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FOOD AND AGRICULTURE ORGANIZATION

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INTERNATIONAL LABOUR ORGANISATION

**JOINT COMMITTEE ON FOREST TECHNOLOGY, MANAGEMENT AND TRAINING**

**Seminar on Environmentally Sound Forest Roads and Wood Transport**

Sinaia (Romania), 17-22 June 1996

**REPORT**

(as approved by the seminar)

**Introduction**

1. The Seminar on Environmentally Sound Forest Roads and Wood Transport was held in Sinaia, Romania, at the invitation of the Government of Romania. The Seminar was held the week of 17 to 22 June 1996. One hundred and four participants from the following 22 countries attended: Albania, Austria, Belgium, Canada, Croatia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Norway, Portugal, Romania, Slovakia, Slovenia, Switzerland, United Kingdom, and United States of America.

**Opening of the Seminar** (Item 1)

2. On behalf of the Joint FAO/ECE/ILO Committee on Forest Technology, Management and Training, Mr. Rudolf **Heinrich** (FAO) welcomed participants. He expressed the Committee's appreciation to the Government of Romania for their support in organizing and acting as an exceptional host of this seminar. He also thanked the IUFRO Subject Group S3.06 which had actively contributed to bring together such a high level audience. He informed the delegates about the

role of the Joint Committee and about the organization of its activities. He also took the opportunity to inform the participants about two important events that FAO is organizing. The first event, namely the 'World Food Summit' will be held from 13 to 17 November 1996 at FAO Hqs in Rome; it will be attended by heads of state, heads of government and heads of delegations. The second event is the '11th World Forestry Congress' which will be held from 13 to 22 October 1997 in Antalya (Turkey). Finally, he wished all participants a stimulating and rewarding week.

3. A Welcome address was given by Mrs. Angela **Voicila**, General Director of Research and Technology Ministry. The speaker underlined the importance of exchange of experience and knowledge in an international forum to improve road planning, design and construction techniques and systems supporting environmentally friendly forest practices.

4. On behalf of the IUFRO Research Group S3.06 "Forest Operations Under Mountainous Conditions", Mr. Hans Rudolf **Heinimann** welcomed participants. He gave a brief overview of the objectives and the activities of IUFRO which is a non-profit organization that sets out to promote international collaboration between forest researchers. He described the objectives of the seminar: (i) to exchange experience about environmentally sound activities; (ii) to discuss the state-of-the-art knowledge from the point of view of different experts, countries and socio-economic conditions; and perhaps most important (iii) to make conclusions and recommendations on future follow-up activities.

5. The Chairman of the Joint FAO/ECE/ILO Committee on Forest Technology, Management and Training, Prof. Paul **Efthymiou** explained that the theme of the seminar is most relevant for the Joint Committee. Forest management and utilization require good access to the forest in order to make rational use of the forest resources. He described the orientation of the Joint Committee's activities which should always integrate five criteria-dimensions: (1) technical perfection; (2) ergonomic performance and safety; (3) environmental features and protection; (4) economic efficiency and profit; and (5) social considerations for employment, cultural values, etc. He stressed the priorities of the parent bodies: European Forestry Commission (EFC) and Timber Committee (TC) and the need to support the countries in transition (CITs). Finally, he declared the seminar open.

6. On behalf of the Romanian Government, Mr. Marian **Ianculescu**, State Secretary of Waters, Forest and Environment Protection welcomed participants. He presented an opening lecture on *Forestry Strategy and Forest Legislation a Framework for Forestry Development in Romania*. Mr. Ianculescu mentioned that the Rumanian Government had recently passed three important laws which set the

foundation for sustainable forest management in the country: the Forest Code which will come into force in July 1996; the Wood Mass Law which regulates the volume of harvested timber; and the Wild-life Protection Law. There is a great need for forest road development in the country to support sustainable forest management. This will require substantial resources in terms of technical know-how and funds.

