Chapter XV

The Electronics Center:

Communication Programs After 1951

Now the times have changed to a point whereby a Ranger has access to radio, microwave, and walkie-talkies for communications. Telephone lines are almost a thing of the past so I guess after all is said and done I was born too soon.

- Leon L. Lake[1]

The name of the Radio Laboratory was finally changed to the Electronics Center at the end of 1963. This was done to reflect "a general electronics development" program as compared to the "previous emphasis on radio communications." The change actually could have been made 12 years earlier.

No radio design projects were initiated or completed after the Radio Laboratory moved to Beltsville late in 1951. All efforts were directed towards assisting the Regions in radio procurement and developing specialized equipment for Servicewide communication needs. Staff duties were limited to handle specifications and certification, "noncommunications electronics development," and IRAC meetings.[2] Biggerstaff was in charge of the Radio and Test Section, Claypool headed the Electronic Development Section, and Loew and Erwin Wagner handled IRAC matters and Washington Office duties.

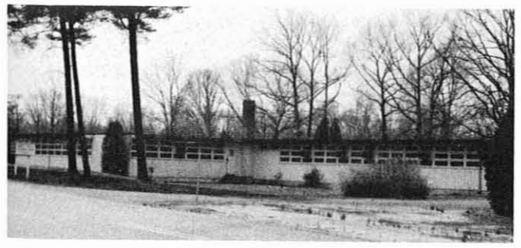

Figure 133. The Forest Service Electronics Center, near Beltsville, Md., in 1979. It is located in the large outdoor Agricultural Research Center of the U.S. Department of Agriculture, outside Washington, D.C.
(Forest Service photo, History Section)

The Region 1 radio network was one of the first matters taken under consideration in Beltsville. "I didn't agree with it," Loew reported, and he initiated steps to bring an end to its use. The response from Region 1 was reluctant and it became a matter of some contention with the Division of Fire Control in Missoula who, Loew said, "didn't think I was doing right by Region 1 by forcing the system out." Loew found the arguments for its continuation financially unjustifiable. Fire control was basically seasonal; the network required year-round funding. When it was necessary to compete with other programs for money "it didn't make much sense" to argue for the network when the telephone was more than satisfactory most of the year.[3]

Loew's next priority was a change in job classifications for the "fellows" who worked in communications. He was sensitive to Claypool's being passed over for the Regional communications position because he lacked a professional degree. Loew wanted to avoid this kind of situation in the future. He worked for a reclassification of job titles in line with the required engineering duties. Loew believed these men "...knew more about radio than most graduate engineers."

"I would hate to think," he confided, "what Fred Biggerstaff could have done with education." He pointed out that Claypool and Wood had technical libraries that would "swamp" most college professors. These men had "grown up" with radio; "...it

had been their whole life."[4] Loew's confidence in the technical abilities of his staff of two carried over to his respect for their administrative abilities. He did not interfere in the day-to-day operation of the Beltsville facility, preferring instead to maintain his office in downtown Washington, D.C.

At Loew's suggestion, Biggerstaff began consolidating the specifications common to all types of radio in the Forest Service, and separated them from the unique features of each set in order to make the bid process less complicated. His early experience as a fire guard and radio operator was helpful, and he established the goal of obtaining "...the best possible equipment, for the best possible price." Yet he recognized that, by definition, all specifications require "compromise" decisions.[5] He sought input from the field so the specifications would not become biased, and he initiated a system of unsatisfactory equipment reports (UR) on equipment at the suggestion of Francis Woods to double check against equipment problems that had not been detected during certification and compliance but showed up during use in the field.[6] Biggerstaff also valued factory inspections, meetings with manufacturers' representatives, and participation in professional engineering meetings as other ways to maintain his objectivity in making evaluations.[7]

This approach to procurement was unique in the Federal Government. By side stepping the lists of products approved by the Government Services Administration (GSA) he enabled the Forest Service to buy communication equipment at a discount averaging 30 to 50 percent.[8] This practice also permitted him to maintain an up-to-date, certified products list representing the state-of-the-art in available communication products.

Applied Research at Beltsville

Biggerstaff also crossed over into applied research. Always seeking a better way to determine radio performance, he developed measurement systems for the fault analysis of vhf-uhf antenna systems. This technique was adopted by International Bell Telephone Co.[9] Another accomplishment was the derivation of a system to measure close-spaced antennas in radio relays.[10] Perhaps a better measure of Biggerstaff's expertise was related by Gaylord Knight when he discussed an Institute of Radio Engineers (IRE) convention in Tampa, Fla. Knight had been amazed to find during the social functions and informal

