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Rec'd. 8/10/79

ENGINEERING TECHNICAL INFORMATION SYSTEM

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VOLUME 11 NUMBER 6

Field Notes

AFFINE FOCAL LENGTH ADJUSTMENT TEST

MOTIVATING YOUR YOUNGER WORKERS

THE SDEDC TREE/SHRUB PLANTER

WASHINGTON OFFICE NEWS

FOREST SERVICE

JUNE 1979

U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

Volume 11 Number 6

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FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Washington, D.C. 20013

AFFINE FOCAL LENGTH ADJUSTMENT TEST

J. B. Stewart
Engineering Staff Group
Region 3

There are several makes of stereoplotters on the market that will not mechanically accommodate 8.25-inch (209.55-mm) aerial photography. The question is, can these stereoplotters be used to produce data to National Map Accuracy Standards using 8.25-inch (209.55-mm) focal length photography?

It has been suggested that an affine solution would solve the focal length problem and allow these stereoplotters to use 8.25-inch (209.55-mm) photography.

The purpose of this test was to determine if National Map Accuracy Standards (see table) can be obtained by setting 8.25-inch (209.55-mm) photography in a 6-inch (153-mm) focal length stereoplotter. (See table.)

NATIONAL MAP ACCURACY STANDARDS TEST COMPARISON

Item	Minimum Contour Interval (ft)	Spot Elevation (ft)	Horizontal (ft)	
			North	East
Map Accuracy Standard	4.85	1.21	2.0	2.0
First Operator		0.42	0.37	0.42
Affine Solution		1.05	0.63	1.00
Second Operator		1.09	0.45	0.49

Step 1: Set an 8.25-inch stereomodel in the Topocart using the correct focal length setting. With the stereomodel relatively oriented, read the pass points and ground control points. The ground coordinates for the pass points and control were previously established. The data were collected on a 1:1 ratio with the stereomodel scale. The model selected was in relatively rough terrain with the control points located on most of the extreme elevation points.

Step 2: Set the focal length of the Topocart to approximately 6 inches (153 mm), then relatively orient the stereomodel. With relative orientation completed, correct for the affine vertical scale adjustment. This adjustment is obtained by the following formulae[1]:

$$K = \frac{c^1k}{ck} \qquad \text{Planimetric scale} \div K$$

where: c^1k = Plotting camera focal length
ck = Aerial camera focal length
K = Vertical ratio

$$\frac{153.0 \text{ mm}}{209.94} = 0.7288 \qquad 1000 \div 0.7288 = 1372.12$$

In this case the planimetric scale was on a 1:1 ratio; the vertical scale was 1:1.3721 ratio with respect to the stereomodel.

The affine correction for the shift of the principal point is calculated by the following formulae[2]:

$$Dx = \frac{ck \cdot (1-K^2)}{K \cdot Pg} x\phi$$

$$Dy = \frac{CK \cdot (1-K^2)}{K \cdot Pg} x\omega$$

where: ϕ = Tip (grads)
ω = Tilt (grads)
Dx = Amount of x movement
Dy = Amount of y movement
Pg = Grads per radian (63.66)

Following is the principal point correction for this model in the Topocart:

Photo 69

Tilt: -0.58 grad

$$\frac{209.94(1 - 0.7288^2)}{0.7288(63.66)} (-0.58) = -1.23 \text{ mm}$$

Tip: 0.67 grad

$$\frac{209.94(1 - 0.7288^2)}{0.7288(63.66)} (0.67) = 1.42 \text{ mm}$$

Photo 68

Tilt: -0.64 grad

$$\frac{209.94(1 - 0.7288^2)}{0.7288(63.66)} (-0.64) = -1.36 \text{ mm}$$

Tip: 0.67 grad

$$\frac{209.94(1 - 0.7288^2)}{0.7288(63-66)} (0.67) = 1.42 \text{ mm}$$

After the vertical scale adjustment was made, the pass points and control reading were recorded.

Figures 1 through 4 show adjustments of the data collected in steps 1 and 2. Figure 1 is a listing of the data used as a standard control for the data adjustment listings shown in figures 2, 3, and 4.

