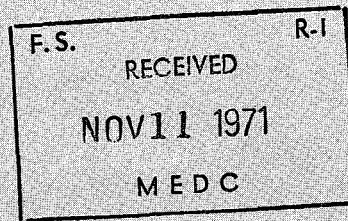


**ENGINEERING
TECHNICAL
INFORMATION
SYSTEM**



FIELD NOTES • TECHNICAL REPORTS • TEXTS
DATA RETRIEVAL • CURRENT AWARENESS

Field **Notes**

Volume 3 Number 9 September 1971

**Transportation System Analysis
and Resource Planning
Victor M. DeKalb**

**A Meter/Recorder to Measure Logging
Road Roughness
Ross A. Phillips and Cleveland J. Biller**



FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

This publication is a monthly newsletter published to exchange Engineering information and ideas among Forest Service personnel.

The publication is not intended to be exclusive for engineers. However, because of the type of material in the publication, all engineers and engineering technicians should read each monthly issue.

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FIELD NOTES

TRANSPORTATION SYSTEM ANALYSIS AND RESOURCE PLANNING ^{1/}

by Victor M. DeKalb

PLANNING FOR RESOURCE MANAGEMENT

Currently, there is much discussion and disagreement concerning what planning is and who does it. Disagreement centers around two questions:

Where does planning end and design begin?

Is planning a management function or a support function?

A simple solution is not possible because overlapping occurs. In fact, in all real-life situations planning, design management and support overlap so much that organization development programs such as Management Grid are necessary to keep participants talking to each other effectively.

For the purposes of this presentation, planning is defined as that activity which establishes design criteria. The activity called design or project planning can take place in any function. For instance, the planning of a specific timber sale can be called project design. This also occurs in other functional areas such as recreation and range.

The planning activity which "develops design criteria" starts at about a 20-year time horizon and provides long-range general direction for land use. The process continues through successively tighter criteria until it provides very specific direction at a 3- to 5-year projection when design begins.

Planning not only delineates the type and amount of use to be placed on a piece of land but also specifies a schedule of development to assure that use is controlled in accordance with the plan. One must be sure that the right timber sale in a watershed is sold first. (To assure that a planned (right major haul road for an area is actually developed.)

Transportation system analysis must be part of planning from the beginning. Experience and studies have shown that the location and standard of roads, trails, or other transportation facilities actually control what kind of use will be placed on the land. Therefore, to be effective, the planning process must include a plan for mobility.

^{1/} A talk given at the Environmental Workshop for Engineering Facilities April 20, 1971, Marana, Arizona, by Victor M. DeKalb, Project Leader, Service-wide Transportation System Planning Project.

The process of resource planning is explained in figure 1.

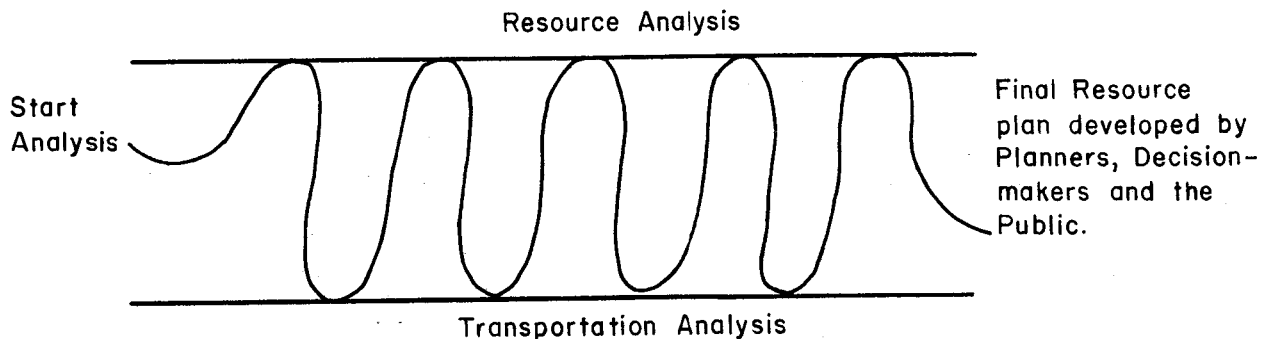


Figure 1.--Resource planning through progressive iteration.

A planning group starts with resource management proposals, and the analysis, through the process of progressive iteration, goes back and forth between "transportation analysis" and "resource analysis", flowing through comparison of alternatives and consequences, until a combined resource development plan is completed which is acceptable to management.