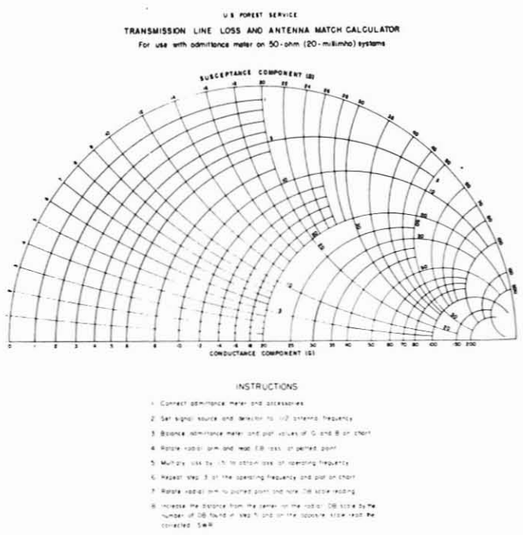

Figure 134. Transmission Line Loss and Antenna Match Calculator developed by W. F. Biggerstaff of the Forest Service Electronics Center. (Forest Service photo, History Section)

conversation that people who learned he was with the Forest Service invariably asked for an introduction to Fred Biggerstaff.[11] He also said, "I can recall time and time again sitting in with engineers from Motorola, RCA, and GE, who had Ph.D.'s, arguing with him over one of his findings, but none of them could back Fred into a hole; he was sound."[12] In 1960, Fred Biggerstaff was awarded a Federal Government "Superior Service Award" citing his "...exceptionally high and continued competency and performance in the field of mobile radio equipment testing and system's maintenance."[13] It was a long way from the CCC and his days as a machinist.

Bill Claypool's Beltsville assignments were primarily of a unique applications nature. With occasional support from Biggerstaff and, after 1967, help from a new member of the radio staff, Howard Webb, he investigated such instrumentation as fire-weather telemetering, a high-speed electronic intervalometer, thermoelectric power generation, and infrared fire mapping.[14]

In each instance, a Laboratory model was constructed and tested; in most cases, models went into commercial production and were bought for Regional use. Other projects ranged from transistorized test equipment to a talking beaver to a Region 3 display.[15] But Claypool got the most satisfaction from combining his mechanical and electrical skills on projects. Not infrequently, he would begin a project with solid aluminum stock and mill it out for a chassis, similarly construct rectangular and circular containers for shielding, and then incorporate the electrical components of his design. Claypool's electromechanical talents, observed a co-worker, bordered on genius.[16]

Figure 135. A signal generator designed by Wilbur Claypool and milled by him from aluminum stock at the Forest Service Electronics Center. (Forest Service photo, History Section)

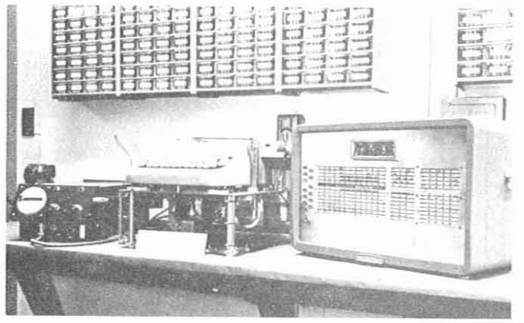

Figure 136. The recording components of the fire-weather telemetering system developed by Wilbur Claypool of the Forest Service Electronics Center. (Forest Service photo, History Section)

The Regions were given more developmental responsibility during Loew's administration. In one case, Carroll F. (Bud) Fontaine, Region 6 Communications Officer then on the engineering

staff, worked with Minnesota Mining and Manufacturing Co. (3M) to complete field tests on the Laboratory-designed thermoelectric power source.

This additional responsibility also carried over into the areas of design and modification. Fontaine learned that his involvement in this aspect of engineering led to familiar problems with nonradio people. On one occasion, William L. (Bill) MacDonald of the engineering staff, inspected the Regional "radio shop" for his supervisor. In his final report to the Regional Forester, he questioned the need for "a so well-equipped" facility. Fontaine was taken aback, even a little annoyed. "This was somewhat of a surprise to me," he wrote. He then proceeded to review the radio shop projects and the resulting large savings for the Service:

Project	Savings Over Commercial Models
Conversion of 500 SCR sets	$220,000
Design of RF wattmeter	$45 to $95 each
18 Conelrad alarms	$1,048
Construct Lowell-Fall Creek telephone	$8,000
Design of deviation meter	$376
Design of battery-operated VTVM	$59 each
Many miscellaneous improvements	Value Unknown

"We can understand," Fontaine concluded for the benefit of Assistant Regional Forester Raymond F. Grefe, the Regional Engineer, "where if a person loses sight of the magnitude of the communications' operation, they may not realize that we are accomplishing our work with a minimum of personnel and equipment."[17]

The level of effort prescribed by Kramer's office for Region 1 was having its effect. Most of the Northern Region forests were well-equipped with low-band FM radios in the 30- to 40-MHz range by 1957.[18] Construction of the Region 1 FM aircraft network under the supervision of Clarence B. Westcott was also in progress.[19]