Figure 5 shows the purpose of moving the principal point on the photo carriers to recover the nadir point.

FOCAL LENGTH CHECK AUTO PASS VALUE =, 1090.00

CONTROL FOR SETUP

84	1681.	621857.37	799752.12	7303.27
84	1682.	623069.12	796154.62	7295.86
84	1683.	623691.00	794217.25	7610.00
84	1691.	624954.25	800435.62	7538.61
84	1692.	626006.00	797589.37	7310.32
84	1693.	627163.87	795314.62	7523.77
84	2007.	624711.25	797288.25	7380.98
84	2207.	623408.50	796480.75	7316.62
84	2102.	625976.12	795550.87	7589.77
84	2103.	625371.37	797644.37	7353.60
84	2104.	624774.25	800540.37	7569.40
98	0.	0.00	0.00	0.00

CONTROL IN FILE 1

Figure 1.--Standard control data.

FOCAL LENGTH CHECK

KIND 3 MOD 68- 69 FL 1 FOCAL LE 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0

S=0.093 69.
S=***** 68.

KIND 3 MOD 68- 69 FL 1 FOCAL LE 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0

STANDARD ERROR AFTER LEAST SQUARE PLANE FIT

0.87 OVER ALL 0.85N 0.67E 0.57EL

RESIDUALS

NUM	IDENT	NORTH	EAST	ELEV
1	1683.	-0.75	0.10	1.09
2	1682.	0.92	0.91	-0.63
3	1681.	1.24	-0.35	0.03
4	1691.	-0.82	0.63	-0.00
5	1692.	-0.33	0.55	-0.69
6	1693.	1.41	-1.20	0.17
7	2102.	0.25	-0.49	-0.34
8	2103.	-0.09	0.03	0.63
9	2007.	-0.15	-0.19	-0.57
10	2104.	-0.99	-0.76	0.52
11	2207.	-0.67	0.78	-0.21

STANDARD ERROR AFTER POLYNOMIAL CURVE FIT
0.52 OVER ALL 0.37N 0.47E 0.42EL

RESIDUALS

NUM	IDENT	NORTH	EAST	ELEV
1	1683.	-0.16	0.05	0.25
2	1682.	0.75	0.45	-0.47
3	1681.	-0.03	-0.18	0.08
4	1691.	0.09	0.78	-0.32
5	1692.	-0.53	0.59	-0.25
6	1693.	-0.03	-0.13	0.08
7	2102.	0.16	-0.29	-0.40
8	2103.	0.12	-0.22	1.04
9	2007.	0.25	-0.67	-0.19
10	2104.	-0.00	-0.62	0.14
11	2207.	-0.61	0.24	0.03

Figure 2.-- Data adjustments--plotter focal length = 209.94 mm, first operator.

FOCAL LENGTH CHECK

KIND 3 MOD 68- 69 FL 1 FOCAL LE 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0

S=0.173 69.
S=0.239 68.

KIND 3 MOD 68- 69 FL 1 FOCAL LE 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0 0 0

STANDARD ERROR AFTER LEAST SQUARE PLANE FIT

3.29 OVER ALL 1.51N 3.69E 2.39EL

RESIDUALS

NUM	IDENT	NORTH	EAST	ELEV
1	1683.	2.15	-6.92	-3.79
2	1682.	0.18	3.99	0.33
3	1681.	1.83	2.45	3.34
4	1691.	-1.00	-1.94	-3.65
5	1692.	-2.00	3.09	-0.29
6	1693.	1.06	-1.50	2.11
7	2102.	1.47	-3.01	0.98
8	2103.	-2.39	2.33	2.13
9	2007.	-0.49	2.06	1.58
10	2104.	-0.77	-4.29	-2.36
11	2207.	-0.02	3.74	-0.38

STANDARD ERROR AFTER POLYNOMIAL CURVE FIT
1.12 OVER ALL 0.63N 1.00E 1.05EL

RESIDUALS

NUM	IDENT	NORTH	EAST	ELEV
1	1683.	-0.31	-0.03	0.11
2	1682.	-0.31	1.63	-0.21
3	1681.	0.27	-0.64	0.29
4	1691.	-0.07	1.26	-1.13
5	1692.	-0.66	0.24	-1.93
6	1693.	-0.44	0.26	-0.55
7	2102.	1.26	-1.69	0.98
8	2103.	-0.81	-0.53	1.40
9	2007.	0.92	-0.84	1.34
10	2104.	0.04	-0.65	0.45
11	2207.	0.12	0.98	-0.78

Figure 3.--Data adjustments--plotter focal length = 153.0 mm, first operator.

