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CHAPTER VII

GENERAL DEVELOPMENT

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This organization is the direct lineal descendant of the organization known in World War I as "Engineering and Research" and thereafter as "Research and Development." In January, 1942, a split was made into two segments, i.e.; "Radar (and Aircraft Radio) Division" and "General Development Branch," both of which are members of the Signal Supply Service. The Radar Division reports directly to Signal Supply Service, while General Development Branch reports to the Materiel Division. Broadly speaking, General Development Branch is responsible for all communication engineering and all sound and light equipment engineering for the Ground Forces of the Army. This involves more than simply research and development, for an engineering consultant service and an emergency engineering service have proven to be basic essentials to cope with the hundreds of requests which come through official channels for engineering services of all kinds on communications and electronic problems.

During the period between World War I and 1935, the Signal Corps development activities were barely kept alive. Due to lack of funds and of Signal Corps personnel, development was necessarily very spotty and entirely inadequate to maintain progress in an art (electronics) which had (by 1930) definitely emerged from its infancy and entered a decade of the greatest and most widespread and rapid advance ever experienced in any field of science. About 1935, with the advent of a trend toward small gradual increase in development funds, a period of increased Signal Corps development activity was started which, by the end of 1939, had just begun to bear fruit to the extent of placing a few modern types of equipment in the hands of troops.

Events of the spring of 1940 brought a new realization of the imagination and originality with which Nazi Germany had applied the advances of science to the art of war. Comparison of the standard United States communications equipment with that of the then-fighting-armies served to present clearly the great magnitude of the development and production task to be accomplished if, upon entry into battle, the United States Army was to be on at least even terms with its enemy in the field of communications and control, - two inseparable and vital elements of battlefield survial and success.

Past experience had indicated that the normal cycle of development for any new type of equipment was at least four years from first statement of military characteristics, through service tests, to the placing of production orders. It was obvious, therefore, that wholly unprecedented activity and decisive action were essential. Fortunately, military characteristics from most of the using branches were on hand or in process for new radio equipment; but, in the field of wire equipment, a less satisfactory situation prevailed.

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Therefore, based upon the foregoing estimate of the situation, the fiscal year 1941 witnessed what was, almost certainly, the most widespread and intensive development of military communications equipment ever attempted by the United States Army. Concurrently with this program, the enlargement and training of the Signal Corps development personnel was initiated and carried forward at an increased rate. Hence, the start of fiscal year 1942 found the Signal Corps development agencies engaged in a struggle against time:

To complete service tests.
Make necessary corrections.
Prepare production specifications.
Get production started on new items.
Improve already standard items for large-scale production.

As always, the enlargement and improvement of organization and the recruitment of competent electronic engineering personnel (together with training thereof) were most serious and difficult concurrent obligations.

The several successive, enlarged war plans and accompanying successive, enlarged procurements (which resulted from our actual entry into the war) required that the development organization reinforce the procurement agencies of the Signal Corps. From December, 1941, to the end of the fiscal year, the development organization has been engaged in aiding the production effort to the extent of at least 85% of its total capabilities, the remaining 15% being devoted to the research, new development and continuation of development work on the highest priority projects only. This is with the exception of wire communications development personnel, because, in view of the serious lack of adequate wire communications equipment, shorter development intervals were allowable; and about 75% of full capacity of this group was utilized on development work.

RADIO EQUIPMENT

There has also been conducted, during fiscal year 1942, a concerted effort to attain an ever-increasing amount of standardization and to reduce the number of types of Signal Communications equipment. These objectives have been basic and well-defined for many years; and a complete plan for radio equipment for the entire Army was formulated as early as 1936.

Thus, the intensive development program begun in 1940 was based in concept upon long-term planning for standardization to the extent possible, considering the many advances in the art, the differences in fundamental needs expressed by the Using Arms in their military characteristics, the time and personnel available for the negotiations involved in compromising these characteristics, and considerin the fundamental development and production techniques of the different communications equipment manufacturers and their machine tool setups upon which these techniques were predicated. Worthwhile achievements were planned and accomplished in standardization during this intensive period, some of which were as follows:

a. An integrated system of frequency-modulated command-radio sets, suitable for voice communication at two normal ranges, was made available. One of these two types is represented by Radio Sets SCR-503, SCR-528, SCR-539, SCR-608 and SCR-628. (The differences in type number indicate differences in frequency and of arrangement of components. For instance, SCR-503 has one BC-604 transmitter and two BC-603 receivers, whereas SCR-528 has one BC-604 transmitter and only one BC-603 receiver.) This type is a ten-mile voice-command set of outstanding performance, flexibility and simplicity of operation.