High-Band Vhf and Uhf

The investigation of high-band vhf (152-174 MHz) and uhf (411-416 MHz) had been underway before the move to Beltsville. Once again, as in Gael Simson's administration, the Forest Service had the advantage of obtaining these frequencies when technology proved their importance. "Although we see no such possibility," Gordon Fox, Alternate Director, Division of Operations, informed the Regional Foresters in mid-1953, "It nevertheless is wise to be prepared and to develop an allocation plan which will permit today's limited use of these frequencies to be made in a manner that will mesh with any expanded use in the future."[21] Motivated further by a disruptive solar sunspot cycle that year,[22] Claypool undertook construction of an experimental dual low-band/high-band vhf test unit in anticipation of moving to the higher frequency.[23]

Developmental work and technical research projects were also requested of Guy Wood in Region 5. One of the first efforts was to investigate FM close-radio-frequency separations (200 kHz on 30- to 40-MHz and 500/700 kHz on 160- to 170-MHz systems). "This network design," he reported on his 1947 experiment, "facilitated establishing Forest and Regional FM radio systems using then available commercial FM radio equipment."[24] Preparing for higher frequencies, he equipped a lookout tower with three transmitters (30- to 40-; 162- to 174-, and 411- to 416-MHz) for test communications with mobile receivers. His data over several months suggested the value of high-band vhf, particularly in reducing skip interference. The Radio Laboratory subsequently recommended "...that a real effort be made to engineer all new networks on the high-band frequencies between 162 and 174 Mc (MHz)."[25]

Another contribution from Wood was Project SNUTS (Something New Under the Sun). The question of using solar cells as a power source for remote radio repeaters led him to undertake field tests at an early date. His efforts, reported in 1958, established the technical feasibility of the concept long before solar cells were economically justified.[26]

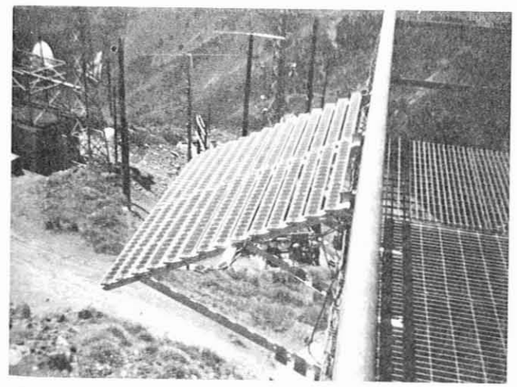

Figure 137. A 1958 project dubbed "SNUTS" (Something New Under the Sun) demonstrated the feasibility of using solar cells as a power source for remote Forest Service radio relay repeater stations. The pioneer unit was developed by Guy V. Wood, communications chief for Region 5 (California, now Pacific Southwest, Region). This photo shows a close-up of solar convertor unit at the test site. (Forest Service photo, History Section)

Contemplating retirement, Al Loew set about selecting his replacement. Meanwhile, Claypool took disability retirement. Several years before, in July 1961, Loew had promoted William B. (Bill) Morton from Region 3 to be his assistant in Washington IRAC matters. Morton accepted the Chief of Communications position. Biggerstaff retired the day after Loew, completing another major turnover in veteran personnel.[27]

Morton's Forest Service experience overlapped many of the significant communication issues of the previous 2 decades. Region 1 versus the Laboratory, telephone versus radio, the shift from AM to FM, and the trend towards centralized control were all familiar to him. After graduating from high school in 1940, he wanted to take aviation training in technical school, but switched to electronics when he learned the aviation

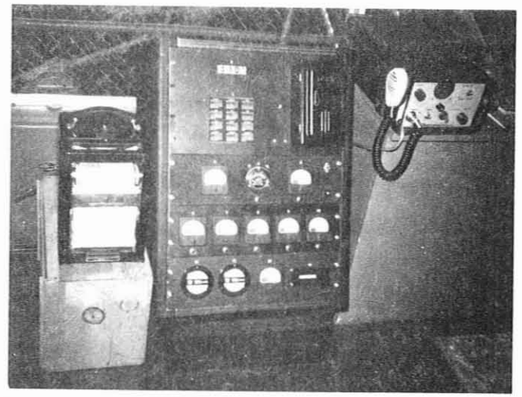

Figure 138. Instruments of the remote Forest Service radio relay repeater station powered by solar energy cells at a test installation in California. Developed by Guy Wood, shown left to right are strip chart recorder, special instrumentation, and the Motorola repeater unit. (Forest Service photo, History Section)

classes were filled. Before transferring to an Oregon college, he passed his amateur radio license exam (W7IOX, K3TGF, D4ABK).

Morton returned to Missoula 2 years later and became a member of Apgar's amateur operator call list for major conflagrations. This led to 6 weeks employment as a live-in station operator at KBCX before being drafted to serve in World War II. During the war, he decoded German messages for the Army Signal Corps at Eisenhower's European headquarters.