FOCAL LENGTH CHECK

```
KIND  3 MOD  68-  69 FL    1         FOCAL LE              0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
        S=0.043            69.
        S=0.124            68.
KIND  3 MOD  68-  69 FL    1         FOCAL LE              0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0
```

STANDARD ERROR AFTER LEAST SQUARE PLANE FIT

1.04 OVER ALL 0.66N 0.51E 1.21EL

RESIDUALS

NUM	IDENT	NORTH	EAST	ELEV
1	1693.	1.06	-0.34	0.64
2	1692.	-0.38	0.22	-0.58
3	1691.	-0.11	0.99	-0.40
4	1681.	1.06	-0.06	1.76
5	1682.	-0.30	0.21	-2.61
6	1683.	0.52	-0.28	0.10
7	2007.	0.01	-0.65	1.32
8	2104.	-0.61	-0.67	-0.71
9	2103.	0.03	0.10	-0.78
10	2102.	-1.07	-0.13	0.86
11	2207.	-0.22	0.63	0.40

STANDARD ERROR AFTER POLYNOMIAL CURVE FIT

0.90 OVER ALL 0.45N 0.49E 1.09EL

RESIDUALS

NUM	IDENT	NORTH	EAST	ELEV
1	1693.	0.36	-0.01	-0.67
2	1692.	-0.14	0.20	-0.39
3	1691.	0.17	0.93	-0.12
4	1681.	0.02	-0.16	0.40
5	1682.	-0.37	0.13	-2.35
6	1683.	0.39	-0.10	0.32
7	2007.	0.51	-0.78	1.96
8	2104.	-0.33	-0.73	-0.45
9	2103.	0.48	0.01	-0.28
10	2102.	-0.99	-0.00	0.76
11	2207.	-0.09	0.52	0.83

Figure 4.--Data adjustments--plotter focal length = 209.94 mm, second operator.

