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Engineering Technical Information System

FastTrack Mapping at the Geometronics Service Center: A Study in Continuous Quality Improvement

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In January 1990, the Geometronics Service Center (GSC) embarked upon a journey toward improved quality of our products and in our worklife, by committing to a program entitled Continuous Quality Improvement (CQI). CQI is similar to the Total Quality Management (TQM) focus growing within the Forest Service today. The differences are not significant; what is significant is the progress that has been made because of CQI.

One of the most familiar products of the GSC is the Secondary Base Series (SBS) map. As the foundation of the Forest Visitor Map, it is readily recognizable to Forest personnel and the public alike. The creation of an SBS map is a complex process, one which requires a great deal of cartographic skill and knowledge. Unfortunately, it is also a process which has taken a disappointingly long time from start to finish.

As a part of the CQI process, we at GSC turned our attention inward, on the methods we had been using, and asked ourselves the hard questions necessary to improve quality. Secondary Base personnel diagrammed the steps in the process then in use, and found ways it could be streamlined. During development, the process was given the nickname "FastTrack mapping," and the name stuck. As the process evolved, some steps were eliminated, some were relocated, and many were "stacked" — a term we devised to describe doing tasks simultaneously, rather than consecutively. We discovered that stacking was the real key to shortening the time necessary for completing a map, but we didn't quit there.

After determining that the realigned process would work, we began to realize there were ways to speed up the process even more, without sacrificing quality.

We looked harder at the process (see Figure 1), and realized that there were only three things we needed to create an SBS map. First, we needed a "mockup," or simple diagram prepared by Regional and Forest personnel, showing the area the map was to cover (see Figure 2). With that in hand, we could begin gathering information from various sources. Second, we needed recently completed Primary Base Series (PBS) information (the 1:24000 scale, 7.5-minute quadrangle maps), to assure that the map would reflect current information. Through judicious scheduling of projects at Program of Work meetings, this could be accomplished. Third, we needed some input from

SECONDARY BASE FASTTRACK FLOWCHART

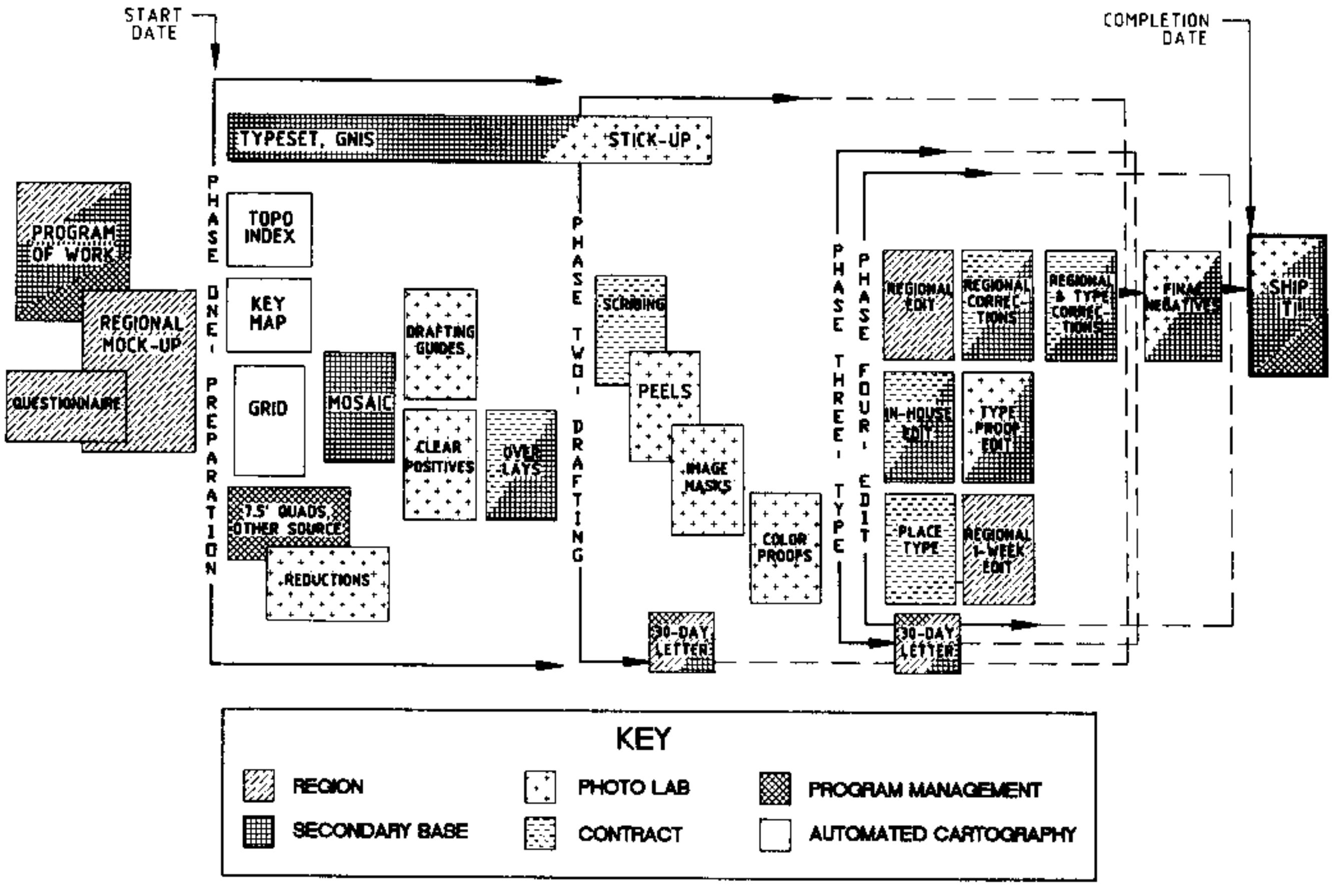


Figure 1.—By diagramming the process we used to produce a Secondary Base Series map, we were able to identify what we did, how we did it, and what could be contracted, "stacked," or eliminated. This is the result of several weeks of "trimming" non-essential steps.