After his discharge, Morton enrolled at the University of Montana in Missoula and worked part-time at Apgar's KBCX while earning a degree in physics. He helped install the Collins transmitter that became an issue with the Radio Laboratory, and he was at Orofino for Biggerstaff's TDF/Collins test. "Personally, I think the Lab was wrong, technically, at that time," he commented much later on that exercise. Pointing out the difference between the 3 dB required for perceptible audio detection, as contrasted with only 1 dB necessary for a measurable change in RF power, he would side with the proponents of high power, at least on technical grounds:

> The matter should have been decided on policy issues. If a high-powered hf network was to be according to Forest Service policy, the extra power could often establish a margin of readability in marginal propagation and noise/signal conditions...The strong effect decentralization attitudes of the Forest Service had on communications policy /must be kept in mind/... The question, then, of high-power versus low-power is an issue only as it related to the requirements of centralization or decentralization and the use of the appropriate bands to meet these requirements.

After graduating from the university in 1948, Morton was assigned to the western half of Region 1 (northern Idaho) as the lone communication technician. Four years later, he was placed on temporary duty in Region 3 where he provided communication assistance for fire control. (While he was there, the first real Smokey the Bear was discovered on the Lincoln National Forest.) Years later, he remembered pondering the state of communications in Region 3 after returning to Missoula. He recalled expressing the opinion that he would not care to be a part of the Southwestern Region's communication problems. Yet, a few months later, in September 1952, Morton accepted the communication position in Region 3.[28]

The communication system that Morton confronted was backward, at best. Telephone lines served most of the Southwest. The lines, built by the Signal Corps on metal poles to keep the Apache Indians from burning them down, were turned over to the Forest Service by the Army after the Indians were subdued. Not surprisingly, the state of radio was not much more advanced. He had a limited amount of 3-MHz equipment and two technicians --one each for New Mexico and Arizona. Morton's first priority was the elimination of "psychological barriers." Wind and sand-precipitation static on the hf frequencies had fostered negative attitudes towards radio. When he left 9 years later to accept the Washington appointment, Region 3 had an FM network, employed technicians for each of the 12 National Forests, and "had a lot less telephone line."[29]

Regional Responsibilities Increased

The responsibilities of the Regional communication officers increased as Loew, Claypool, and Biggerstaff left. Morton supported and encouraged a more decentralized approach towards Regional communications, although he did not put the emphasis into written policy. His philosophy was: "Do your job, and we'll help you all we can."

Morton viewed the Electronics Center as a service agency for the Regions. Questions on number and type of equipment were to be left to the discretion of Regional authorities. If the Regions needed to know the capacity of a given number of sets to handle traffic, required special permits, had problems with frequency assignments, or wanted to know what commercial equipment was available, the Center would be quick to respond.

Techniques or problems too complex in scope or too costly for the Regions also remained the Center's responsibility. "The revision of the Forest Service *Manual* to establish communications policy; the defense of Forest Service procurement policies against bureaucratic and money-wasting GSA policies; promoting development of the 9,600-channel FM aircraft radio as a necessary base for nationwide fire aircraft operations;..." and satellite communications, first used in 1975, were examples.[30]

Morton believed these functions gave his group a unique quality--a quality that had accrued during the history of Forest Service two-way, land-mobile communication, certification, and specification. This reputation generated requests for assistance from other Government agencies, ranging from Laboratory design assistance to Claypool's assignment to the Mexican hoof-and-mouth program, and took Morton to New Zealand and Saudi Arabia as an advisor. "When Fred Biggerstaff first started he had to argue with the manufacturers about a test. Now we are quoted by others verbatim, as a result of the reputation he established."[31]

Administration of the communication program came full circle after Morton's appointment. It had begun with a decentralized approach, followed by more control during the Duvendack-Loew years. Morton was able to loosen the administrative ties because most points of contention had been removed between 1947 and 1967. After 1967, the Federal Telecommunications System (FTS) provided a less restrictive alternate communication source, Regional fire radio systems were well established, and a recognizable body of expertise existed in the communication profession and industry.

Two further developments removed much of the guesswork associated with earlier communication systems, reducing the need for Washington control. They were a Servicewide attempt to define systems communication planning and the establishment of an interagency fire cache.

Centralization of fire equipment inventories evolved early because the costs of purchasing and maintaining maximum levels of equipment for each National Forest were prohibitive and resulted in unnecessary duplication. During major fires, the equipment could be flown or shipped as needed to particular hot spots. In Region 1, for example, this expanded into such systems as a remount depot for supplying pack horses, a fire equipment center in Spokane, and a separate cache for the smokejumper's headquarters in Missoula.

