered solutions to system weaknesses do not generate themselves from the field. In fact, quite the opposite occurs in many cases with the field fix failing to solve th e problem addressed and often generating new, unrecognized and more subtle difficulties.

The problem indicators are not new and have proved to be unsolvable with field quick fixes and haphazard engineering change proposals to treat various symptoms. As



Many factors affect proper functioning of a radio communication system. Engineering which doesn't consider the total system leads to many small difficulties which can seriously degrade operation. The FM radio communication system (AN/VRC-12 Series) is a good example.

shown in figure one, the tactical FM system is made up of many other factors besides the radio/receiver itself. Indicators of comm system difficulties are:

In 1977, 68 AN/VRC-12 series radios were inspected in V Corps. Of these radios two were considered operational pursuant to appropriate specifications.

Also in 1977, 381 radios were checked in a divisional artillery with the following results:

- All 381 radios required a direct support maintenance alignment
- 40.9% had bad antenna matching units
- 36.5% matching unit cables were missing or bad
- 25% of the lower antenna sections were bad

Later in 1978, 101 radios were checked in an armored cavalry regiment with the following results:

- 100 radios needed repair or alignment
- 16 units had bad antenna matching units
- 24 had missing or bad matching unit cables
- 40 had bad lower antenna sections

Maintenance exhibits other indicators besides the large number of radio failures cited above. The organizational level radio repairman has no tools or capability to test the critical performance parameters of the radio. Maintenance troubleshooting winds up being performed by random substitution frequently resulting in good components incorrectly identified as bad and bad items overlooked. With this witchcraft approach to maintenance, multiple fault situations become extremely difficult to correct and personnel experience levels become critical for even marginal job performance.

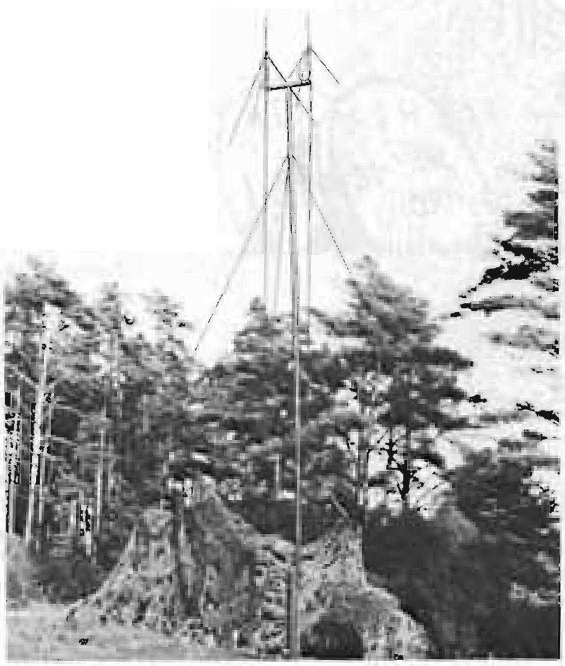
In the direct support, or second echelon maintenance effort, eight pieces of discrete test equipment are required to troubleshoot, repair and align a radio. This circa 1955 technology equipment is interfaced with a variety of various home built cable and wire systems. If not careful, maintenance personnel can damage test equipment and further damage to the radio can result from improper hookup. All together it takes over four hours to properly align each radio.

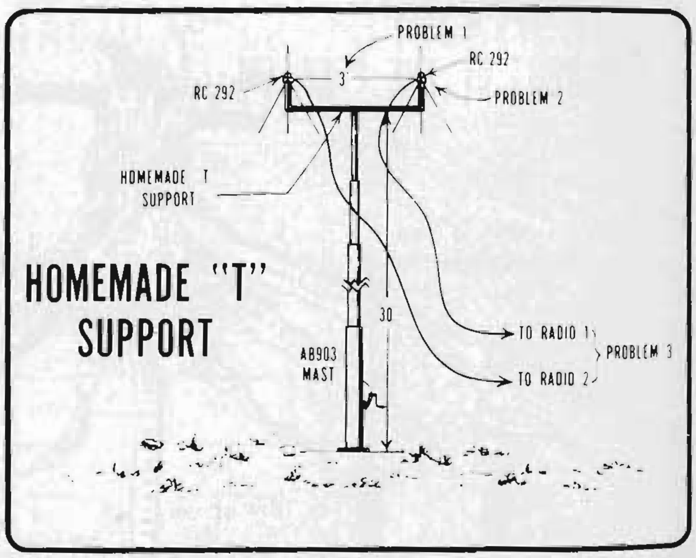
Antennas have long exhibited system weakness indicators. Numerous antennas in tactical command posts cause increased visual signature. Since each radio requires its own antenna, mobility is decreased because of needed antenna set-up and tear-down time. Closely spaced antennas result in mutual interference and radiation pattern distortion. The design of the best FM antenna commonly available, the omnidirectional RC-292 antenna, requires antenna element adjustment for proper performance. Since frequencies are generally changed at night, these antennas are supposed to be lowered (through the camouflage net), in the middle of the night, adjusted properly, and set back up.