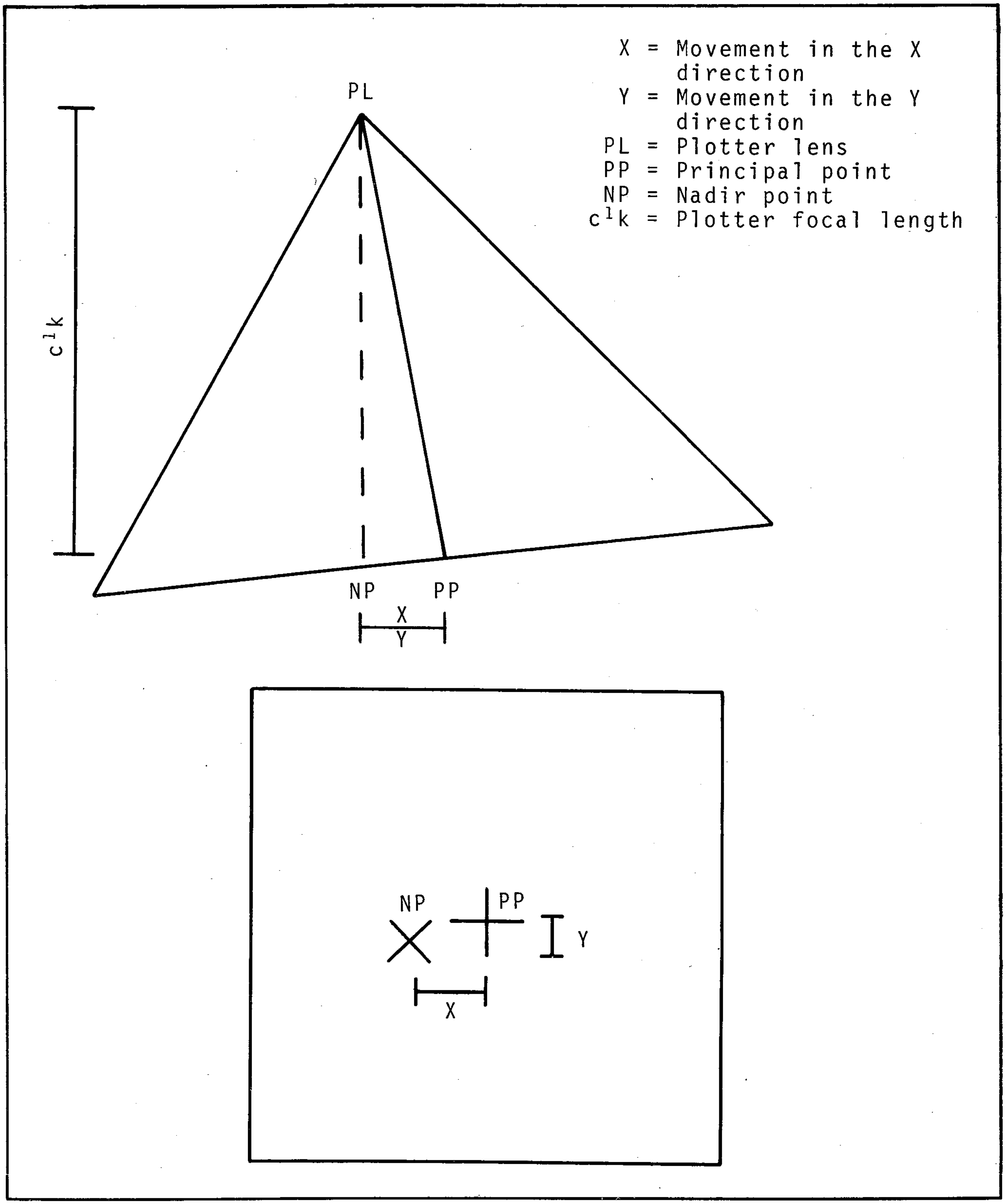

Figure 5.--Movement of principal point on photo for recovery of nadir.

The results of this test support the conclusion that 6-inch (153 mm) focal length stereoplotters can be used to obtain National Map Accuracy Standard data by using the affine solution.

The test data show that the affine data fall within the expected accuracy range when two operators do the same project. In this case, the two operators used the correct focal length (209.94 mm) for the aerial photography in the stereoplotter.

The aerial photography for this test was taken with a ZEISS Aerial Camera with a calibrated focal length of 209.94 mm. The planned scale of this photography is 1:12,000; flight height is 8,250 feet (2514.6 m). The photogrammetric plotter (Topocart) used for this test has a C-factor of 1700.

REFERENCE NOTES

[1]*Albertz, Jorg, and Kreiling, Walter. Photogrammetric Guide, (translated by G. Richter) Karlsruhe: Wichmann, 1975*

[2]*Formulae furnished by Kern Instruments, Inc.*

MOTIVATING YOUR YOUNGER WORKERS*

Henry C. Ruark

Bored workers who take a day off at the slightest excuse or deliberately foul up a job are causing major problems for American industry according to both private and government studies.

Whatever the reasons, the resultant casualties are costing us dearly in both productivity and dollar losses. It is becoming obvious many of the traditional approaches to motivate workers are no longer nearly as effective as they used to be.

Today's young worker has a different set of mores and values; a different sense of responsibility and perhaps a less sharply focused feeling for what he wants to become.

Most persons now in management learned long ago that all human behavior is motivated. There is an effective "reason why" for what people do or don't do, even if that "reason why" is not readily visible or easily understood.

Managers also have learned that understanding what affects people and what will bring forth desired actions from them is an essential part of leadership and an indispensable component of effective management. But that's a much harder skill to acquire today.

The traditional Monday morning hangover holiday and day after payday blues are still with us, but today's young worker may also be subject to the effects of drugs and the "shove it" syndrome.