Considerable literature in the planning field discusses "why plans fail." Experienced planners have propounded a variety of "planning purposes and plan formats", and found that the on-the-ground development was not in accordance with the plan. Perhaps the only reason for planning is to minimize irrevocable decisions. This is a very important reason and should be remembered by all who work in the planning field.

Historically, the Forest Service has become very good at "project design" or "project planning" (also called "functional planning") but ironically, it has neglected total-resource planning. Perhaps such planning has not been emphasized because of the complexities involved in analyzing and deciding between a variety of alternatives and a variety of consequences while working under a public involvement constraint. Does the famous scientific quote apply here? One might paraphrase it as follows: "Functional planning might almost be defined as a process of substituting unimportant questions which can be answered for important questions that cannot." (The questions raised in total-area planning are most difficult to answer).

In planning for resource management, the following jobs are important:

Decision making: political and administrative
Data analysis.
Data management and collection: input and retrieval.
Monitoring: predicting and feedback.
Interaction of the forest user with the planned development.

The Service-wide Transportation System Planning Project is involved in all of the above fields as it develops new transportation system analysis tools. Because of overlap and similar procedural applications, the processes developed may be used in decision making and in resource analysis fields with a little modification.

There is an apt statement by Professor J. Forester of the Massachusetts Institute of Technology: "Long-range forecasting and planning are not acts done to an unresponsive object. They are activities carried on within and as part of an interacting system.

"To think of planning as unilateral, or as a leader setting the way for the system to follow, is dynamically incorrect. Planning is based on information coming from the remainder of the system. If planning has any influence, it alters the system which then produces new information on which further planning is based.

"To understand planning and to understand its failures, we must see the planning process as part of the total structure of a system. Long-range forecasting and planning methods are in no sense different from any other policy that controls action within a system. Methods and policies are based on current information which converts that information into a present course of action. We act only in the present. Long-range planning is simply another of our many processes for converting history into current activity.

"...Long-range planning has no distinction from other system decisions. It identifies a problem and then establishes an action to alleviate the problem." 2/

2/ Excerpt from a talk entitled "Planning Under Dynamic Influences of Complex Social Systems" given by Professor J. Forester, Massachusetts Institute of Technology, at the O.E.C.D. Working Symposium on Long-range Forecasting and Planning held 10/27 - 11/2, 1968 in Bellagio, Italy.

PLANNING VERSUS DESIGN

Planning differs from design in several ways. The most important difference is the concept of probability or chance. Planning is based on forecasting which is estimating the probabilities of what will happen in the future; therefore, we can expect some parts of any plan to be wrong when the time arrives to apply it. Uncertainty increases as the forecasting period increases. In design there is little uncertainty involved. We know that the designed structure will function or the designed timber sale will be sold and cut in accordance with the specifications. Another difference is that planning is long-range (probably more than 3 years) and includes a schedule for development, whereas design looks only slightly into the future and has an established date of construction or development. Planning tends to be more general in scope while design is quite specifically concerned with structural or functional development.

SOME PLANNING ASSUMPTIONS WHICH SHOULD BE QUESTIONED BY FOREST OFFICERS

The following four planning assumptions need reassessment and redirection to assure that planning decisions are effective and lead to commitment:

1. Multiple-use planning precedes transportation planning. As previously discussed, this assumption is fallacious because the correct transportation system is necessary to assure that multiple-use direction is carried out. The transportation system must fit the total planned "mix" of users, and the uses must be adjusted to fit the transportation system able to serve them. This happens when a design of a building includes certain main travel corridors in the initial layout of the building. Uses and travel ways are planned at the same time.
2. Many Forest Service planners provide only one plan for a decisionmaker to review--this approach is untenable. Although the objectives of a plan might change after evaluating the alternatives, we must understand that the planning process includes the evaluation of many alternatives and their consequences in consideration of the objectives given to the planning group. When a variety of alternatives with their consequences are not given to the decisionmaker or to the public so that choices can be made, the plan is then a document produced from preconceived notions and precludes decision making by those held responsible for this activity.
3. Many people feel that one alternative has to be best. In conceptualizing the planning process and using of judgement and intuition by the decisionmaker, it is important to emphasize that no one alternative is right or best!