**Adoption of the agenda** (item 2 of the agenda)

7. Chaired by Mr. Efthymiou, the provisional agenda as set out in TIM/EFC/WP.1/SEM.43/1 was adopted.

**Election of Officers** (Item 3)

8. After a proposal by the Chairman, Mr. Efthymiou, the seminar elected Mr. Marian Ianculescu, State Secretary of Waters, Forests and Environment Protection Ministry (Romania) as Chairman and Messrs. Ovidiu Cretu (Romania) and Hanns Höfle as Vice-Chairmen. The seminar agreed to the nomination of the following moderators:

Item 4	Mr. Walter Warkotsch (Germany)
Item 5	Mr. Hans Rudolf Heinemann (Switzerland)
Item 6	Mr. Bjorn Akre (Norway)
Item 7	Mr. Ed Aulerich (U.S.A.)

**Environmentally Oriented Forest Road Planning, Design, and Location** (Item 4)

Moderator: Walter **Warkotsch**

9. Mr. Hans **Heinmann** (Switzerland) presented *Opening-up Planning Taking into Account Environmental and Social Integrity*. Public awareness of environmental issues has increased constantly in the last few years. The construction of forest access structures is presented as one of the main forest activities responsible for destroying the environment. Forest professionals therefore have to look for improved procedures for planning, designing and constructing forest transportation networks to improve public acceptance. A framework for the planning and design process for forest transportation networks based on a systems engineering approach was presented. The planning process must be transparent and ensure public involvement in the project process model. Public acceptance is improved if (1) technical capability, (2) economic efficiency (3) environmental integrity and (4) social integrity are assessed using indicators that may be quantified. He introduced analysis methods to evaluate the different indicators and criteria, as well as a multicriteria decision-making

procedure.

10. Mr. Hubert **Dürstein** (Switzerland) presented *Opening up of a Mountainous Region, Decision Making by Integration of the Parties Concerned Applying Cost Efficiency Analysis*. In the mountainous region of Central Switzerland, the forest transportation development alternatives are (1) roads, (2) railways and ropeways combined with roads. Alternatives are evaluated and compared by considering economic, technical, and environmental concerns. All relevant interests and needs must be addressed. An appropriate method for considering different needs, risks, and effects is cost efficiency analysis. This method was chosen because it can be used in a simple transparent way the influence of the investment costs remains distinguishable until the end of the evaluation. The most important elements allowing all sides to accept the decision-making procedure were an extensive goal system and the weighting of the criteria by the parties concerned from which a logical selection of the most desirable alternative could be made. To gain satisfactory compromises and solutions the parties concerned must directly participate in the decision-making procedure, for this, simple and understandable methods must be available.

11. Ms. Renate-Susanna **Spaeth** (Germany) presented *Environmentally Sound Forest Road Construction in Nordrhein-Westfalen, Federal Republic of Germany*. Growing pressure on forests for recreational activities result in increased involvement of the general public and demands for a forestry road network able to handle the multiple uses of forests in a highly industrialised and densely populated country. Research by the University of Göttingen resulted in several recommendations for forest roads. New road construction should be examined carefully with the view of favouring other technical means and avoiding altogether in particularly sensitive woodland areas. If the decision is made to proceed with new construction then alignment, design, and choice of materials should be determined according to ecological principles. If suitable construction material can not be extracted from the immediate vicinity then specific criteria should be observed when obtaining materials from extraneous sources. Recycled building materials and industrial by-products must be environmentally compatible.

12. Asked how the forest authorities manage to ensure that no harmful wastage material is used in road construction, Ms. Spaeth replied that proper documentation and screening is a pre-condition for the use of recycled material in road construction. It was commented that the use of recycled material could have a great cost-cutting potential if applied in the right way.

13. Mr. Igor **Potocnik** (Slovenia) presented *The Multiple Use of the Forest Roads and Their Categorization*. Fifteen of the most frequent uses of forest roads were analysed from a sample of 1/6 of all the forest roads in Slovenia.

Forestry uses accounted for more than 40% of the total use of the roads. Hunting at 17% and farms at 13% were the next largest road uses. Forest roads can be categorised such that road maintenance standards, signs, markers, safety facilities, and road use rules can be defined by road category.