The other type is represented by Radio Sets SCR-509, SCR-510, SCR-609 and SCR-610, all of which look and operate exactly alike and are manufactured by the same manufacturer. (Their differences, also, are in frequency band and number of components.) This type of set is a four-mile voice set for short range reconnaissance, fire control and like purposes, extremely simple in operation.

The foregoing two types of radio sets are used by the Armored Force, Field Artillery, Tank Destroyer and Signal Corps.

Early in the fiscal year 1942, Signal Corps personnel demonstrated these types of sets to the Infantry Board and the Coast Artillery Board to promote coordination of communication equipment.

b. A multi-purpose type of radio set (SCR-284), to afford a one-set compromise for several applications, was designed. This SCR-284 set replaced the following types of sets, most of which were obsolete or obsolescent several years ago:

SCR-131	SCR-178
SCR-161	SCR-288
SCR-171	SCR-245 (in part)

c. A long-rang mobile radio set (SCR-299), for the conduct of radio communication between large, important, tactical elements of the Army, was designed. Unlike all of its predecessors, this set operates in its vehicle while the vehicle is moving at high speeds, and provides voice or telegraph communication at ranges of the order of 100 miles or more. This set replaces in part or entirely the following types of sets, i.e.:

SCR-177-( ) - in part
SCR-193-( ) - in part
SCR-197-( )

and is used by the following branches of the service, viz:

Air Force (long distance nets and ground-to-air communications)
Armored Force
Signal Corps (in Division, Corps and Army radio nets)

WIRE COMMUNICATIONS

The wire communications field was one of continually expanding activity during the past fiscal year. From a development standpoint, much has been accomplished to bring to completion, in the shortest possible time, projects designed to provide the Army (and especially the larger tactical units thereof) with modern wire communication systems of greater portability and wider range, requiring less material, less time and installation effort. Although much remains to be done to improve, refine and extend the usefulness of the new wire developments, it can be said that modern, long-range, rapid-construction wire telephone systems are now standardized and in production.

The principal equipments developed and standardized for this purpose are:

Carrier and Spiral-four Equipment (Components:
(Telephone Terminal CF-1 (Carrier)
(Telegraph Terminal CF-2 (Carrier)
(Repeater CF-3 (Carrier)
(Ringing Equipment EE-101 (voice frequency)
(Associated Cable Assemblies CC-358 (spiral-four)

This is the first application of commercial carrier practices to Army field-service equipment and provides much-needed long-line facilities. It permits high-quality, multi-channel communication for distances up to at least 150 miles, using the light spiral-four cable which can be laid rapidly, or up to at least 1,000 miles using open-wire lines. Four telephone communication channels are provided; and one of these four can be used to provide four channels of high-speed printer telegraph service. The bulk and weight of material for the carrier and spiral-four cable is approximately 5% of the lightest type open-wire construction which would be needed to provide the same amount of service using voice frequencies. It is anticipated that carrier equipment, plus spiral-four cable, will save over 1,500 tons of copper in the next year.

During the past year, emphasis has also been placed on development of teletype communication equipment, in view of the increased demands for this type of service. Telegraph-printer and central-office sets which permit field use of teletype equipment in Army Communication nets, and connection to commercial systems, are now in production.

STANDARDIZATION PROGRAM

Added large scale demands were placed upon the communications industry as this fiscal year saw the proving of the enormous practical value of radar equipment, rapid extension of this art into many SCR- applications, further extension of electronics into many new applications for airborne and ground radio frequency aids to aerial navigation, and into many new radio frequency devices for the control and direction of combat aircraft. These added demands upon the communications industry placed even greater emphasis upon the exercise of restraint, economy in types, and standardization of components.

The intensified program was reviewed and reorganized and new projects initiated after the formation (about the middle of the fiscal year) of the Army Communications and Equipment Coordination Board in the Office of the Chief Signal Officer, comprising representatives of all the Using Arms. Coordinated effort along the lines agreed upon was then initiated by this agency and the General Development Branch to maintain utmost economy in the types of communication equipment and to assure that no equipment was standardized which was not entirely essential for military use. On the other hand, the program included expediting to the maximum possible extent the standardization procedure for equipment which was judged to be essential.