Different forest supervisors will choose different alternatives and they will all be right. In this situation, it should be pointed out that analytical tools being developed by many teams in the Forest Service cannot all be presented in the same way and, consequently, will not produce an optimized solution. The decisionmaker will have to examine at least two, and sometimes five or more, separate analysis documents. Many of the documents will include narrative statements of the consequences rather than numerical indexing narrative of the good and bad aspects of an alternative. As an example: transportation system alternatives cannot be broken up to assign portions of the costs and benefits to each line of a functional output. In an area where timber and recreation are both serve, it is not possible to determine what percent of the cost and benefits of a road should be allocated to recreation and what percent to timber.

4. An optimum plan must be developed. As suggested in item 3 above, a decisionmaker and his advisors must realize that under the present state of the art, and probably even into the foreseeable future, it is impossible to optimize a group of activities on the land for the purpose of determining the correct alternative. Consequently, analysis in the planning process must provide data to the decisionmaker in a form which allows him to make a decision using his intuitive judgement and experience. Output from analytical processes must not be so analyzed or presented that the analyst and the computer make decisions for the decisionmaker. If this happens, most decisionmakers will reject the output and will rely solely on their own judgement. In looking at optimization, Professional and lay people concerned with natural resource use, frequently speak of an optimum use of resources. Upon examination it becomes obvious that the term optimum means different things to different people. Mischief is done when professional people use a term in a limited professional sense but their statements are interpreted to mean something different." ^{3/} Efforts to show optimization in Forest Service planning have often produced a mix of optimum data in which one evaluation is based on optimum ecology and another on optimum economics.

3/ Unpublished paper, Professor Emory Castle, Oregon State University, Criteria and Planning for Optimum Use.

INFORMATION FOUND TO DATE IN THE TRANSPORTATION SYSTEM ANALYSIS TOOL
DEVELOPMENT PROJECT:

1. A generation attraction model for recreation travel can be of use of planning recreation developments. This and other analytical work indicates that many transportation system network and statistical models can and should be used for resource analysis. This also applies to other modes of travel, such as trail, ship, and helicopter.
2. More than 100 cars a day can travel safely on a single-lane road. This fact will require a change in present Forest Service Manual standards which strongly suggest that designers go to a two-lane road when volume is expected to be more than 100 cars a day.
3. Low-volume, low-speed roads are unique. In the past, the Forest Service and other road management agencies have taken high-speed, high-volume road research data and subsequent standards and adjusted these to standards for low-volume, low-speed roads. The results are inaccurate and have resulted in poor allocation of resources. Recent transportation system analysis has shown that different criteria for these unique roads can be established in traffic measurement, traffic interaction analysis, and traffic safety. In most cases a true analysis of a low-volume, low-speed road will save funds in construction, operation, and maintenance when compared to expenditures resulting from standards developed for high-volume, high-speed roads.
4. Resource and transportation analysis for Forest Service and other rural planning is different from urban planning because of dispersed traffic attractors. Very little attention has been focused on formal planning procedures where traffic attraction or generation locations are more widely dispersed than in urban areas. Rural attractors are widely dispersed compared to urban analysis, even though rural and "wild land" planners feel that attractors are in close proximity. Little transportation analysis has been done using the concept of dispersed attractors.
5. It appears that no one travel model will provide all the answers for resource planning. The recreation travel model is considerably different from a timber haul travel model. Therefore, it is probable that an analyst will have to use several models separately to determine a proper transportation network for a resource management alternative.
6. Network analytical procedures are very useful to planning analysts, and will be useful in many other areas of Forest Service management. It is interesting to note that the game "Instant Insanity," which consists of four cubes with different colors on each side of each cube, can be solved by hand computation in about five minutes using network analysis procedures.

The Six Rivers National Forest is doing network analysis to determine consequences of a variety of wilderness area configurations on transportation flows. The forest personnel feels that this application has helped the boundary analysis considerably.

7. Analytical procedures being developed for transportation system analysis will be most valuable for the operation and maintenance of transportation systems. It is believed that such analytical tools will allow effective closing of roads, better control of traffic, and better expenditure of the maintenance dollar.

MULTIDISCIPLINARY PLANNING TEAMS AND PLANNING TOOLS

The principal goal of system development groups in the Forest Service, such as the Transportation System Planning Project, is to provide rapid analysis tools for multidisciplinary planning groups on a National Forest. These tools are to be in a form which provides rapid analysis of planned alternatives so that consequences can be provided to the decisionmaker in a form he can trust and evaluate with understanding. Presently, planning efforts involve hand methods which are costly and time consuming and their results are limited.