14. Mr. Tuomo **Häyrinen** (Finland) presented *Forest Road Planning and Landscaping*. Landscape is partially formed by the law of nature and partially by the actions of human beings. How one interprets a forest road within landscape is influenced by one's own personal experiences, objectives, hopes and attitudes. Landscaping is very much a matter of aesthetics. In forest road building a planner is faced with the task of how to optimise economics, ecology and aesthetics at the same time. The planning method and the tools used in forest road planning depend on each planning case and available resources. Very often a visual method with "multiprofessional insight" is the best method. Numerical methods for landscaping will come in the future, especially for some routine road planning cases. Some advantages of advanced methods and tools were discussed. The beauty of landscapes reflects the tones of each era. Cultural backgrounds and development phases of societies have a remarkable influence to landscape values. Landscaping in forestry and in road building is the mirror of the surrounding values in societies. When producing proper landscapes a forest road planner must use various skills besides technical know-how. Many constraints and public awareness require that conflict management and public participation have come into the forest road planner's "tool-box".

15. Mr. Ovidiu **Cretu** (Romania) presented *Forest Roads in Romania, Planning and Designing*, co-authored by Constantin **Rusnac** (Romania). The Romanian forest lands extend over 6.3 million ha, representing 27% of the total area of the country. The distribution of forest lands is such that 90% of it is on landscapes classified as hills or mountains. Forest accessibility is low because of a lack of adequate access roads. From the total of 6.3 million ha of forest land, only 4.1 million ha could be considered accessible, the rest of these forest lands are not connected to an existing transport system. At present the forest lands are served with a 39 186 km transport system (truck roads, narrow gauge railways, public roads, and servicing roads). The density index of the forest road network is 6.2 m/ha. According to detailed studies, which have considered the economic and environmental conditions and consequences, the optimum transportation system density averages about 13.3 m/ha. This density results in average collecting distances of 700 - 800 m. Approximately 42 260 km of road will have to be built to achieve this system density.

16. Mr. Norocel-Valeriu **Nicolescu** (Romania) presented *Aspects Regarding the*

*Accessibility of Mountainous Stands Subject to Windfalls.* The forces of nature can have very damaging effects on forests. When the phenomenon is spread over a large area a significant result is that a heavy work load of wood harvesting, transportation, and conservation activities must proceed immediately. Unfortunately, large scale windthrow is quite common in Romania. There is good Romanian experience in coping with such situations but the major difficulty now faced is related to the forest road network. The road network is characterised by a low density of roads per hectare and poor road quality. The optimum technical solution to be put into practice in the Romanian mountainous stands subject to windfall seems to be the use of cableways. Taking into account the complex peculiarities of wind-damaged stands, the possibilities of using various Romanian and foreign types of cableways in such conditions were discussed.

17. It was asked what the main causes to the large windthrow were in 1995. Mr. Nicolescu explained that very strong winds, up to 200 km/h, in combination with the fragile conditions of the forest stands had contributed to the large-scale damage. Until now, only 50 % of the wood had been removed from the forest stand.

18. Mr. Ján **Tucek** (Slovakia) presented *Technological Requirements for Forest Roads Location in Slovakia Conditions*. The importance of the technological requirements of road and landing location was presented in connection with economic, ecological, social, and management requirements. The possibilities of using computer techniques, digital terrain models and geographical information systems in the planning of forest roads was discussed. Forest operations planning and modelling were described with the possibilities for solutions. Some of the latest trends and solutions in this field, studied by the Department of Exploitation and Forest Mechanisation of the Faculty of Forestry, Technical University, Zvolen, were presented.

19. Mr. Mihallaq **Kotro** (Albania) presented *Forest Road Network in Mountainous Forests Ecological, Technical, Economical and Social Aspects*. Albania has a forest land cover of 1 million ha with a standing wood volume of 80 million m<sup>3</sup>. The Albanian forestry faces considerable problems with low forest accessibility which is due to an inadequate distribution of forest roads. In addition only 50 % of the roads are in a usable condition. Forest studies showed that 70 % of the forest area could be used for commercial wood harvesting providing the road network was improved. To achieve this, there was a substantial need for external technical and financial assistance.