The "shove it" syndrome? It occurs when even promising young workers decide you can "shove it, I can do better" and disappear out the door. This happens despite extensive training and very good opportunity freely furnished by management at considerable cost.

How to cut down these problems in younger workers, for whom motivational factors are far more complex than they ever were for their parents, is drawing attention from many skilled personnel in industry and business. What follows is a roundup of some trends and ideas shown by recent studies and reports compiled in connection with my consulting practice.

* * *

Effective communication with the worker at all levels is an absolute necessity to offset such situations. Many workers feel themselves trapped in boring, routine, repetitive work situations and physically and emotionally taxing operations. When uncomfortable and sometimes dangerous and demanding work conditions are added, the level of motivation drops off rapidly. That's when the "shove it" syndrome strikes.

Even in times of comparative economic downturn, fear of job loss is not nearly the factor it was with previous generations. The younger worker today is more ready to move on to somewhere else that is just as good or even better, even to another region of the country or foreign nations.

Increased wages creates what one study describes as "positive attention" among many workers, but less so for younger ones than older ones.

Other studies show more and more younger workers refuse to continue in working situations with many negative factors. They prefer to move on, often claiming there is no future for them within the company.

What do they want? Better working conditions, more flexible hours and shift assignments and more responsibility for one's own efforts seem to be prime positive factors in building job satisfaction and staying power in younger workers. A practical "career ladder" clearly leading to more responsible job opportunities also seems attractive to many, especially when coupled with effective on-the-job training and a formal work/study program leading to technical expertise.

Many studies indicate once the younger worker is hooked on a working situation which he sees can lead to solid opportunity and professional status, he is perhaps an even more eager learner and participant than was his father. Similar studies show young women are as motivated, or even more motivated, by such opportunities than their male colleagues.

There have been many changes in values and lifestyles over the past two decades, and we must expect even more. But that doesn't mean you must share in them or even agree with them to work effectively with the younger worker. What it does mean is that you understand and appreciate such changes for what they mean in relation to your workers. There's no simple way to do this. To do so requires effective one-to-one communication for each situation and with enough group members to ensure an overall perspective and balanced judgment.

Personal dialog carried out with flexibility, humor and a willingness to listen and understand is perhaps the major tool. Today it's unavoidable and one of the strongest human managment tools there are.

* * *

There are many techniques to improve and strengthen such communication and it pays to look at these.

"Feeling finding" is closely related to (but often more important with younger workers than) fact finding. You must learn to listen carefully and attempt to achieve an empathetic understanding with younger workers. This takes persuasion as well as persistence. But it can provide reliable and valid guidelines for the judgments you must make.

Leadership style has a very strong influence on both acceptance and effectiveness in stimulating workers. Studies show that personal traits of the leader mean less than other elements with younger workers. What really counts is that the leader must be perceived as knowing more than his subordinates about the group task and how to accomplish it effectively.

Two major clusters of behavior and attitudes have been the main focus of studies of leadership recently. One cluster is labeled "autocratic, authoritarian, task-oriented," the other "democratic, equalitarian, group-oriented." Both oversimplify leadership, but they can provide a foundation for an examination of what leaders really do when they lead--and thus a starting point in your own self-examination in terms of your problems.

We know there are a limited number of ways in which one person can influence another to work. He can coerce or coax; tell what to do and how to do it; or share the decision making and concentrate on the relationships with workers, rather than job execution.

For those who work with the younger employee, a special blend of these clusters and approaches is needed. But first, start with an examination of your own interpersonal skills and relationships. Compare and contrast what you used to do years ago. Learn from the changes and look into the lifestyles and values of your younger employees. Then you're ready to consider the moves they may indicate to you.

Properly handled, younger workers can anchor your organization with talent, opportunity and understanding, and may well be your most creative and productive working partners tomorrow.

THE SDEDC TREE/SHRUB PLANTER

Ted L. Pickett
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Equipment Development Center
San Dimas, California

Over the past several years, engineers and technicians at the San Dimas Equipment Development Center (SDEDC) have been developing two pieces of equipment to revegetate steep slopes along roadsides. Work on a steep-slope seeder has been completed and reported upon (see Field Notes, August 1978, Vol. 10, No. 8, pp. 22-24 and Equip Tips, February 1979, No. 7977 1301). Work on a tree/shrub planter continues; the latest status of this effort is presented in this short article.