Definitions

Topo index: the index to topographic maps. Grid: the 7.5 minute geographic coordinates at 1:126720 scale (1/2"=one mile). Mosaic: a composite of 7.5' PBS maps in negative form, reduced to SBS scale. It is used to photographically create a set of negative-engraving layers, used to produce (1) the scribed linework map layers, and (2) a photographic positive (clearfilm) copy. Overlays are mylar sheets registered to the map showing additions, deletions, and changes. Scribing: negative-engraving plates. Peels: "open windows" to photographically add color areas. Image mask: used to block color or linework. Color proof: a visual representation of the composed map layers, as the final printed version would appear. Type: the lettering on a map. Final negatives: photographic layers, ready to be sent to a printer.

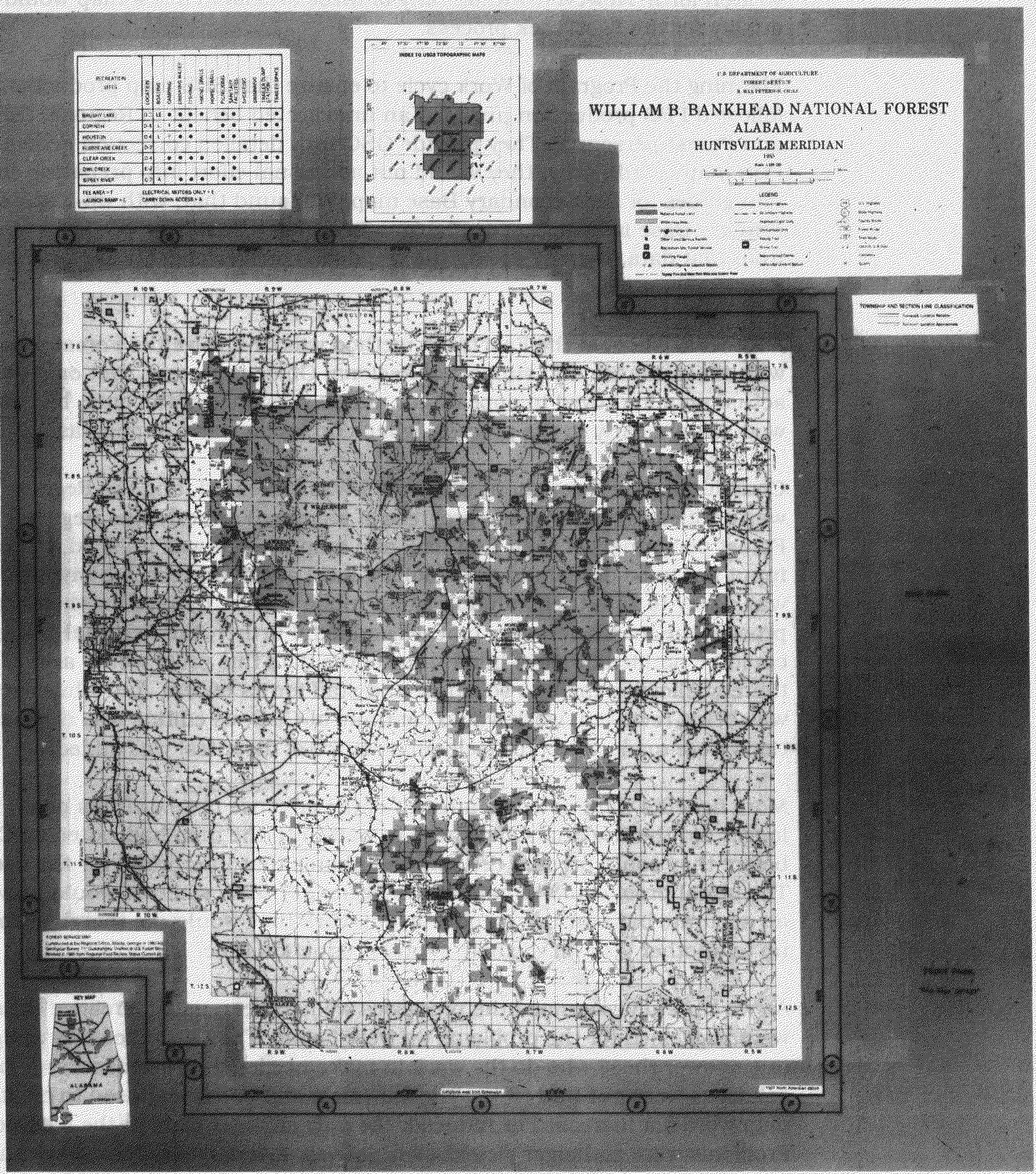


Figure 2.—A mockup may consist of an old copy of a map, accurately positioned on the correct size sheet. Alpha-numerics, legend, position of the index to topographic maps, key map, and recreation indexes should be shown. Somtimes, when a map is to be completely redesigned, a mockup may be little more than geographic coordinates or Township and Range lines indicating the actual map area. The earlier the mockup is received at GSC, the earlier preparation can begin.

Regional and Forest personnel that would enable us to tailor the map to their specific needs. To simplify the gathering of this information, we developed a brief questionnaire, which can be completed using the Data General, or in written form. However, without any of these crucial items, a map would not qualify for the FastTrack process.