The various Service-wide tools being provided to allow for faster analysis in planning will require specialists who understand the background of such tools and who are skilled in statistics, probability, and systems analysis. They must also be skilled in the particular discipline they represent. Thus, to be sure alternatives are considered expediently, we must not only have a variety of disciplines but also trained analysts. Under this concept, a group of planning specialists from the various disciplines will provide the best planning support to a decisionmaker. This team plus the intuition and judgement of a decisionmaker, if allowed adequate time for the participants to think and for the public to be involved, will provide effective plans for the future. This results in collaboration -- not coordination.

PLANNING IS EXPENSIVE

Forest officers must realize that good planning costs effort and dollars. It is expected that the cost of collecting data for analyzing a transportation system on a forest will run from 30 to 50 thousand dollars. This does not include resource analysis, which must be integrated with the transportation analysis to produce effective plans.

Although initial costs are expensive, they result in a good investment in several ways. First, much of the first cost is data collection which will not have to be done so extensively again; second, manipulation of data can be done very rapidly when replanning is necessary, and third, well-developed plans should save time and costs in the implementation phase. Over a long time period, good planning should cost no more.

A METER/RECORDER TO MEASURE LOGGING ROAD ROUGHNESS -- PROGRESS REPORT

by Ross A. Phillips and Cleveland J. Biller,
Research Mechanical Engineers, Northeastern Forest Experiment Station

The Engineering Research Project needed a numerical measure of logging road roughness for logging road studies. Because commercial instruments that would handle the surface deviations encountered were not available, an instrument using a gyroscope was developed to measure road roughness. The instrument is presently undergoing tests. In addition to use in research, the instrument may be used to determine if forest roads need maintenance, to establish a standard for maintenance, to measure bump severity, and to indicate the amount of attention required by the road.

PRINCIPLE OF OPERATION

An application of a gyroscope is the gyropilot often referred to as the automatic pilot in an airplane. The gyropilot is set so that the axis of rotation is along a predetermined course. Any deviation from the course applies a torque to the gyroscope, which in turn generates a signal. One signal is for pitch and one signal is for roll. These signals can be used to operate controls to keep the plane on course.

We are using a gyropilot in this study in nearly the same manner as it is used in an airplane, except we are recording the signal for pitch and roll on chart paper. The gyroscope, on an adjustable mount, is installed in a vehicle (fig. 1). When a bump is encountered that causes the vehicle to change in position (pitch and/or roll), a signal is generated. The magnitude and the frequency of the bumps are proportional to the signals generated by the gyropilot.

Power is supplied to a converter by two heavy-duty 12 volt batteries. The converter converts 24 volts d.c. to 110 volts, 3-phase a.c. (400 c.p.s.). This is stepped down through transformers to 24 volts, which feeds into the gyroscope motor. The converter also provides excitation voltage for pitch and roll signal output. Each signal output feeds through a 400-cycle noise limiter in the control box. The signal feeds into a Wheatstone bridge DC amplifier, and then it is filtered for noise and rectified in the control box. The signal feeds from the control box to the galvanometer of the chart recorder where it is recorded on chart paper (fig. 2).