The concept was also applied to radio inventories and resulted in establishment of a broad Federal Government fire equipment warehouse at the Boise Interagency Fire Center (BIFC). It was made up of the National Oceanic and Atmospheric Administration, the Department of Commerce; Bureau of Land Management, Department of the Interior; and the Forest Service. Large-fire communication systems were made available on an as-needed basis to these three agencies. BFIC retained control of maintenance and procurement; replacement of existing inventories was in accordance with the guidelines of the National Telecommunications Study.[32]

Thus, a part of the communication responsibilities in the various Regions devolved on BIFC, and Regional communication inventories decreased correspondingly. The Forest Service continued to make purchases in accordance with its needs, but the cache relieved part of that responsibility, allowing the Regions to coordinate purchases for their own use in harmony with the systems available through BIFC.

The first generation of Forest Service communication officers knew systems planning; each one had to give attention to the capability of their communication systems to perform certain prescribed fire-control tasks. These efforts at first ranged from the detailed maps and charts of Bill Apgar to the Region 3 inventory system of "this is what I have, this is what I want."[33] As time went on, new communication elements were added and the planning phase became more complex. Fire camps, fire bases, lookouts, slurry bombers, smokejumpers, observation planes, repeaters, Ranger stations, National Forest headquarters, and air bases might all be in need of radio communication on one fire. Communication officers realized their limitations in planning the proper number of radios, the exact assignment of frequencies, and the traffic-carrying capability of a network.

Al Loew recognized the seriousness of inadequate capability of a fire network to provide service consistently to all users. He assigned a committee chaired by Bill Apgar to review the problem at the 1953 communications conference. The other committee members were the Communication Chiefs for Regions 2 and 3, Roy L. Weeman and Bill Morton, respectively, and the Assistant Fire Control Chief in the Washington Office, Boyd L. Rasmussen. Its systematic approach bore Apgar's imprint.

It was suggested that a mock "battle condition" be duplicated. "Through the use of (1) sealed envelopes, (2) containing action instructions, (3) to be executed in accordance with carefully worked-out times, and (4) in a completely manned Forest with all clocks synchronized just about any kind of a fire condition that can be envisioned could be duplicated and the necessary communications messages fed into the network."[34] While the approach had some merit, it lacked administrative support and was not implemented. However, it did anticipate the complex fire simulator developed later.

Fire Communication Needs in the 1960's

The problem of determining the communication needs for the many elements involved in a fire fight continued to be a problem into the 1960's. Region 6 reviewed these issues after the 1960 fire season and suggested a number of recommendations to correct deficiencies. A shortage of radios, lack of communications with other agencies, need for temporary relays, and

assignment of fire-radio frequencies into an integrated network all suggest that the logistics of communication were becoming more complex.[35] Hoping that an estimate of network capacity could determine the optimum number of radios, the Pacific Southwest Forest and Range Experiment Station (PSW) in Berkeley, Calif., contracted with Paul Rech at the University of California, to seek a solution using mathematical theory.

In 1964, Rech selected a mathematical model based upon machine repair problems. He utilized queueing theory, probability, and statistics to come up with equations for estimating "...the maximum number of radio sets which can be in operation in a given Forest net and/or the number of channels needed to insure adequate communication."[36] It did not take into account such factors as repeater links, radio interference, commercial communication sources, and topography, so the study provided only the foundation for a more precise followup.

Four years later, after additional work by Gideon Schwarzbart of the PSW Management Sciences staff,[37] a Communications Study Task Force was appointed from staff of the various divisions of the Forest Service. This group met in Washington during mid-1968 to consider objectives, scope, and a suggested approach. The Task Force noted the numerous problems in the system that cost $21 million and $3 million annually for replacement and maintenance.[38] At the Task Force request, Schwarzbart and Ernst S. Valfer of the Management Sciences Staff at PSW completed both a system-design criteria study and, with Prem S. Puri of Purdue University, an applications study on network operating characteristics.[39] The Task Force recommended a Servicewide telecommunications study to "...evaluate the management of the radio systems needed to satisfy the communications requirements of present and future Forest Service programs."[40] On July 1, 1970, the Forest Service approved the guidelines as a method "...for setting up requirements, financing procedures, and organizational structures for Communication Management."[41]

During the 18 months of the telecommunications study, a concerted effort was made to gather fire-radio network data, get a composite picture of Servicewide communications, and project the uses of communication systems in areas other than fire control. An all-Region conference was planned and study team members were assigned specific topics for evaluation.[42]

The complexion of Forest Service communications had changed considerably by this time. FTS, automatic data processing, leased lines, telegrams, and the mails--all combined to replace A. T. & T. for administrative use. Networks, the mere mention of which would have brought paroxysms of anguish 20 years earlier, were evident in Forest radio nets, zone-fire radio nets, fire-cache radio nets, and air-radio nets.[43] More significant, radio had long since outdistanced the telephone in Forest Service inventories. Between 1947 and 1959, radio inventories had increased almost fourfold, and Forest Service-owned telephone lines had decreased to one-eighth of their earlier postwar total. By December 1969, there were 22,123 radios and only 7,482 miles of Service-owned telephone lines.[44]