Planning the Program of Work cycle to ensure that SBS map production followed PBS production provided an unexpected benefit to Regional Office and Forest personnel. They provide GSC with detailed correction guides for PBS maps. Ordinarily, they would put additional effort into preparing correction guides for the Secondary Base map. We found that, with up-to-date Primary Base information available, a Secondary Base map could be produced from that data, thereby easing the workload considerably for Regional and Forest personnel.

Another offshoot of the FastTrack method was to involve the Forest personnel, with the guidance and support of Regional Office personnel. Not only was the actual map improved in appearance and in relevance of the data, but errors were caught early in the process, when correction was a simple task.

Communication throughout the project was increased, and the Regional Office was notified regularly of the progress of its map. Formerly, the Regional and Forest personnel got their first look at a map when it was finished, too late for input not to be devastating. By looking hard at the process, we saw that there was a way to gain their valuable input much earlier, by sending them a color proof of the map before any type was added. Further, the Regional Office could be notified 30 days in advance of the date this proof would arrive, thereby allowing them to schedule and staff for its review. And while the proof was being reviewed, work would continue at GSC, as editing was done, corrections were made, and type (seldom a source of disputes) was added.

More benefits were noted as a result of the advance review of this proof. No longer did the Regional Office have to wait until the map had exited GSC before they could prepare the text and photos that interpret it for the user. The initial proof could remain at the Regional Office, where it would provide an accurate base for the graphic layout work they would do, thereby trimming up to another year off the map's total production time.

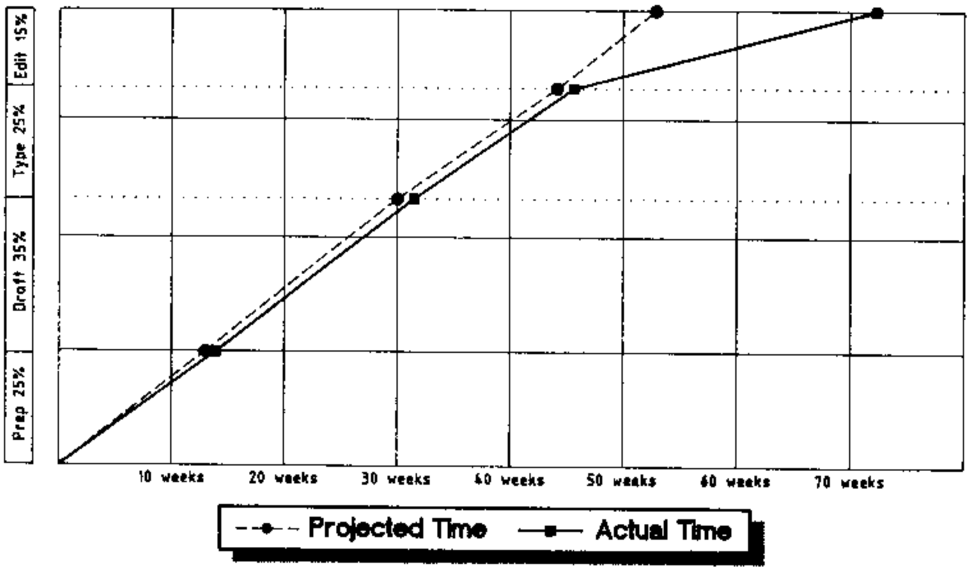
As we carefully examined the processes we had been using, creative solutions were suggested for the problems we were facing. The CQI process is designed to empower those who do the work to make needed improvements, so our solutions were put into effect. The materials and personnel used to create the map were not increased or reduced; the only changes were in the methods. Problems were no longer viewed as negatives; instead, they took on the aspect of positive challenges.

One of the basic aims of CQI is to eliminate surprises, or more accurately, disappointments. Therefore, planning and evaluation became even more necessary, and the involvement of everyone in the unit was essential. Instead of one person assigned total responsibility for a particular project with little authority to ensure its success, ownership in all projects became the norm. Weekly production meetings, where all projects currently in work were discussed, encouraged involvement of all unit members, regardless of their grade level. New, untried solutions were attempted; old, previously unsuccessful methods were resurrected and modified to fit the current situation. Some succeeded; some failed. But no failure was seen as a reason to lay blame; rather, it was dissected carefully and used to the benefit of other projects. More importantly, no project came to a halt when a barrier was encountered. The barrier was identified, and the whole team went into action to find a way to surmount it.

The FastTrack process had evolved into the FastTrack attitude, a new level of teamwork, mutual support and encouragement, and camaraderie.
Attitude is the most important outcome of the CQI process, and the most difficult to define clearly. But its benefits are just as real as the shortened timeframe for production of SBS maps, which has decreased from an average of three years, to under 18 months. Even shorter timeframes are the goal. CQI is, as we say, a journey rather than a destination.