This is not the only system weakness, however. Extended ranges are required because of wide frontages covered by the divisions in Europe. These ranges exceed the capability of the omnidirectional antennas available. Directional, increased range antennas are not available.

Directional antennas, besides increasing range, also provide the equally important feature of an inherent Electromagnetic Counter Countermeasure due to the directionality of the radio wave propagation. The simple application of directional ½ rhombic or log periodic antennas can reduce the enemies probability of radio intercept or directional finding by several orders of magnitude. ECCM in the field has been talked about for years, yet very little has been done to improve the *current* system while waiting for new systems such as SINCGARS, PLRS, JTIDS, and so on.

The present method provided for many units to cope with extended ranges is FM retransmission stations. Certainly, directional antennas will not eliminate the need for these retrans stations. They, too, warrant a closer systems evaluation. Also, these stations exhibit many poor system design indicators. They are invariably employed in a fixed location (not mobile) operation for relatively short, to extended periods of time. No protection in the form of shelter is provided for the equipment or operator. No improved antennas are provided nor are any of the unique requirements for tactical operation, such as operation in





Though mounting two RC-292 antennas on one AB903 mast increases range and mobility, it introduces new problems: increased power loss and possible radiation pattern distortion.

blackout, specifically considered in retransmission systems design.

The frequency management of the FM system and the mechanics of call sign assignment and net structure are accomplished though the Communications-Electronics Operative Instructions (CEOI). This paper system, published by NSA, is bulky and inflexible. It takes 13,000 pounds of paper to supply one division a one month supply of CEOI material. It takes a long lead time to change a paper CEOI format item such as is needed to support a commander's task assignment of his forces or even the simple change of adding or deleting a call sign. Low level codes used with the FM system are similarly awkward. Field commanders have been fighting for years to get subordinate units to use these low level, approved and effective codes rather than homemade, ineffective and down right dangerous brevity codes such as the point of origin method of coding grid coordinates.

Though the indicators sound like a litany, the tactical FM radio system has certainly demonstrated its robust nature for suboptimal performance by functioning as the major comm means below brigade level. However, with the emerging digital and other add-on devices like VINSON, digital message devices and facsimiles, the effect is to reduce the operational robustness. The system will fail if the root problems of these indicators remain unsolved.

Field units, while recognizing these problems and difficulties, have by and large been unable and incapable of establishing proper, lasting, effective fixes even with limited R & D command help. Many attempted, and still currently used, field fixes are marginally effective and frequently create new difficulties. For example: Large numbers of bad radios or matching units have resulted in field demands for better radio repairman training and crash drills to perform rapid local upgrades of equipment which cannot be sustained. Maintenance personnel are still unable to increase productivity and effectiveness without needed, proper and effective TMDE. No effective method could be established for proper testing of critical performance parameters. At best, equipment upgrade projects are short-lived and chronically needed.

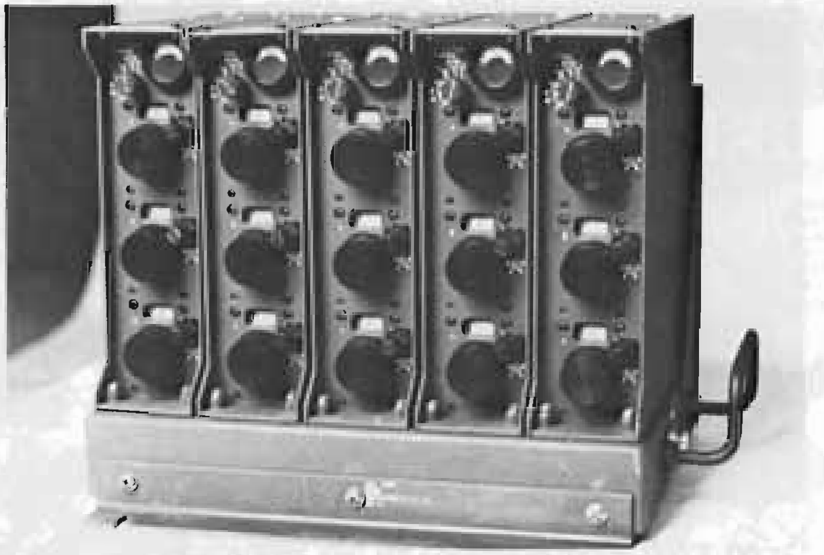
In an effort to increase radio performance, mobility, and reduce antenna numbers, two RC-292 antennas have been mounted on one AB903 antenna mast. While this action increases antenna height for increased range and reduces the number of masts, thereby increasing mobility, new problems are created. First, increased power loss in the longer coaxial antenna cable decreases power delivered to the antenna and reduces the benefit in range created by increased antenna height. The approximate 3 foot separation of the antennas is far too close and may result in severe radiation pattern distortions. Still, the adjustment problem of the RC-292 antenna during the nightly frequency change has not been solved.