Communications technology was affecting the Forest Service administration. Policies in force for years now came in for criticism by the general public. Tommy R. Hensley, in a draft of "New Technology and Its Possible Applications" for the Telecommunications Study, gave thought to what he called the Communication Revolution and its effect upon Forest Service programs, public lands, and resource management practices. He noted the public's mounting criticism of these policies and the inability of the Forest Service to respond properly because of a "lack of good monitoring" of the effects of management on all resources under its control. Hensley called for an extension of new technology to "improve our field communications." Recognizing that "knowledge power" had shifted over the years from the exclusive domain of the "special interest" to the "general public," he expected "...that the public will become more and more knowledgeable and more and more effective in voicing their conclusions about resource management."[45]

The Telecommunications Study Group findings were thorough, all-encompassing, and voluminous. The work was published in four volumes in November 1972, with an additional two volumes of appendixes.[46] Much of the study was directed to historical issues.

It noted that one frequent criticism of both the Radio Laboratory and the overall communication policies of the Forest Service was the long assignment of the Radio Laboratory to Region 6. This situation created problems in its relations with other Regions, leading them to treat the Radio Laboratory as an organizational equal, not a superior. Lacking a defined place in the national organization, the Radio Laboratory had "developed somewhat like an orphan child." Without a specifically assigned Service-wide responsibility for management of the radio development program, the Laboratory could provide no more than technical support. "It has not been planned," pointed out the Telecommunications Study Group, "but /it/ has evolved because of the accumulation of piecemeal actions." The group concluded, "In short, there has been no specific organization entity at the WO /Washington Office/ level to develop and handle a management system that would allow fully justified field telecommunication needs to be consolidated at the Washington level."[47]

Study Stresses Value of Leadership

In a tone that would have pleased Jack Horton, the study reiterated the benefits of direction and coordination that accrued from effective management leadership. "This leadership must start at the Washington Office level and pervade the entire field /of/ telecommunications organizations."[48]

The study pointed out that the lack of financial support for the radio development program had created cumulative costs of obsolescence estimated at $6,300,000 by 1971. Blaming this on a 33-year-old budgeting system, the group found fault with the delegation of planning authority to the line officers--from District Rangers through the Regional Forester. Even though they did not have the funds, these administrators were planning and approving a level of field communications that could not be achieved. "Consequently, the Regional electronic organizations are receiving criticism from line management for not providing the level of communications planned and approved." From the standpoint of the communications officer, it was "a bleak looking situation."[49]

For the first time in the history of Forest Service radio, it was possible to critically compare radio systems with telephone systems. The radio provided consistent year-round operation and also ushered in other developments such as airborne operations and better area coverage. "Radios do all of this now at equal or less cost per month than a leased commercial telephone."[50] If the Forest Service had still maintained 63,125 miles of telephone tree line at a per-mile cost of $25, the study reported, the estimated annual maintenance costs would have been $1,578,125, with no more field coverage than in 1940.

In an attempt to give credit where credit was due, the Telecommunications Study Group complimented those directly involved in the history of Forest Service communications. By separating the problems of policy from the accomplishments of action it was found, in spite of the handicaps, that:

> A meager force of engineers has worked with the technicians within financial constraints which preclude consideration of really viable alternatives and have had demands made on their time for assistance in a multitude of areas other than field communications. Historically the Forest Service mobile radio systems have been examples for others to follow. This has been accomplished, in a large part, because of the dedication and tenure of the engineers and technicians.[51]

In some respects, it is not possible to find fault with the administrative levels of the Forest Service for not recognizing this point a generation earlier. But if hindsight has its advantages, leadership also has its responsibilities.

Many factors kept the Washington Office from recognizing the benefits of unrestricted application of radio; indeed, the applications could have been formulated as early as Beatty's demonstration. The A. T. & T. lease agreements posed the most apparent barrier. But a more insidious factor was the ever-present, pervasive concern that the Forest Service might cross the fine line between private enterprise and Government involvement and perhaps even approach socialism. Constant reminders of the secondary role of Forest Service radio vis-a-vis A. T. & T. leases, protests over the failure of commercial entities to supply commercial radio equipment, and the resistance towards policies reflecting able management occurred time and again.

This reaction was perhaps not out of the ordinary, given the time and the circumstances. It could not have been expected that the concept of lightweight, low-power, portable radio would have such limited application for so long, or that the Government would need to involve itself in set production. Even the best informed opinions, undoubtedly, gave the Radio Laboratory no more than a 5-year existence. It appeared certain that private enterprise would have suitable equivalents on the market long before the Laboratory could become a permanent part of the Forest Service. When 5 years passed with no change in the situation, the inevitable only moved 5 years closer, and there was even less reason to invest further in the Forest Service radio development program.