20. Mr. Tetsuhiko **Yoshimura** (Japan) presented *Fuzzy Expert System Laying out Forest Roads Based on the Risk Assessment (Voluntary paper)*. In most mountains in Japan, it is very difficult to construct forest roads because the topography

is very steep and slope failures are often caused by constructing roads. Therefore, it is very important to locate forest roads on stable slopes. He discussed a quantitative risk assessment estimating the degree of slope failure potential using topographic maps. The objective of the presented study is to support decision-making of laying out forest roads in mountainous areas based upon a risk assessment. The study focused on the decision-making of selecting passing points of forest roads using the fuzzy set theory. The advantage of this method is that a computer can automatically suggest the lay out of forest roads as if it were a human brain. It made it much easier to plan forest roads in mountainous areas avoiding the possible areas of failure.

21. Mr. Roger **Hay** (United Kingdom) presented *Forest Road Design*. The construction of a forest road has the most potential of any forest harvesting operation to cause damage to the amenity and environment of the forest, yet is a most essential part of the strategic and tactical harvesting and other forest operations. Without road access most of the production of a forest would not be available. He examined the impact of road construction on the environment of the forest and suggested ways in which the effects can be reduced and environmental benefits could be obtained.

22. During the discussion, the importance of good drainage was stressed. Asked why the UK Forestry Commission only had one road standard, Mr. Hay explained that this was because the vehicles which were used required only one road standard.

23. Mr. Walter **Wolf** (Austria) presented *Assessment of Alternatives of Forest Roads with Special Emphasis on Environmental Protection*. Future forest road construction (15 000 to 20 000 km in Austria) will face increasing difficulties regarding terrain and land ownership. This will require extensive studies and assessment of alternatives to forest roads. A new system of assessment based upon a valuation scheme was presented. Two groups of equally important criteria are defined. One group considers monetary benefits and costs. The other group includes items that are difficult to value monetarily (non-monetary values). A system of value points are allocated according to the importance of the criterion. An example of the assessment together with the completed forms was given.

24. In the discussion that followed the presentation, several speakers underlined the need for less complicated evaluation models which could be used in the field. It was also stated that there is a need for a tool which would enable objective assessment of non-monetary values.

25. Mr. Tibor **Pentek** (Croatia) presented *The Influence of Building and*

*Maintenance Expenses of Forest Roads on their Optimal Density in Low-lying Forests of Croatia.* A theoretical model for the optimization of the density of a forest road network was described. A specific example was presented showing the use of locally collected data in the optimization. Detailed calculations, results, and useful graphics were displayed.

26. **Summary of Discussions** - Following the presentations under this item the moderator, Mr. W. Warkotsch, led the discussion on the following three topics:

(a) **Improved planning procedures, including social, environmental and landscape aspects and the participation of the public and other parties concerned.**

During the discussion several speakers expressed concern over the problem of communication between environmentalists and foresters. Experience in some countries showed that there is often a vast polarisation of parties involved which make it difficult to apply decision-making procedures. Messrs. Heinemann and Dürrstein stated that the chances for successful planning are greater if the stakeholders are involved at an early stage. In addition, procedural rules based on democratic principles would facilitate a solution which is acceptable to all parties concerned.

In the UK, the local District Manager was obliged to consult with local interest groups. This was done on a regular basis and enabled informal and close contacts with the public.

Concerning the mediation it was found that, sometimes, it could be an advantage to appoint a neutral person acting as facilitator. In South Africa this concept had proved to be successful.

(b) **The application of modern technology in forest road planning**

It was pointed out that the use of modern technology can result in considerable time savings which allow more investment in the planning and design process. However, basic knowledge is indispensable to ensure that sound forest engineering practices are applied.

It was stated that in order to make good use of advanced technology it must be accompanied by tools which enable objective evaluation of non-quantifiable criteria.

(c) **Improved road design, road standards, specifications and design criteria**

The need for specifications concerning the gradients of the roads were

discussed. Different opinions on the maximum road gradients were expressed. Besides technical issues, social and ecological ones have to be taken into consideration, as well. It was mentioned that the problems of the use of the forest road for recreational purposes can require special road standards. The question of compensation for public access to private forests was raised.

A representative of the Romanian delegation emphasized the importance of striking a balance between technical, economical and ecological interests in opening up forests. It was stressed that foresters certainly have the capacity of being good ecologists.