As a part of this program, several worthwhile achievements were accomplished in the field of standardizing components, as follows:

a. Development of Head Set HS-30 was culminated. This had been initiated very early in the fiscal year for the purpose of providing a modern head set which could be worn underneath the new standard steel helmet, and which would be universal for all Ground Forces of the Army for all radio and wire telephone headset applications.

b. A standard plug and socket combination was developed. This was initiated as an Army Communications and Equipment Coordination Board case, with the assistance of the American Standards Association, and resulted in a plug and socket combination suitable for mass production from non-critical materials to replace the many different types of plugs and sockets in use throughout military equipment.

c. Standardization of dry batteries and general all-power supply units was actively begun and has resulted, to date, in the elimination of a number of types. Development away from dry batteries has also been prosecuted; and, at the close of the fiscal year, prospects were very favorable for the considerable reduction of the use of dry batteries.

d. A standardization program was conducted jointly with the Navy Department, with the objective of effecting a consequential reduction in the number of types of vacuum tubes utilized in the communications equipment of the two major services (Army and Navy). The objectives of this standardization were not only to reduce manufacturing difficulties, but also to enable joint use by both Services of stocks of spare vacuum tubes established throughout the world as joint operations became more widespread. This program was near a successful completion at the end of the fiscal year.

e. Increased emphasis was placed (near the close of the fiscal year) upon coordination of communications systems between the United States Army and Navy, the Armed Forces of the United Kingdom , and other members of the United Nations. Plans were in progress in General Development Branch to furnish liaison officers and engineers to British development establishments, and to continue and enlarge its active participation in the Combined Communications Board, its several committees and sub-committees.

SUBSTITUTIONS OF CRITICAL MATERIALS

One of the most serious problems encountered by the Signal Corps during the latter half of the fiscal year was the necessity for making substitutions, during production, for many critical materials. The activities in this respect grew to proportions which placed a severe strain on the engineering facilities of the General Development organization, both in Washington and at Fort Monmouth. However, it was possible to give full support and cooperation to the War Production Board in this program and to obtain, with few exceptions, the substitution of less critical materials for those which were so urgently needed for prosecution of the aircraft production schedule.

Production delays did result from this program of substitution but, fortunately, were not extremely serious. This was largely due to the fact that, in planning the development of new equipment in 1940, the use of critical raw materials had been minimized whenever practicable. At the end of the fiscal year, development work on substitution for critical raw materials were making progress, although the shortage of qualified engineering personnel was becoming an increasingly serious problem as the engineering needs continued to multiply.

A few examples of the substitution study which have resulted (or are about to result) in definite relief of critical items, are as follows, i.e.:

(1) Paper condensers for mica condensers, thus saving critical mica.
(2) Steel for aluminum generally throughout radio sets.
(3) Neoprene and vinylite resins for natural rubber.
(4) Porcelain, mycalex, vycer, glass, plastics, and polymers for critical steatite.

For the fiscal year 1942, savings were approximately as stated in the following partial list, viz:

Aluminum	650	tons
Copper	149	tons
Nickel	40	tons
Tin	18	tons
Zinc	26.5	tons
Rubber (crude and latex)	255	tons
Steatite	40	tons

For the fiscal year 1943, the following savings will be effected:

Aluminum	1809	tons
Copper	2734	tons
Nickel	85	tons
Tin	50	tons
Zinc	107	tons
Rubber (crude and latex)	3504	tons
Steatite	100	tons

QUARTZ CRYSTALS

Still another activity which constituted a large part of the engineering efforts of the General Development organization was the task of building up in the United States a quartz crystal industry adequate to supply the needs of military communications systems. This problem was complicated by many features. Prior to the war, the principal concern had been the assurance of an adequate supply of the raw material from Brazil; but, due to the prompt and energetic action of the War Production Board, the State Department and the Board of Economic Warfare, the raw material has not proven to be the most serious problem. The lack of a well-developed manufacturing technique, adequately instrumented to obtain production control, and the high accuracy and performance requirements imposed upon the crystal unit by the designers of radio equipment were the most serious problems. By the end of the fiscal year the total production was nearing the first million crystal units, and had been expanded to approximately 100 times the normal pre-war production rate.

With the extraordinary assistance of the Bell Telephone Laboratories and the Western Electric Company, there have been developed a standard manufacturing technique and manufacturing equipment for its institution. Those crystals which have been designed for mass manufacture, such as those in the two types of frequency-modulated sets described above, were being produced in adequate quantities to meet the rates of delivery and issue of the radio equipment; but much engineering work was ahead to obtain adequate production of the more difficult types. It appears that a continuing struggle will be necessary in the future to iron out all of the dark spots in the crystal picture. However, the problems are not impossible of solution, provided adequate engineering personnel can be diverted to this work.