The project to develop and test a seeder and a planter was undertaken to reduce the costs and improve the efficiency of stabilizing soil on slopes newly created during road construction in mountainous terrain. Other goals were to minimize the esthetic impact of hillside revegetation, increase the effectiveness of replanting on roadside slopes, protect hillside watersheds, and reduce lake and stream siltation. The device reported here is a crane attachment that transplants tree and shrub seedlings with minimum soil disturbance.

The criteria established for development of the planter were that the implement should:

- Operate on cutbanks or fill slopes up to 1:1, even if terrain is irregular and littered,
- Plant container-grown nursery stock that maximizes the opportunity for "first time" planting success,
- Handle stock from containers up to 8 inches (20.3 cm) tall--these seedlings can be as large as 2 inches (5.1 cm) square in cross section and have an overall height of 18 inches (45.7 cm), and
- Be capable of exact-spot planting, not just row planting.

The latest SDEDC tree/shrub planter prototype (figure 1) has been successfully tested at San Dimas. It planted several varieties of

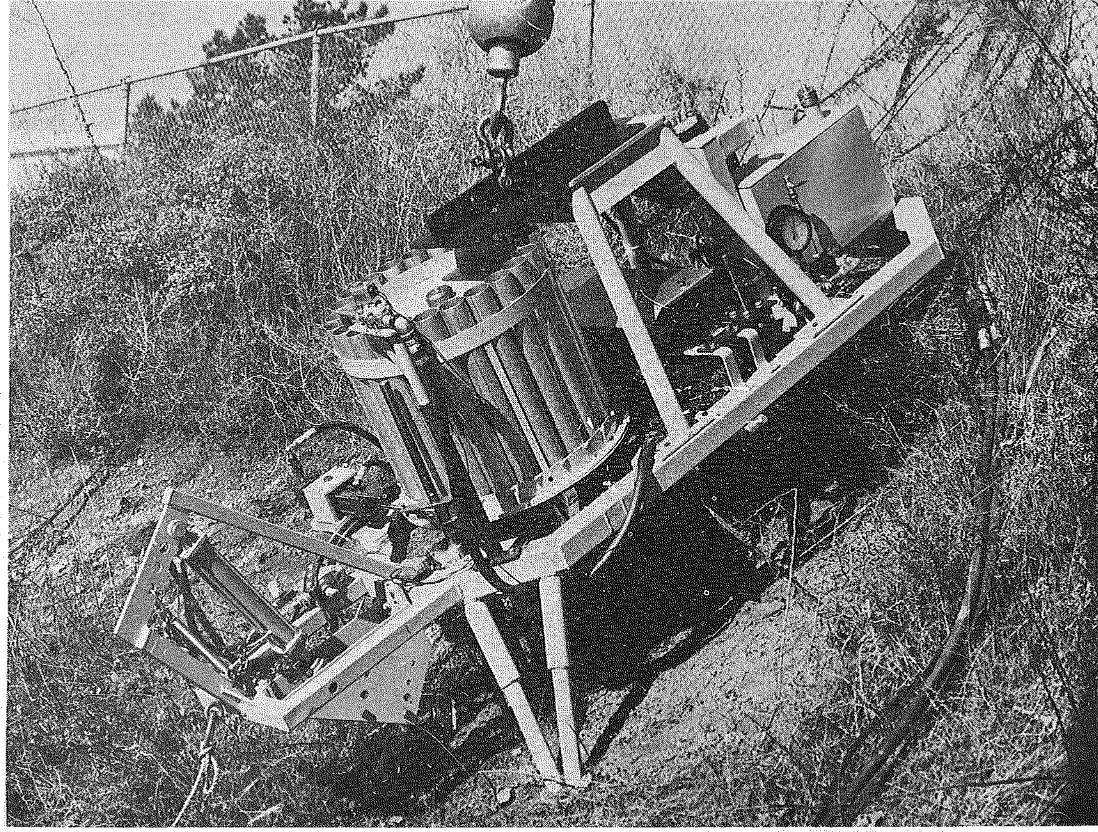

Figure 1.--SDEDC tree/shrubs planter prototype.

shrub seedlings and was used on slopes of approximately 60 percent without any problems. Further field testing to establish implement reliability, production rates, plant survival, and planting costs is now being conducted in the Pacific Northwest Region.