**Environmentally Sound Forest Road Construction and Maintenance** (Item 5)

Moderator: Hans Rudolf **Heinimann**

27. Mr. Bjorn **Akre** (Norway) presented *Forest Road Construction Policies, Guidelines and Code of Practice*. National measures, regulations, and guidelines for the construction of forest roads are a part of the national forest policy program of Norway. He referred to a national grant program for forest road construction that was initiated in 1934 in Norway. Change of harvesting/transportation methods and equipment, increasing environmental consideration, and public multiple use have all resulted in regularly updating governmental measures to promote and ascertain proper construction procedures. He provided specific Norwegian examples of forest road planning and approval regulation, forest road standards, and forest road construction practises code.

28. Mr. Otto **Sedlak** (Austria) presented *Forest Road Construction Policies in Austria*. A problem of the forestry sector on the political and practical level worldwide is environmental concern about forest development and utilization. Instead of a permanent confrontation, pragmatic and integral solutions must be found that are well adapted to the socio-economic and environmental conditions of a country. He discussed Austrian and international experience in policies and regulations of planning and building forest roads in the context of multi-purpose management and environmentally friendly techniques. Specific practical Austrian experiences were presented.

29. Mr. Raffaele **Spinelli** (Italy) presented *A Review of the Environmental Impact of Forest Road Construction*. A comprehensive compilation of world-wide references on the environmental consequences of forest operations was done. A computer analysis of the collected data mapped the characteristics of the available information. It defines the "pillars" of environmentally sound road building and points out the most urgent research needs.

30. A question was raised whether the bibliography was going to be continuously updated. Mr. Spinelli replied that this was the intention but the question of financing has to be solved. Users of the database were invited to make suggestions and comments on how the database could be improved.

31. Mr. Stanislav **Sever** (Croatia) presented Problems of forest opening in Croatia. About 80 % of Croatian forests and forest land are state forests. During the last five years road density has increased from 6.6 m/ha to 7.0 m/ha. Until the year 2025 the programme of the state enterprise, Hrvatske sume, includes further strengthening on these efforts. The target is a road density of 15-20 m/ha. Forest road construction has accounted for between 24-62 % of the total investments in the enterprise.

32. Mr. Ed **Aulerich** (USA) presented *Better Engineering and Control of the Construction of Forest Roads*. The concern for the environment and for rising costs has increased the importance of engineering for all levels of forest roads. It is no longer feasible to "eye-ball" design and construct a forest road that may not meet the needs of the users or has a higher probability of failure with the resulting costs and environmental degradation. Of the four major activities (Location, Design, Construction, Maintenance) that dictate the success or failure of a road structure, the construction phase is often the least controlled. In many parts of the world, roads are temporarily located, and then the equipment operator attempts to design and construct a road that will meet all of the criteria specified. In many cases the result is that the road is over or under built, thus increasing the cost, or it is not structurally sound, thus increasing the probability of a failure. He stressed the importance of construction control and presented some of the basic ways to achieve such control.

33. In response to the question why they had selected the center line method with slope staking in the field, Mr. Aulerich responded that the method was efficient, easily understood by the contractor and allowed the road construction to be monitored during and after the completion of the work. In Europe, generally, the grade line method is applied.

34. Mr. Ion **Cazan** (Romania) presented *Building and Maintaining of Forest Roads, Technologies and Equipment*. General national demands, especially the scope of wood working and civil works required more wood. The national development program focused on the utilization of Romanian natural resources and raw materials. It was necessary to enlarge the logging operations for the woodworking industries. Forests had to become more accessible. The best way was the extension of the forest roads network. Between 1956 -1961 forest roads building was at a very low rate (70-120 km/an) and costs were high. Lack of equipment and materiel was such that forest road building was carried out with

hand tools. Such conditions did not allow progress in this field. Productivity was very low and the number of workers was very large. After 1962 large numbers of workers were replaced by machines. Beginning with 1966 the rate of forest roads building was between 900-1570 km per year until 1987. Maintenance of forest roads has become a very important matter due to the large network of existing forest roads.