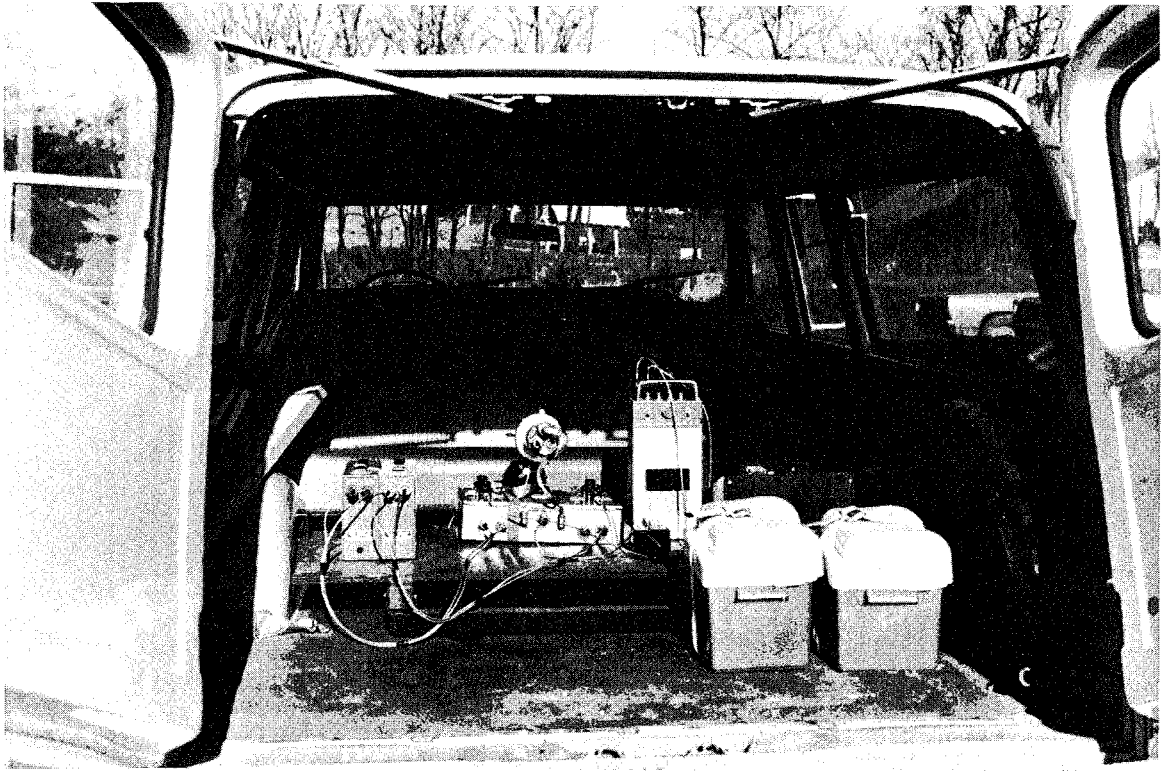


Figure 1.--Roughness meter/recorder mounted in truck.

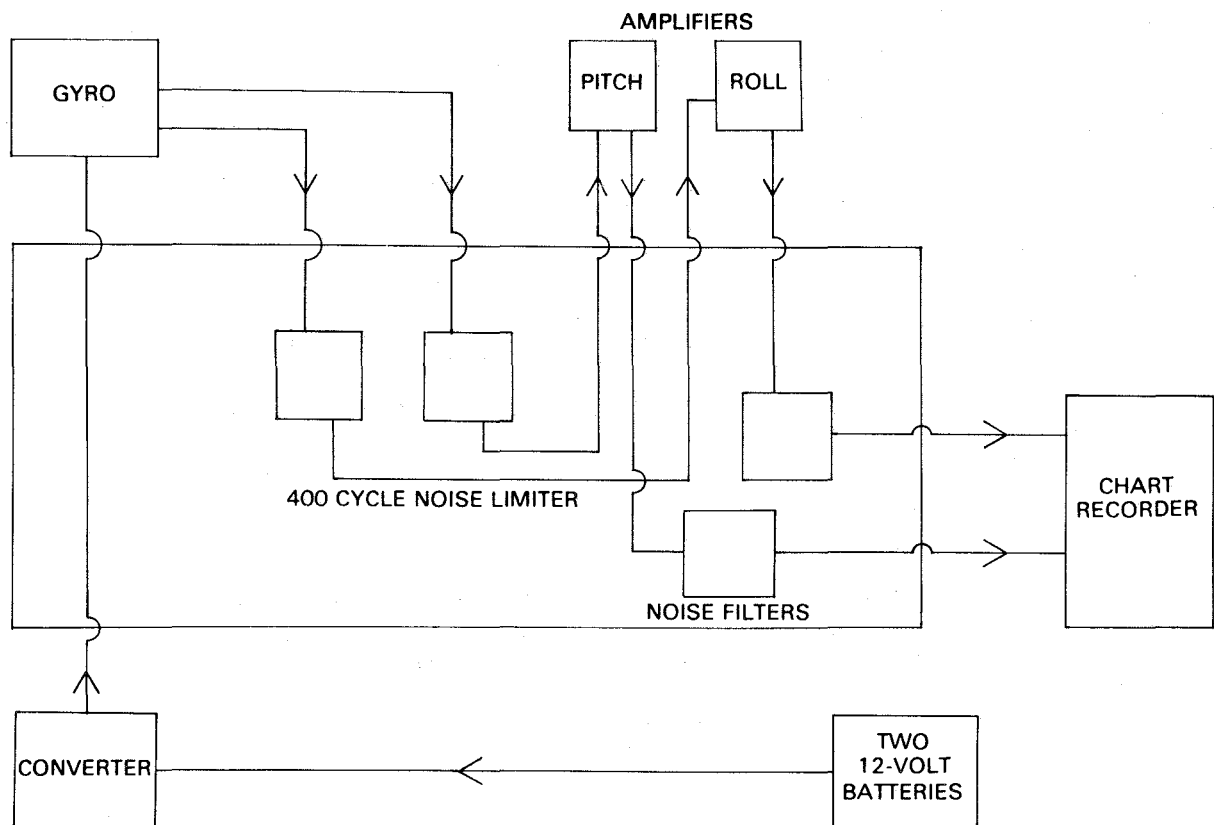


Figure 2.--Instrumentation block diagram of electronic equipment.