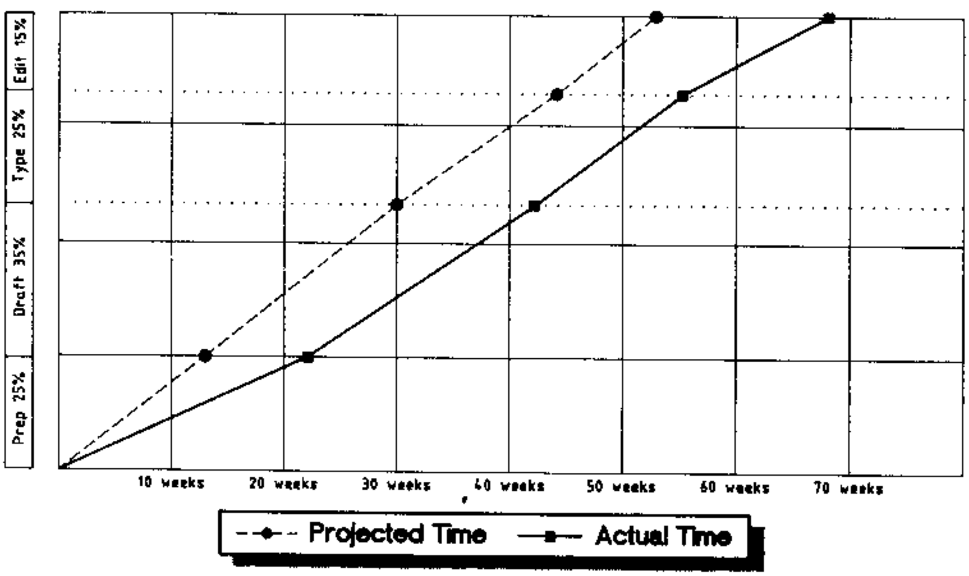
To be successful at CQI, or TQM, or any quality improvement program, the people involved must become free of one kind of fear — the fear of change. Change is required to improve any method, and change is difficult. However, once the fear of change is overcome, exciting things begin to happen, and keep happening. An atmosphere which reduces the fear of change is one which allows risk-taking, and is pro-active in its support of those who would try new ways, who would again tackle the perceived impossibilities. It has to be genuine, and constant, and each person involved has to be willing to go the extra mile for others. It takes time and care to develop that kind of attitude, but once you have worked that way, it goes with you wherever you are.

2 MAPS - 47 and 53 QUADS
71 Weeks/1.4 Years



SAN ISABEL NF PROJECT **PROGRAM OF WORK ESTIMATE: 84 WKS**

2 MAPS - 73 and 62 QUADS
68 Weeks/1.3 Years



WHITE RIVER NF PROJECT **PROGRAM OF WORK ESTIMATE: 84 WKS**

Figure 3.—As part of the CQI training, we learned to use our project folders to create statistical analyses of map progress. Because we had defined the four phases of production (see Figure 1) as Preparation, Drafting, Type placement, and Edit, we could identify that a map had completed one phase and entered another. Our records showed where we had run into problems that slowed production, and graphs helped us to see exactly where our progress needed to be improved. Both these projects beat the estimated Program of Work completion schedule (84 weeks for each), but we still have not quite met the optimum FastTrack projection.

TASK ANALYSIS CHART

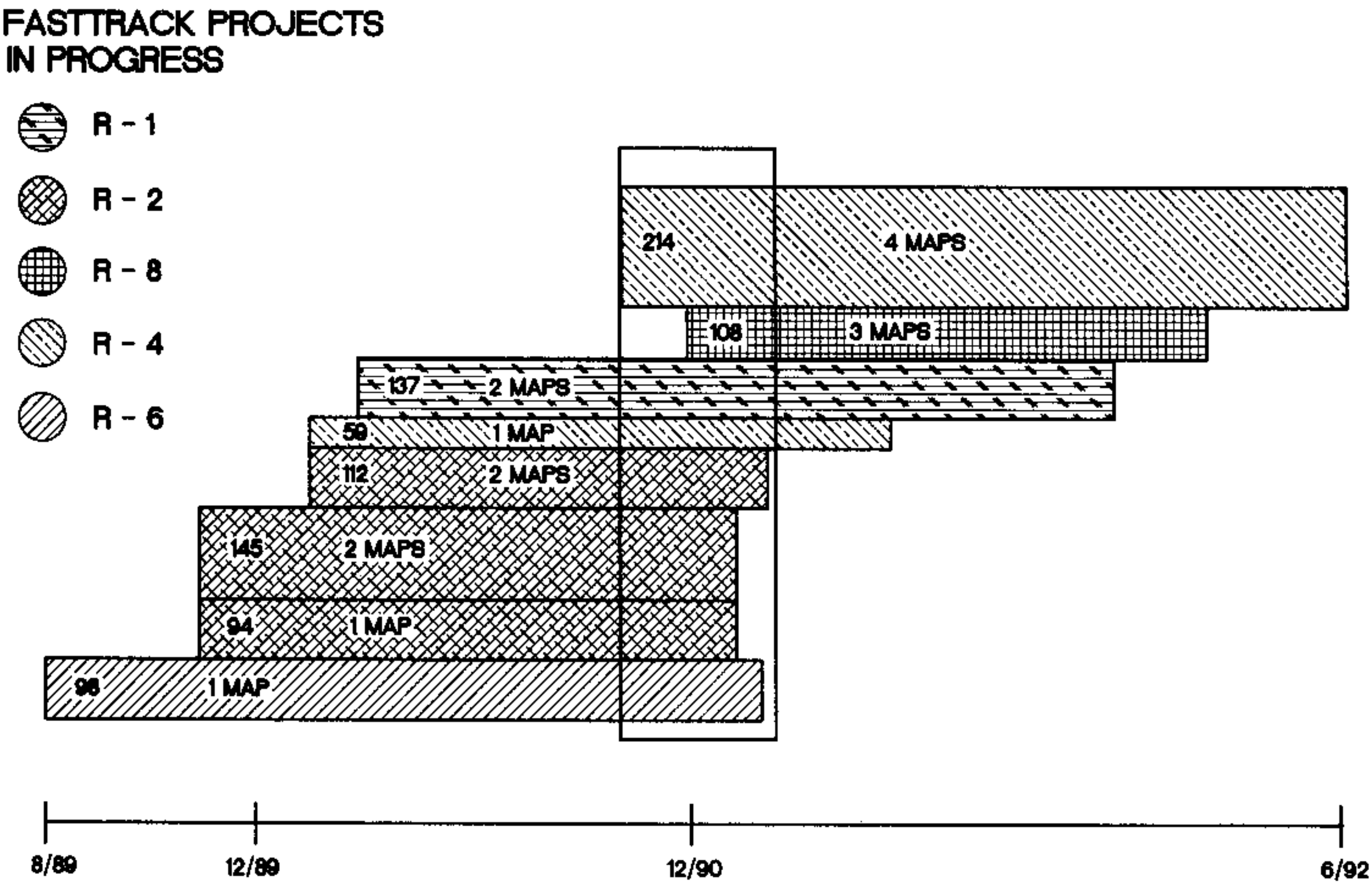


Figure 4.—Some of our statistics indicated the impact FastTrack was having on other units at the Geometronics Service Center. The boxed area indicates the FastTrack workload increase for GSC's photo lab.