ENGINEERING SERVICE

An engineering service, with liaison officers in the engineering sections of the other Supply Services (particularly the Ordnance and Quartermaster) was established to maintain up-to-the-minute coordination on engineering problems. Prime consideration of this group is given to proper provisions for the installation of Signal Corps radio and noise suppression equipment in vehicles designed, procured and issued by those Services.

The magnitude of the vehicular program, insofar as number of types of vehicles is concerned, the quantities under procurement and the number of different manufacturers engaged in producing those vehicles required the maintenance of Signal Corps inspectors in all of the plants concerned. These inspectors and engineers render technical assistance on problems of vehicular installation and ignition noise suppression. They are under supervision of the Detroit Installation Division of the Signal Corps General Development Laboratory, which location is central to all vehicular manufacturing activities.

To insure the proper and rapid installation of the various types of vehicular equipment in tanks, combat cars and trucks of recently activated Armored Force, Field Artillery or Tank Destroyer organizations, or for organizations designated as Task Forces (and which recently have received new vehicles), a number of engineering and installation field groups are equipped to make the required installations and instruct personnel in the proper operation of the equipment wherever required in the continental United States. Similar groups apply ignition suppression systems to those vehicles now in the hands of troops. The importance and scope of this phase of the General Development engineering service is readily appreciated when it is realized that field suppression groups are now active in overseas theaters of operation. They are applying suppression systems to the vehicles of troops soon to be engaged in active operations, so that radio reception will be unimpaired by interference from controllable sources, such as the ignition system of tanks and combat vehicles.

SPECIFICATIONS

The General Development Branch reviews, edits, clears, and distributes all specifications which are prepared by the Signal Corps General Development Laboratory. It also clears and distributes all other Signal Corps specifications. During the last half of the fiscal year, the volume of specification matters handled reached large proportions, as evidenced by the following:

21,000	copies of 3,398 specifications (approximately)
84,000	copies of drawings "
12,000	copies of parts lists "
30,000	photographic prints "

RESEARCH ACTIVITIES

As previously indicated, major efforts have necessarily been directed toward aiding production, and to a lesser extent toward research and development. A relatively small amount of research activity continues by the Signal Corps General Development Laboratory, but the trend is toward reduction of these activities in the Signal Corps in favor of more pressing production and development work.

The Office of Scientific Research and Development was activated by Presidential proclamation early in 1940, indicating the importance attached to basic research. An ever-increasing portion of the Signal Corps' research requirements have been carried on through an agency of the O.S.R.D., namely the National Defense Research Committee. Many important contributions (especially in the communication field) have been accomplished by this Committee, in close coordination with the Signal Corps. Some of the more important of these contributions are:

Speech scrambling equipment, permitting telephone communication over wire or radio circuits which is difficult for the enemy to decode;

Flash telegraphy equipment, making possible transmission of messages by telegraph (radio) in a form difficult to detect;

Improved direction-finding equipment for locating enemy radio stations;

Interference generating equipment for jamming enemy radio communications.

There is every indication that the excellent work of the National Defense Research Committee will continue; and an active group is maintained in General Development Branch for liaison with this Committee for the purpose of closely coordinating Signal Corps requirements with the N.D.R.C. It is felt that particular commendation is due to Committee C-1 (Communications) for the vision, energy, and complete competence which their exceptionally talented membership has made available to the armed services.

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At the close of the fiscal year, insofar as the major items of equipment for the Ground Forces are concerned, a modern radio set was in production, being delivered and issued to meet nearly all basic essential needs which had been determined and approved prior to the current fiscal year. Development work was being sacrificed to throw engineering reinforcements into the effort to enlarge the production flow. Certain needed equipment was still in the development stage, due to the time required for development by contractors or to inherent difficulties in meeting military characteristics.

Much remains to be done in the field of wire telephone and telegraph systems and equipment. New, modern equipment has been developed and is now in production, which will replace obsolete equipment and provide new types of the more important links of wire systems.

Current activities are being directed toward a more complete integration of the wire system as a whole, with particular emphasis on improved line construction and line maintenance methods and equipment, on improved field wire, and on telephone and telegraph repeater equipment. Broad technical studies of existing and proposed arrangements are being made with much greater frequency, in conjunction with Army Communications and Equipment Coordination Board studies.

As to the outlook for the future, it appears that improvement and refinement of present standardized equipment and the development of communications equipment for new applications (the importance of which has been emphasized by the character of the present war) will continue to tax the personnel resources of the General Development organization. Seemingly, the resources of the nation, insofar as electronic engineers are concerned, have been nearly exhausted; and conservation of this specialist group is imperative.