Further attempts have been made at attaching up to five radios directly to one antenna. A photograph of such a field built multicoupler is at figure two. The result of the use of such a device is certain — though not immediate — failure of certain components in the radio. With sufficient "spare parts," radios abused in this manner can be kept operational for limited periods, but at excessive cost. This is an unacceptable solution, but the perceived need to reduce the number of command post antennas is sufficient in some instances to tolerate this practice.

Field expedient, directional antennas such as a half rhombic antennas have been well known for many years. Diagrams of such antennas are available in a number of Army publications such as survival handbooks. Some of these have actually been built and used. However, to get such an antenna to properly operate requires a properly designed balun or termination/matching device. Where does the soldier in the field find a 500 ohm impedance matching balun? How does he make one? The answer is, he can't. So the soldier ends up with an antenna that performs as poorly as the omnidirectional whip antenna he already has.

For retransmission stations, virtually every signal battalion in the US Army builds a plywood shelter to house the equipment and operators during extended operation,

This field-built multicoupler was designed so that as many as five radios could be connected to a single antenna. Almost certainly, it will cause some radio components to fail.



A properly designed multicoupler, the TD-1289, also makes it possible to connect as many as five radios to a single broad band antenna, such as the OE-254 — without causing radio component failure.

particularly in adverse weather. The design and effectiveness of such plywood shelters vary. Often the result is a fire hazard, increased electrical shock potential from a poorly installed grounding system, and only marginal protection for man and equipment. The overall result is hardly indicative of the world's premier military force.

GENERATING SOLUTIONS

What has the Communications Systems Engineering Program done to solve some of these problems? Examples:

First, to attack the maintenance failure indicators, a tool was developed for the organizational level FM radio repairman to check the critical performance parameters of the radio. This test set, the AN/PRM-34, enables the field mechanic to test the proper operation of the receiver, squelch circuitry, power output, and insure correct transmit frequency. Initially, 55 of these sets were built and have been field tested. Reactions like, "V Corps reports that the PRM-34 has proved to be absolutely essential in assisting managers to maintain correct FM radio alignment." The observations of V Corps have been mirrored in the 1st AD where the PRM-34 has been received with unbridled enthusiasm at both operator and managerial levels. It has filled what had been a void in our maintenance TMDE. The first production contract for this test set was awarded in September 1980.

Besides giving organizational mechanics the correct tools to perform their jobs effectively, a closer look was taken at the training they received. It was discovered that they were taught a lot about the radio itself but very little about how it fits into a system with power connections, various antennas, and other ancillary devices such as crypto equipment. This systems type training has been greatly expanded so that the mechanics understand how the radio sets in which they are primarily interested relate to the overall FM comm system.

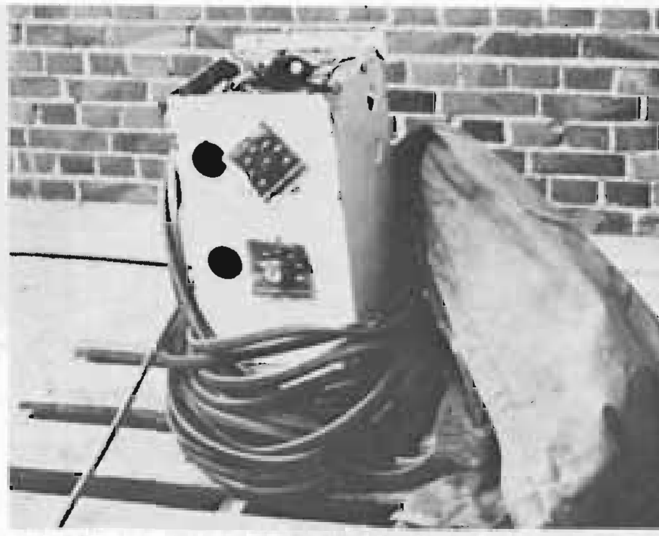
To enable the Direct Support maintenance repair effort, a series of actions have taken place and are ongoing. First, a properly built special tool, the MK-1978, has been built for each DS Maintenance bench set up enabling the repairman to properly interconnect his test equipment and radio. The device has built-in protection circuits to prevent such occurrences as accidently keying the radio into a piece of test equipment and damaging it. This is an immediate quick fix. It does not do anything relative to the antiquated test equipment, so a second effort has been made to find a compact, modern piece of test equipment to replace, for FM radio maintenance, the many currently discrete pieces of obsolete test equipment. A test set called the AN/GRM-114 was developed from a commercially available test set. Field tested, it has proven to be excellent for the job.