INITIAL TESTING OVER ARTIFICIAL BUMPS

In order to calibrate the gyroscope, we needed a road with known bump height. A short section of asphalt road was used for the test. Lumber was used to make bumps on the road. Three sizes of lumber were used: 1" X 6" boards, 2" X 4" planks, and 4" X 4" timbers. these were spaced at different intervals perpendicular and diagonal to the direction of travel (fig. 3).

The calibration runs have been completed, and the apparatus is performing as anticipated. Chart output and the deviations in the road are closely correlated.

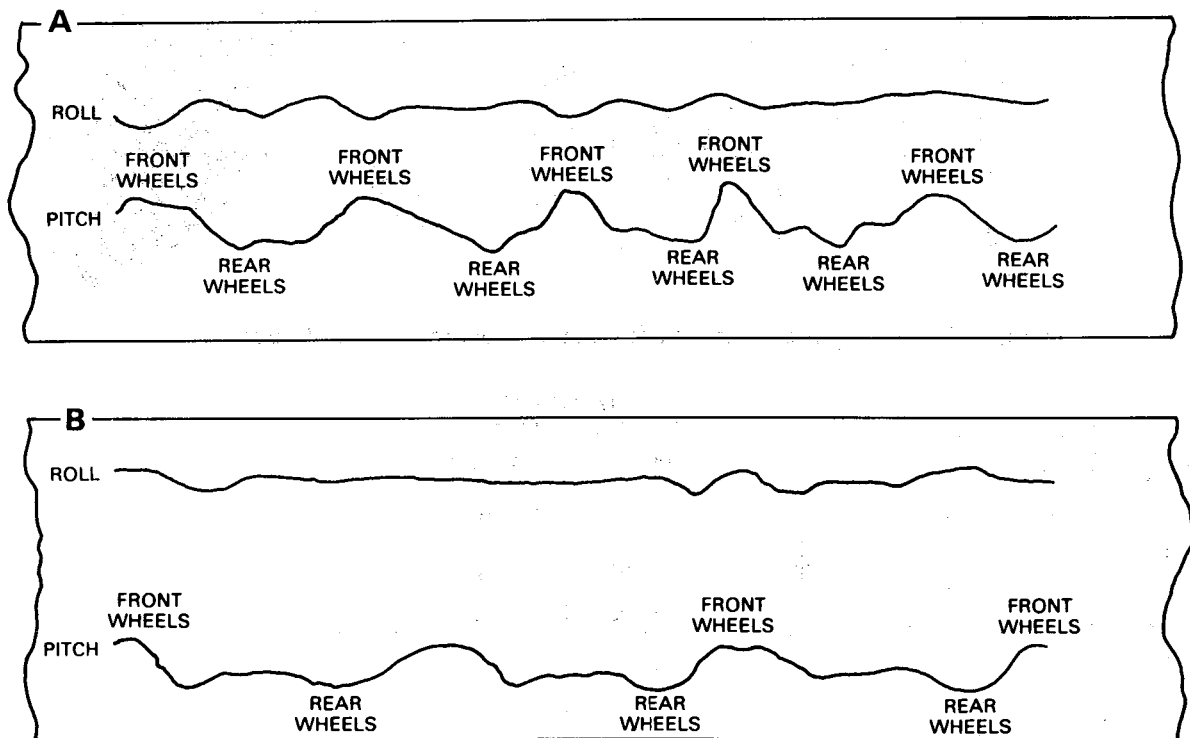


Figure 3.--Chart output when traversing 4" X 4" timbers (a) 4 feet apart and (b) 6 feet apart.

FUTURE TESTING

Next, the instrumentation will also be tested on a selected road bed having pitch and roll deviations (a road having a ditch crossing both tracks and also potholes not in alignment with both tracks). The deviations on the test road will be measured for length and depth to determine how close the chart reading compares to the actual road.