The Forest Products Laboratory (FPL), for example, established by the Forest Service in Madison, Wis., in 1910 to test and develop new forest products, was considered supportive of, not antagonistic

to, big business. The initial investment of FPL included a staff of 20, a payroll of $28,000, complete test equipment, and abundant test materials.[52] In 1946, during the 14th year of its radio development program, the Radio Laboratory had only seven employees, a budget under $28,000, and not enough laboratory equipment to adequately measure the performance of a single Forest Service radio set.[53]

In this context, the Radio Laboratory was placed in the organizational hierarchy where it would have a low profile. It was no accident that this situation persisted and that the Washington Office scorned pleas for more effective leadership. Once it was certain that private industry could supply radios to meet Forest Service standards, George Duvendack was appointed to the long-needed position of communications czar. But the Radio Laboratory could not claim the legitimacy it had been denied for 15 years. Unfortunately, the changed commercial scene eliminated the reason to continue its existence as a producer of radio sets.

Broad Accomplishments of Radio Laboratory

For 20 years, the staff at Portland was handicapped by lack of resources and leadership. Yet, ever after a virtual shutdown during World War II, it still took private enterprise 20 years to catch up with the Laboratory. The Laboratory staff never went above eight employees, yet they designed, modeled, tested, produced, inspected, and shipped an array of hf and vhf portables, semiportables, and fixed-base units second to none. As the Telecommunications Study Group correctly observed, "They have constructed and maintained literally hundreds of systems--systems which warrant no apology."[54]

The accomplishments of the Radio Laboratory went far beyond the bounds of the Government agency for which it was intended. Both the military and private industry benefitted in ways that transcended technical application. The responses of Motorola, GE and RCA during the Duvendack-Lawson 1947 exploratory trip to eastern manufacturers indicate a considerable technological spin-off from the design efforts of the Radio Laboratory.

Fred Link, the unofficial dean of FM radio design, reviewed this contribution from his vantage point some years later. He recalled the Forest Service reputation for simplifying circuit designs and producing sets that withstood bad weather and abusive treatment. Link remembered investigating Forest Service sets at his laboratory in New York City and a number of visits with the Radio Laboratory staff. He agreed it was fair to conclude that Forest Service radios contributed to lightweight, low-power technology. "I would never say, Link emphasized, "that industry led the way in this regard." In any event, he concluded, "The Forest Service certainly had an impact on Fred Link Radio."[55]

The impact of Forest Service radio upon the frequency, duration, or intensity of forest fires cannot be documented. Coincident with the development of radio were such other advances as fire-weather forecasts, additional access roads, better machinery, new firefighting techniques, increased manpower, and public education. Each affected the other; the historical record reflects only the aggregate.

There were many instances of radio influencing potentially catastropic situations, saving lives, and averting the destruction of property. Few Forest Service fireline personnel are at a loss when asked to recount such experiences. Some anecdotes have even become legend.

An influence more difficult to measure is Bristow Adams' speculation in 1906 about the psychological benefits of electronic communication in the Forest Service. Yet here is the ultimate measure of the Radio Laboratory accomplishment.

The level of judgment and the degree of confidence, emotion, and physical durability that an individual takes to the fireline are directly related to the effectiveness and reliability of the tools at hand. The complexity of these tools may at times be a handicap. A chain saw without gasoline is not equal to the axe.

This latter point was emphasized during a visit by this author to the Missoula Aerial Fire Depot in 1978. After a tour and briefing, the conversation came around to a discussion of the soon-to-be-installed, 9,600-channel communications system. Several staff members were uneasy about the new technology, but most felt that the system would provide a higher level of fireline control.

Milton "Cookie" Calloway then asked a question that brought silence. As a veteran pilot for countless air drops of equipment and smokejumpers, he had lost track of the number of times he had decided whether to place himself and his cargo in jeopardy. He was used to billowing clouds of dense smoke, narrow canyons with vicious downdrafts, and low-level flights over the tree tops. Yet, he wanted to know if the Fire Depot Operations Center would be able to continue its practice of placing a check call to pilots every 30 minutes. He wanted reassurance that if he failed to answer this call and a subsequent call, a search and rescue mission would be launched immediately. This function of the radio was the most important to Calloway.[56]

Dwight Beatty and those who followed him at the Radio Laboratory recognized that radio was more than an electrical box permitting two-way communication; it was a tool that allowed men to extend their abilities in the face of adversity.

Simple, rugged, and reliable were more than adjectives; they were design commands. In today's language, human engineering was the first watchword at the Radio Laboratory. It captures the essence of the Laboratory's contribution to radio science and the men on the fireline.[57]

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4. Loew, interview with author.

5. W. Frederick Biggerstaff, interview with the author in Saratoga, Calif., January 1978.

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21. Gordon D. Fox (Washington Office) to Regional Foresters, 13 August 1953, Gaylord A. Knight Collection.

22. *Electronics Center Newsletter*, no. 19, December 1963.