Besides the added benefit of a better, integrated test set, the AN/GRM-114 is small and greatly facilitates the use of maintenance contact teams for the concept of repair as far forward as possible. This has been in effect impossible with previous bulky and fairly delicate TMDE available. The first production contract award was made in September 1980.

The longer term effort has also taken place towards developing a fully automatic piece of TMDE. Seven models of a completely automatic test set with software packages for diagnostics, alignment and quality control began field testing in October 1980. It is anticipated that this test set will virtually revolutionalize the procedures now used in the DS maintenance shop.

Much has been done to help the FM radio system operationally. It was discovered, for example, that a broad band FM antenna, the OE-254, had been designed and built for use with the SINCGARS radio. Efforts were taken to expedite this antenna from depot stock to the field as a replacement for the RC-292, thus eliminating the need to readjust the antenna during frequency changes. To reduce the number of antennas needed to be set up in the command post, a development of a properly designed multicoupler device, the TD-1289, was accelerated with a first production contract award in May 1980. This device enables up to five radios to be connected to a single broad band antenna such as the OE-254.

The AN/PRM-34 test set enables the field mechanic to check the critical performance parameters of the organizational level FM radio.



Field fixes, such as home fabricated power transformers, are dangerous. The result may be lost communications -- or worse.

To compliment the omnidirectional antennas, two directional antennas have been built and field tested with excellent results. The OE-303, half rhombic antenna and OE-314 log periodic antenna provide significantly increased range and the added benefit of a degree of Electronic Counter-Countermeasure (ECCM) protection due to the directionality of these antennas. With these antennas, the field tactical communications officer now has the ability to tailor the communications system to better suit and support the commander and his needs in a wider class of situations.

Two other major developments which are taking place to improve the Tactical FM system are development of a properly designed FM retransmission/Radio Wire Integration system with all the equipment needed to fit a variety of missions and uses. A prototype should be completed in early 1981. A second development is the Hand-Held Encryption and Authentication Device, the HEAD, which can replace the currently used paper CEOI. This small, "pocket calculator" type device has the potential to revolutionize the current method of paper assignment of frequencies, call signs and use of low level encryption codes. Prototype devices have been built and are about to undergo concept evaluation. Electronic transmission of the CEOI can eliminate the delays inherent in printed paper. Greater ease of use will facilitate wide field use of low level codes.

All of these efforts towards improvement of the current tactical FM comm system plus a variety of others such as VINSON, SNAP (Steerable Null Antenna Processor, an ECCM device) and use of Digital Message Devices must fit in a logical, systems engineered way. It is the efforts of CSEP which will insure that these individual efforts succeed as intended and do not result in unforeseen failure due to a system oversight. The overall result is a viable, survivable, flexible and effective comm system for the field commander.

CONCLUSION

The ultimate reason for the continuation of a program is demonstrated results. Realizing that the purpose of the CSEP effort is to recognize and articulate problems and subsequently provide quick-reaction solutions where viable, two critical assumptions must remain valid. First, it must be understood and accepted that it may be necessary to cut across some of the traditional operating mechanisms and be able to capitalize on any existing methods for expedited action in the bureaucracy. Second, it must be recognized that the personnel resources working on and supporting the CSEP effort are the ones best qualified for the job and receive the authority commensurate with expedited action. The CSEP effort has demonstrated results and must continue towards its objective.

Actions are underway to more formally structure and support the program effort. This institutionalization has a number of essential facets which must take place. First, there is a need to establish a firm funding base with the availability of RDTE funds to identify and articulate problems, develop solutions, and field evaluate these solutions. Second, a method must be established to evaluate needs and provide needed procurement funds to support near term, quick reaction purchase of low dollar items faster than the current congressional budgeting procedures permit. Existing procedures which formally document and validate communications requirements must be streamlined, and unnecessary bureaucratic staffing, delays and inaction must be eliminated. Emphasis must also continue to be placed on development of realizable, affordable solutions to problems that meet the needs of the field that are not designed, and redesigned, and further developed to the point of obsolescence before perfection.

The CSEP program does involve some risk. These risks are carefully evaluated and calculated, but it is clear that quick reaction channels are needed.

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