35. Mr. Katsuhiko **Kitagawa** (Japan) presented *Development of a Forest Road with a Newly Designed Subbase Structure*. A newly designed subbase structure was described and its advantages discussed. The surface of roadbed (subgrade) soil is formed by a gentle slope of about three to seven percent down toward the valley side from the mountain side. A waterproof polyvinyl-cholide mat for separating the roadbed soil and subbase ballast covers the entire surface of the roadbed. The ballast is scattered on the mat and the road surface is made level. The subbase itself has the function of a drainage facility and rainwater passes through the ballast and is drained onto the valley-side slope. No erosion occurs on the side slope and the forest land below the forest road is irrigated. Long-term observation of actual forest roads constructed by this method has shown that this new type forest road was still usable years after construction.

36. Mr. Paul **Efthymiou** (Greece) presented a paper *Alternative Stabilization Methods of Forest Roads for an Efficient and Gentle Mechanisation of Wood Harvesting Systems*, co-authored with Mr. P. Eskioglou. The stabilization of forest roads can substantially improve the efficiency and the quality of wood harvesting systems with respect to their detrimental impacts. Three alternative methods of stabilizing forest roads (limestone, cement and ash) were discussed from the technical and economic view-points.

37. Concern was raised that the ban of forest machines in the forest stand would lead to other adverse impacts due to the increased need for secondary roads. It was questioned whether lime and cement on road surfacing could be considered as natural materials, Mr. Efthymiou answered that experience showed that the risk for run-off of the lime or cement was very small. Furthermore, only limited quantities of cement was used in road stabilization, and all stabilizers are after curing fully incorporated into the pavement of the forest road.

38. Mr. Randy **Foltz** (USA) presented *Traffic and No traffic on an Aggregate Surfaced Road: Sediment Production Differences* Aggregate is placed on forest roads in wet climates to provide structural support for traffic and in dry climates to reduce sediment production caused by precipitation. In both climates good quality aggregate is often not available. To measure the

difference in sedimentation rates, the US Forest Service conducted a sediment study using two aggregate qualities, one exceeding all specifications, the other marginally failing to meet two of the specifications. The results showed that the quality of the aggregate made a notable difference in sediment production. When subjected to heavy logging truck traffic, the marginal quality aggregate produced from 2.9 to 12.8 times as much sediment as from a similar section surfaced with the good quality aggregate. Sections with traffic produced 2 to 25 times as much sediment compared to sections with no traffic.

39. Mr. Randy **Foltz** presented *Measuring and Modeling Impacts of Tire Pressure on Road Erosion*. Unpaved forest roads used to transport forest products can be operated in an environmentally sound manner by the use of variable tire pressure on logging trucks. Variable tire pressure can be implemented in two ways. Central Tire Inflation Systems (CTIS) allow a vehicle driver to reduce tire pressure while in motion. A three year study was performed on the effect of using variable tire pressure trucks on the sediment production from aggregate surfaced forest roads. The average sediment reduction from the use of CTIS was 80% compared to highway tire pressures. When using CRP tire pressures, the average sediment reduction was 45%. The results of this test were used to calibrate a physical process based erosion model, WEPP (Water Erosion Prediction Project). The calibrated model was used to estimate the sediment reduction expected at two locations in the United States, one in Brazil, and one in Romania.

40. A question was raised whether they measured the actual volume of sediments from the road. Mr. Foltz responded that they had measured sediment losses averaging 30.000 kg/ha/year from the highway tire section. He urged, however, caution when applying this figure to other road sections.

41. Mr. Sjur **Haanshus** (Norway) presented *Environmentally Sound Construction Methods and Use of Appropriate Equipment*. Construction of new forest roads is often criticised from an environmental point of view, in Norway as in other parts of the world. He discussed construction methods and equipment to be used under the assumption that all terms and conditions permitting road construction have been met. The challenge for the road planning officer and the road contractor is to take all environmental aspects into consideration when choosing methods and equipment for the different jobs. He referred to the methods and equipment used in Norway under varying conditions in geology, topography and climate. He also discussed by what means the authorities may influence the choice of construction methods, and what environmental issues are particularly significant in road planning and construction.