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Leader), Valfer, William P. Kennedy, and Miles R. Hall, all of PSW; Jack F. Carter, R-5; Karl W. Spelman, R-4; Bill Morton and Tommy R. Hensley of the Electronics Center; Chester A. Shields, Director, and Lewis E. Hawkes, Administrative Management, Washington Office, and Merle S. Lowden, Director, Fire Control, Washington Office. Hawkes had come in from R-3. Others were added as the study progressed.

42. Edward W. Schultz [Deputy Chief, Forest Service, for Administration] to Regional Foresters, 5 Ausust 1970, Gaylord A. Knight Collection. Memo includes roster and agenda.

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48. Forest Service, *Telecommunications*, vol. 3, p. 7.

49. Forest Service, *Telecommunications*, vol. 3, pp. 67, 68.

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53. [D. S.] Nordwall, "Memorandum for the Record--Radio Laboratory Inspection," 24 March 1947, app., Gaylord A. Knight Collection; F. V. Horton, "Memorandum," 19 May 1946, National Archives and Records Service, Seattle, Wash., Box B4266; Harold K. Lawson, interview with the author in King City, Ore., May 1978; and W. Frederick Biggerstaff, interview with the author in Saratoga, Calif., January 1978.

54. Forest Service, *Telecommunications*, vol. 3, p. 45. The Study Group was equally complimentary to the entire communications organization of the Forest Service.

55. Fred Link, telephone interview with the author in Denver, Colo., 26 January 1979.

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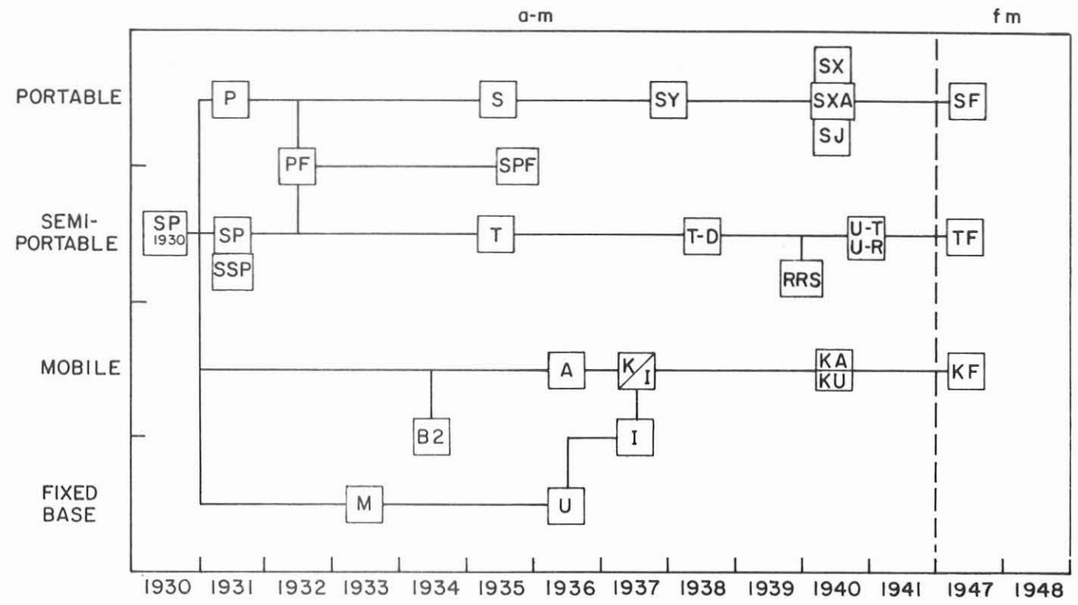
57. The radio function was realined in the Washington Office in 1980-81 under the Computer Technology and Telecommunications Staff--at first renamed Radio Management, then changed back to Communications and Electronics, and finally Radio and Electronics--with some shift in responsibilities. There is a basis for some concern over the potential for misjudgment. *Radio for the Fireline* recounts many of the problems associated with past administrative decisions of a like nature. It is hoped that this history will provide a more thorough understanding of the relationship of telecommunications planning to other Forest Service programs, as well as point out a priceless legacy, and a future, which "warrants no apology."

Appendix I

Forest Service Radio Models—Photos, Diagrams, and Data

Chronological Development of Forest Service Radio Sets, by Type and Function



Hf Types

100 meters (2.9–3.5 MHz)

(NA:95G-249757)

SP - 1930

Designed by:	Dwight L. Beatty, 1930
Number produced:	9
Price:	$140
Models:	Original only
Frequency:	3 MHz
Transmitter:	1 watt, c.w., AM
Receiver:	Regenerative
Antenna:	Long wire with counterpoise
Dimensions:	6 x 14 x 8"(radio only)
Weight:	17# 14 oz. (79# 5 oz. complete)*
Principal use:	Test purposes
*Comments:	Radio: 17# 14 oz. Equip. case: 11# 11 oz. Antenna equip.: 5# 12 oz. Battery with case: 44#