The planter can be carried and positioned by either hydraulic cranes, or even by cable cranes (figure 2) if a second cable drum is available to keep the planter properly oriented. Some of the cranes can reach over 100 feet (30.5 m) from the road with the planter attached. The planter has a 24-tube carousel; each tube is 2.5 inches (6.35 cm) in diameter and 21.5 inches (54.61 cm) high. Sharpened shovels, attached to each of the three feet of the planter, hold the implement on the slopes during the planting cycle.

A seedling can be inserted into the ground at a rate of one every 15 seconds. After the tree or shrub seedlings are removed from their containers and are loaded into the carousel tubes, the crane operator places the planter on the slope. The planting cycle, once initiated by the operator is fully automatic (electric over hydraulic). First debris is scalped or scraped off the ground where the seedling is to be inserted. Next, a hole is augered and the carousel rotates; a rachet mechanism lines up a carousel tube with the augered hole.

As alignment occurs, a high-velocity blast of water propels a seedling down the carousel tube, through a drop tube into the hole in the ground. Finally, a packing foot compacts the soil around the root system, while forming a small depression for water. SDEDC's final design will have two planter mechanisms, one at either end of the frame. They will be arranged to plant seedlings 6 feet (1.8 m) apart. The hydraulic power supply now being used should be adequate for both planters.

Figure 2.--Cable crane positioning tree/shrub planter.

WASHINGTON OFFICE NEWS

OPERATIONS

Harold L. Strickland
Assistant Director

MICROFILMING OF ENGINEERING DRAWINGS AND SPECIFICATIONS

For some time, we have been revising our portion of the Filing System Handbook (FSH 6209.11) in a manner that will accommodate microfilming of your project records. This has led to Administrative Management's approval for Region 6 to microfilm all engineering drawings, and the purchase of 3M-201 Reader-Printers for each Forest in Region 6.

Following the Region 6 approval, a letter (6230-April 13, 1979) was sent to Regional Foresters, Station Directors, and Area Directors that authorized the microfilming of all engineering drawings, and the subsequent disposal of the original documents. We support this action and recommend that it be applied to specifications and related project documents.

There are some problems associated with such an undertaking; for it to work, you must have documents and plans that are suitable for microfilming, the necessary equipment for reading the microfilms, and access to equipment that will produce hard copies.

Preparation of Material

There is not much we can do about our old plans; as a rule, you can get a fair microfilm image from them. However, when you prepare new drawings, there are some things you can do that will ensure a top quality microform. The following are some recommendations for microfilming all project data:

1. Use original full-sized drawings for microfilming,

2. Use the 35 mm aperture card format for drawings,

3. Use the microfiche format for specifications and other documents, with a reduction ratio of 1:24 (24x), and

4. Produce all microforms as negative images. This will result in a black line image that is easier to read.

Lettering

In making all drawings, charts, graphs, tables, plats, and other material that include lettering, take particular care to ensure that the size of lettering in the final copy is of adequate size to be read from the reader-printer. Many microform readers and reader-printers do not bring the image back to its original size; as a result, letters and numerals must be of sufficient size to make the retrieved image legible.

The minimum letter height of the final copy must be 0.125 inch (0.3175 cm), and capital letters (not lower case) should be used. Spacing between adjacent letters should be twice the thickness of the letter lines. If the material is to be reduced to a final form that is smaller than the original drawing (such as a drawing reduced photographically to fit on the page of a publication), the minimum letter height applies to the reduced copy that will be microfilmed, not to the original drawing; therefore, the lettering on an original drawing might have to be oversized to obtain the minimum letter height.

Headings should be twice the size (0.25 inch or 0.635 cm) of the text letters. Spacing between lines should be no less than half the letter height. Letters should be bold, straight, and open; type, if used instead of hand lettering, should conform to the same dimensions and style.