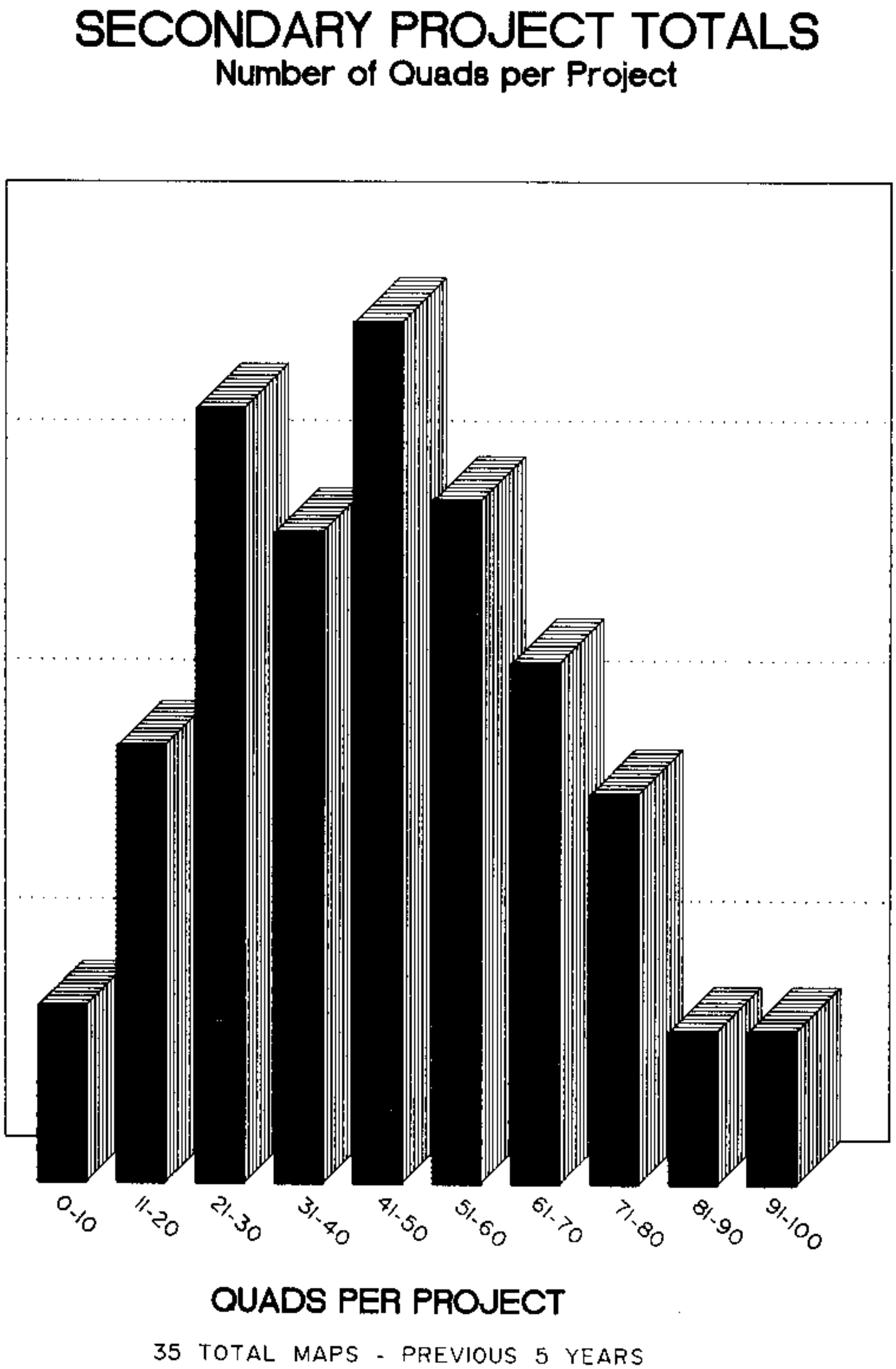


Figure 5.—Secondary Project Totals: Number of quads per project.

Raster Scanning and Plotting at GSC

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The Geometronics Service Center (GSC) is the national center for mapping revision of Primary and Secondary Base Series maps for the Forest Service. In addition to these duties, GSC produces photogrammetric work, orthophotos, and digital elevation models (DEM's). Additionally, GSC is entering the third year of a 5-year program to create digital Cartographic Feature Files (CFF's) of all Primary Base maps for use in automated map production and Geographic Information Systems. A new scanning and plotting device has recently been acquired at the GSC. Our new scanner was obtained to aid in the production of these programs.

The scanner is an Optronics 4040 scanner/plotter manufactured by Optronics Inc. for Intergraph Corporation. It is an optical reflectance scanner with a laser plotter included. It will scan or plot images approximately 39 inches long by 40 inches wide. Images may be scanned at 12.5, 25, 50, 100, or 200 microns. Corresponding measurements in dots per inch would be 2032, 1016, 508, 254, and 127. Plotting may be performed at 12.5, 25, or 50 microns. This device can scan many different types of media. It will accept positives or negatives, paper or film, and monochromatic or color images. Plotting will reproduce line work such as drainage or road layers for mapping, and continuous tone images such as aerial photos. While plotting color separation layers for color map reproduction is possible, the plotter is incapable of plotting in color. However, the generation of color separation negatives is possible.

The hardware itself is a drum scanner. The item to be scanned is mounted on a rotating drum which is 40 inches long and 40 inches in diameter. The media is held on the drum surface by vacuum suction from inside the drum and tape which holds the ends of the media down. The scanning head moves behind the drum so the entire surface may be covered. All optics, reflectance lenses (for laser plotting), and color filtration wheels are contained within the head. The light sources, quartz for scanning and a laser for plotting, are both contained in the lower portions of the cabinet. The light beams are reflected by prisms until they reach the scanning head where they are directed onto the drum surface. The scanner itself is very heavy, weighing in at over one ton. This provides stability so that the instrument does not shake, which would introduce "flutter" to the scanned image.

Both scanning and plotting utilize pixels - an acronym for "picture elements" - for image generation and reproduction. Scanning takes place by having the quartz light source focused via fiber optics on the media to be scanned. It is reflected off the media, through a lens system (and color filters if needed), and read by a photo-multiplier tube. The tube converts reflected light into digital data. The data take two forms: run length encoded (rle) for linear data, and continuous tone (cot) for data with tonal variations, such as photographs. For "rle" data, a pixel is read as "on" when a line is encountered. Only the "on" bits and their location are recorded, yielding a small file. For "cot" data, each pixel is given a value between 0 (lightest value encountered) and 255 (darkest value encountered). Parameters are entered prior to scanning, which set the sensitivity of the scanner. This allows for "fine tuning" of images for maximum reproduction capability. The parameters are used to adjust for differing background shades on the original and varied line quality. The lightest and darkest shades may be adjusted to "shift" the values for better line quality. The values may also be "stretched." This procedure includes both spreading the values apart and condensing them. It is used to enhance the tonal differences between pixels for "cot" scans. Each pixel is measured for the degree of reflectance and a value determined by the pre-entered parameters is assigned. This assigned value is entered into a file as a raster value (a raster being an array of pixels).

Scanning color originals is fairly simple and operates in the same basic manner as described above. The main difference is that the user begins by selecting a color scanning option from the set-up menu. This will queue the user to set the color filter wheel to a desired color (red, yellow, or green). This file will be given a letter designation (r, b, or g) which corresponds to the selected color on the color wheel. At the completion of this scan, the system automatically requests the user to change the color wheel to a second color and perform a second scan. This is repeated for the third color. The three basic reflective colors have now been scanned and the files are in the system. These files may be plotted back to produce color separation negatives for printing the image.

Once the raster file is completed it may be examined on the scanner workstation. We have the capability to examine and change individual or groups of pixels in the file. Due to the complexity of scanned files this is done on a limited basis. Most of the raster file manipulation is done in a clean-up mode to remove "noise" (background speckels) and other imperfections. Some of these clean-up functions operate in an automatic mode by setting desired parameters. The cleaned up file may then be archived, manipulated for later output, or sent to a customer for the customer's use.

One of the capabilities the scanner workstation has is to vectorize scanned data. This process converts the pixels in the scanned data into connected line segments for attributing and plotting. Vectorization will work on almost any size line or line symbol, and will recognize characters (lettering on the map). This vectorized data may be stored on separate layers in the same file, separated into separate files for color reproduction, or symbolized for viewing and reproduction. This capability gives the scanner a broader range of output potential than previous scanners we have used.

Future uses for the scanner/plotter are challenging. We hope to support the CFF program by scanning and vectorizing layers for data capture. We feel this should solve the positional accuracy problem we encounter. At this time, the procedure sounds feasible, but it will require testing prior to implementation. Data generated for the CFF program may be used in both Primary and Secondary Base Series maps. This potential of data exchange between programs has the possibility of decreasing our overall workload. We will also experiment with separation layer production on the plotter by producing Primary Base Series layers using the appropriate line weights and symbology. GSC is scheduled to undergo a reorganization soon and we should experience a much greater demand on the resources of the scanner than previously. It may become a major output source for digital layers in Primary Base. The DEM program will continue to be supported by scanning the contour layers for data input to the LTPlus system. At this time, providing support for the DEM program will continue to be our major emphasis. While we still need to acquire additional software for image enhancement, we will eventually produce orthophotos digitally on the plotter. This should become another major impact area.

We are very excited at having this new tool available to us. It will provide many opportunities to enable us to perform new tasks and to speed up and enhance processes we have used in the past. With the switch to and emphasis on digital mapping, it is necessary for us to make these advances to keep up with the national mapping community. This is necessary so that we can provide our customers in the Regions and Forests with the most up-to-date and accurate products available.

Bibliography of Washington Office Engineering and Technology & Development Publications

This bibliography contains information on publications produced by the Washington Office Engineering Publications Section and the Technology & Development Centers located in Missoula, Montana, and San Dimas, California. This listing is arranged by publication series and includes the title, author or source, document number, and date of publication.

This issue lists material published since our last bibliography (Engineering Field Notes, Volume 22, November-December 1990). Copies of Engineering Field Notes, Technology & Development News, Engineering Management Series, and other publications listed herein are available to Forest Service personnel through the Engineering Staff Technical Information Center (TIC). Copies of "Project Reports," "Equip Tips & Tech Tips," and "Special & Other Reports" are available from the Technology & Development Center that is listed as the source.