Lines

For the same reasons given in the preceding paragraph, line weight should be 0.01 inch (0.025 cm) or heavier. Open spaces between lines should be four times (at least 0.04 inch or 0.102 cm) that of the line weight.

We are working with Consultation and Standards to develop micrographic standards for all engineering drawings and documents. These will include an indexing system to be used on a Service-wide basis; the standards and indexing will be incorporated into our Directives system. Until these are published, we recommend you use the preceeding as interim guidelines.

If you have any questions on micrographics, call Al Colley on FTS 235-8077.

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

SLASH WARMS WALLA WALLA

A lightweight cable yarding system developed by the Equipment Development Center at Missoula recently yielded an unexpected benefit to the citizens of Walla Walla, Washington, when the yarder was used on a logging slash utilization project on the Umatilla National Forest. Normally inaccessible slash was made available as firewood to the citizens of Walla Walla, a community about 28 miles (45 km) away. In 29 days, 3,050 cords (11,056.128 m^3) of Western-larch and Douglas-fir were removed from steep slopes and piled on a roadside. Eighty-five to ninety percent of this choice firewood was picked up by citizens to stock their woodburning stoves and fireplaces. In fact, energy valued at $224,000 was made available by the Forest Service--enough energy to heat 470 Walla Walla homes for 1 year.

This project saved the citizens of Walla Walla money and achieved the land management objective of reducing fire hazards. The direct cost to the government for removing the slash was $2.87 per cord (3.625 m^3). When the cost of equivalent energy for fuel oil, electricity, and natural gas are averaged for the Walla Walla area, the firewood made available was worth $86.18[1] per cord (3.625 m^3).

This project should interest the Northwest Forests because fuels managers on the Umatilla were able to rid themselves of accumulated slash, a problem common throughout the region. For example, in the Pacific Northwest Region in 1978 more than 326,000 acres (approximately 132,000 hectares) of forest residues (slash) were created from an annual timber harvest of nearly 4-1/2 billion board feet (approximately 10-1/2 million m^3). Since 1961 in Washington and Oregon, over 2-1/2 million acres (approximately 1 million hectares) of untreated slash have accumulated. In Montana and Idaho, the accumulation exceeds 700,000 acres (approximately 280,000 hectares.

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[1]*Energy equivalent values for Walla Walla were: furnace oil--$.50 per gallon ($.50 per 0.3 l); natural gas--$.3915 per hundred cubic feet ($.3915 per 2.8 hundred cubic meters); electricity--$.0174 per kilowatt hour; wood--$86.18 per cord ($86.18 per 3.625 m^3).*

Prototype yarder treating slash on the Umtilla National Forest.

Although other Forests have made this residue available to citizens, the wood is often inaccessible to them and the removal cost is much higher for the Government. Slash treatment is usually done by prescribed burn, chipping, or masticating. Handling costs for materials are high and the burning of large concentrations has an obvious impact on air quality. Some slash remains untreated, and eventually decays; however, accumulations of untreated residues are a potential fire hazard. Residues also represent a waste of natural resources and have undesirable effects on wildlife and watersheds. Land managers are often unable to treat slash because steep slopes and heavy fuel loadings are inaccessible by rubber-tired skids and are uneconomical for a large cable yarding system. Other factors such as the spacing of residual trees, number and height of stumps, and soil conditions might prevent treatment.

In January 1977, Harry Cummings, a fire management officer on the Clearwater National Forest, requested that the Missoula Equipment Development Center (MEDC) design and build a lightweight, inexpensive prototype yarder for removing slash. In tests on the Clearwater Forest, the yarder[2] met production goals, while removing slash selectively and at an acceptable cost on steep slopes. It was this prototype yarder that enabled the fuel managers on the Umatilla National Forest to effectively treat their slash while contributing a substantial energy savings to the people of Walla Walla.

The potential for using slash as an energy source is enormous and should receive increased attention from fuels managers.

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[2]*Publications on the yarder are available from MEDC, Bldg. 1, Fort Missoula, Missoula, Montana 59801. Drawings and specifications are planned for distribution in the fall of 1979.*

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