Forest Service—USDA
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201 14th St., SW
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San Dimas, CA 91773

Forest Service—USDA
Missoula Technology &
Development Center
Fort Missoula, Bldg. 1
Missoula, MT 59801

Engineering Field Notes

This publication is a bimonthly periodical that supplies the latest technical and administrative engineering information and ideas related to forestry and provides a forum for the exchange of such information among Forest Service personnel.

EFN by Title

Roadway Surface-Water Deflectors	Rosman, Curt. EFN 23 (May-June 1991): 3-6.
Sixmile Bridge: A Component Structure	Porior, Don. EFN 23 (July-August 1991): 23-31.
(The) South Branch of Kinzua Creek Bridge	Hinz, Jerry J. EFN 23 (July-August 1991): 17-20.
Trail Hardening Test	Gusey, Daryl L. EFN 23 (May-June 1991): 53-68.
Two Technology Transfer Awards for the Technology & Development	Editor. EFN 23 (July-August 1991): 15-16. Program
Using Autolisp To Compute Design Quantities in AutoCAD Drawings	Strassmaier, Tom. EFN 23 (May-June 1991): 37-45.
Using GPS in Fire Fighting on the Shorts Fire (Okefenokee Swamp Fire)	Luepke, Douglas. EFN 23. (September-October 1991): 31-34.
Where Is First & How Far Is Second—GPS	Luepke, Douglas. EFN 23 (January-February 1991): 9-16.
Where Is First & How Far Is Second—GPS (Errata)	Luepke, Douglas. EFN 23 (September-October 1991): 41.
Why Weight, Rate, & Calculate Decisionmaking Is Unsound—A Challenge to the "Rational Method"	Collett, Lee. EFN 23 (May-June 1991): 7-11.

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Anderson, Glen R. EFN 23 (July-August 1991): 3-5.	Impoundment Control Structure Design for the Mechanical Removal of Beaver Dams & Debris
Andrus, Ron. EFN 23 (May-June 1991): 47-51.	Possible Problems With Chip Sealing Over an Aggregate Surface
Bowser, Jerry. EFN 23 (September-October 1991): 35-40.	Getting There and Back—Program Strategy
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Drake, Phil. EFN 23 (January-February 1991): 17-24.	Fire Mapping Using Airborne Global Positioning

Duperon, Debbie. EFN 23 (September-October 1991): 5-10.	Inching Our Way to Metrics
Editor. EFN 23 (July-August 1991): 1.	(The) 1990 "Engineering Field Notes" Article Award Winners
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Editor. EFN 23 (July-August 1991): 15-16.	Two Technology Transfer Awards for the Technology & Development Program
Gusey, Daryl L. EFN 23 (May-June 1991): 53-68.	Trail Hardening Test
Haakensen, Ron. EFN 23 (July-August 1991): 7-13.	(The) New & Unique Fall Lake Dam
Hegman, Skip. EFN 23 (September-October 1991): 21-30.	Field Testing of Roto Trimmer Mobile Rock Crusher
Hinz, Jerry J. EFN 23 (July-August 1991): 17-20.	(The) South Branch of Kinzua Creek Bridge
Johnson, Stephan D. EFN 23 (May-June 1991): 47-51.	Possible Problems With Chip Sealing Over an Aggregate Surface
Kreyns, Kathleen. EFN 23 (September-October 1991): 21-30.	Field Testing of Roto Trimmer Mobile Rock Crusher
Lewis, Charlton S. EFN 23 (September-October 1991): 11-19.	Mexico/USDA Forest Service Road and Bridge Design Workshop
Luepke, Douglas. EFN 23. (September-October 1991): 31-34.	Using GPS in Fire Fighting on the Shorts Fire (Okefenokee Swamp Fire)
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Luepke, Douglas. EFN 23 (September-October 1991): 41.	Where Is First & How Far Is Second—GPS (Errata)
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McKenzie, Dan W. EFN 23 (September-October 1991): 1-4.	Pump Flow Testing

Meadows, Joe. EFN 23 (January-February 1991): 25-26.	Precautions for the Removal of Vinyl Asbestos Floor Tile
Miller, Clifford. EFN 23 (July-August 1991): 21.	(The) Hobo Engineer Revisited
Miller, Gloria A. EFN 23 (November-December 1991): 1-8.	FastTrack Mapping at the Geometronics Service Center: A Study in Continuous Quality Improvement
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Nutter, Robert. EFN 23 (November-December 1991): 9-11	Raster Scanning and Plotting at GSC
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Quenoy, John. EFN 23 (September-October 1991): 35-40.	Getting There and Back—Program Strategy
Rosman, Curt. EFN 23 (May-June 1991): 3-6.	Roadway Surface-Water Deflectors
Solheim, Richard O. EFN 23 (September-October 1991): 11-19.	Mexico/USDA Forest Service Road and Bridge Design Workshop
Strassmaier, Tom. EFN 23 (May-June 1991): 37-45.	Using Autolisp To Compute Design Quantities in AutoCAD Drawings
Valdez, Harold L. EFN 23 (September-October 1991): 11-19.	Mexico/USDA Forest Service Road and Bridge Design Workshop
Visconty, Greg. EFN 23 (May-June 1991): 33-36.	Bradford Quarry Volume Determination

Wilcox, Sterling J. EFN 23 (May-June 1991): 1-2.	Road Obliteration
Yager, Duane D. EFN 23 (September-October 1991): 11-19.	Mexico/USDA Forest Service Road and Bridge Design Workshop

Engineering Management Series & Other Publications

The Engineering Management (EM) Series contains publications serving a special purpose or reader and publications involving several disciplines that are applied to a specific problem.

Cartographic Feature Files: A Synopsis for the User	EM 7140-21
Forest Service Remote Sensing Summary—1991	EM 7140-23
Geometronics Service Center Brochure	EM 7140-22
Get Inside the Great Outdoors—Partnership for Travel In The National Forest System	PA-1474
Get Inside the Great Outdoors—Posters	
Biking	FS-476
Watersports	FS-477
Camping	FS-478
Fishing	FS-479
Hikers	FS-480
Seniors	FS-481
Wildlife	FS-482
Skiing	FS-483
ATV	FS-484
Children	FS-485
Hunting	FS-486
Driving for Pleasure	FS-487
Commodity	FS-488
Managing Historic Buildings	EM 7310-7

Technology & Development News

"Technology & Development News" contains information on specific projects, new ideas, and new technologies being developed by the Technology & Development Centers to help solve many different kinds of resource management problems.

Title	Issue
Blast Fence	January-February 1991
Chain Saw Protection	March-April 1991
Chief Presents T&D Program Two Technology Transfer Awards	March-April 1991
Crew Supervisor Training Video	July-August 1991
Current Recreation Program of Work	January-February 1991
Fire Shelter Training Aids	July-August 1991
Fireline Explosives	May-June 1991
Fireline Explosives	July-August 1991
Foot Care Video	May-June 1991
Global Positioning System (GPS)	May-June 1991
GPS Receiver Upgrade	January-February 1991
GPS Receiver Upgrade	March-April 1991
Helicopter External Load Stabilizer	May-June 1991
Isozyme Laboratory	March-April 1991
Laser Tree Measurement	May-June 1991
Laser Tree Measurement Device	January-February 1991
Mountain Bike Trail Standards	January-February 1991
MTDC Publications	January-February 1991

Equip Tips and Tech Tips

Equip Tips and Tech Tips are brief descriptions of new equipment, techniques, materials, or operating procedures. The name was changed from Equip Tips to Tech Tips in 1991. This change reflects the varied audience and expanded subject matter of the series.

Title	Source*	Number	Date
Laser Tree Measurement	MTDC	9124 2336	9/91
New Fireline Explosives	MTDC	9151 2330	8/91
New Exploding Bridgewire Detonator	MTDC	9151 2331	8/91
Pollen Equipment for Forest Service Seed Orchards	MTDC	9124 2341	9/91
Roto Trimmer Mobile Rock Crusher	SDTDC	9177 1301	1/91
Safe Helitorch Pump	MTDC	9151 2307	12/90
Seedling Box Lifter	MTDC	9124 2340	9/91
Small Target Identification—Binoculars vs. Monoculars	SDTDC	9157 1303	4/91
Two New Aviation Hearing Protectors	SDTDC	9157 1304	5/91
Update—Faucets for Recreation Sites	SDTDC	9123 1302	3/91
Water Purifiers for Backcountry Use	MTDC	9167 2329	

*Missoula Technology & Development Center (MTDC);
San Dimas Technology & Development Center (SDTDC).

Project Reports

Project Reports are detailed engineering reports that generally include procedures, techniques, systems of measurement, results, analyses, special circumstances, conclusions, and recommendations rationale.

Title	Source*	Number	Date
Do Biological or Chemical Additives Really Control Vault Toilet Odors?	SDTDC	9123 1203	2/91
Evaluation of Central Tire Inflation Internal Drive Axle Seals	SDTDC	9171 1207	4/91
Field Equipment for Precommercial Thinning & Slash Treatment—Update	SDTDC	9124 1201	1/91
Guidelines for Selection of a Toilet Facility	SDTDC	9123 1204	4/91
Improving Safety of Observation Aircraft	SDTDC	9157 1206	4/91
Portable Wetland Area and Stream Crossings	SDTDC	9024 1203	12/90
Precommercial Thinning and Slash Treatment Machine—A Prospectus	SDTDC	9124 1204	3/91
Spark Arrester Test Carbon Replacement Study—Final Report	SDTDC	9151 1202	2/91

*San Dimas Technology & Development Center (SDTDC)

Special & Other Reports

Special & Other Reports include papers for technical society meetings and transactions, descriptive pamphlets, bulletins, and special purpose articles.

Title	Source*	Number	Date
1990 Publications and Audiovisuals	MTDC	9171 2801	10/90
An Earth Anchor System: Installation and Design Guide	SDTDC/ PNW	GTR-257	7/90
Central Tire Inflation. . . What's In It For Me?	SDTDC	FS-415	Rev. 7/91
Chunkwood Roads Status Report	MTDC	9171 2817	4/91
Evaluation of Data-Supplement To Aerial Applications of Insecticide to Suppress Insects in Douglas-Fir Seed Orchards	MTDC	9152 2808	2/91
Evaluation of Portable Water Treatment Devices for Removing Giardia Lamblia from Natural Waters	MTDC	9167 2816	6/91
Field Quality Control of Fire Retardant Chemicals	SDTDC/ BIFC	NFES 1245**	3/91
Fire Investigation Procedure for Multiposition Small Engine & General Purpose Spark Arrester Exhaust Systems	SDTDC	9151 1801	3/91
Fish Passage Through Culverts	SDTDC	2600/7700 FHWA-FL-90-006	11/90
Foam Applications for Wildland & Urban Fire Management	SDTDC	Vol. 4, No. 1	1991
Health Hazards of Smoke Status Report	MTDC	9167 2809	2/91
In-Depth Design and Maintenance Manual for...Vault Toilets...	SDTDC	9123 1601	7/91

* Missoula Technology & Development Center (MTDC); San Dimas Technology & Development Center (SDTDC).

** National Fire Equipment System (NFES) publications must be purchased from the Boise Interagency Fire Center (BIFC), BLM Warehouse Supply; 3905 Vista Avenue, Boise, ID 83705.

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