42. Mr. Serghie **Varjoghe** (Romania) presented *Forest Road Engineering*. Road

construction under Romanian conditions results often in a large number of river crossings, drainage problems and measures for protection and consolidation of road beds. A number of different technical solutions has been tested and applied during the past 40-50 years with varying results. Some new culvert and bridge constructions were discussed: the introduction of pipe culverts of prefab components of square section with better drainage and reduced risk of clogging; and prefab components for bridges with larger widths to shorten construction time.

43. Mr. Miklos **Kosztka** (Hungary) presented *Maintenance Management System of Forest Roads*. Pavement design realizing cheap and up-to-date principles for material usage of forest roads can only be accomplished by well-considered pavement management strategies. Using a model of changes in bearing capacity he examined different pavement management strategies. With the comparison of these strategies, appropriate rules for pavement management of forest roads can be formulated.

44. **Summary of discussions** - Following the presentations under this item the moderator, Mr. Hans Rudolf Heinemann focused the discussion around four themes which reflected the 13 papers presented under this item.

(a) **How to design forest roads**

The question of maximum gradient on forest roads created a lively discussion. In this context it was mentioned that erosion problems already occur on gradients over 7%. Several speakers were of the opinion that gradients on forest roads should generally not exceed 12% because of drainage and environmental reasons. The maximum gradient can be increased, if an overall evaluation of alternatives demonstrates that this has the least impact. The need for an adequate drainage system in steep terrain was emphasized. Furthermore it is important to define the use and category of a road network at an early stage in the planning process. This minimizes the risk for more costly and complicated up-grading work which could be the result of an inadequate design.

There were different opinions on whether increasing inclination of culverts is an advisable method to prevent clogging. Some speakers thought that the waterflow, if not slowed down, would increase the sediment run-off and have an adverse effect on fish. There was a consensus that the gradient in any case should not be more than the slope of the stream bed.

(b) **The transfer of good engineering methods to field practitioners**

It was a unanimous recognition of the importance of a well-trained forest workforce to ensure that good engineering practices were carried out in the field. Considering the key role of the machine operators, it was noted that far too little was invested in training of operators. The need of training on other levels such as supervisors was also emphasized. Austrian studies showed that substantial productivity gains could be made through increased training. It was stressed that good design planning could not be called sufficient until the planner had put his foot on the ground.

**(c) Appropriate road construction practices**

During the discussion the Norwegian model of enhancing good local knowledge of the conditions was recognized. It was stated that medium and small-scale contractors should be promoted. Asked what the Norwegian safety requirements for forest workers were Mr. Haanshus replied that there were no special regulations for forestry. Forest operations were covered by the same regulation as for other occupations. He added that it was compulsory that the contractor was insured.

As an alternative to geotextiles used in road construction on wetland, it was suggested that surplus wood material such as stumps could be used to stabilize the sub-base of the road. However, in some cases when this timber rots there may be difficulties. The mobile rock crusher was highlighted as a machine that merited more attention for its potential to make use of local road material and thus reduce the transport distance.

On ground with low bearing capacity, lime or cement stabilization is a good option to save aggregate material. However, it was stressed that mechanical stabilization technologies remain the principal method.

**(d) Road maintenance considerations**

Central Tire Inflation System (CTIS) is in use quite extensively in USA and have given good results in reducing the impact on the road. The costs for fitting the system to a truck was in the range of US\$ 10.000-15.000. It was noted that it might be hard for the contractor to see the benefit if he was not compensated in some way. Experience from USA showed that contractors often manage to recover the cost in the negotiation of the contract. In addition, the use of CTIS has some direct positive effect for the driver, such as smoother running and less vibration.

**Forest Engineering Structures and Protection Works** (Item 6)

Moderator: Bjorn Akre

45. Mr. Christoph **Gerstgraser** (Austria) presented *Soil Bioengineering Measures for Hill and Slope Stabilization Works with Plants*. For centuries wood and living plants were the only material for hill and slope stabilization works. Today, some of these old techniques have been modified and applied again. New methods have been created which mainly use living material such as willow branches, willow cuttings and rooted deciduous trees. There are numerous different hillside and slope stabilization methods which utilize plants in combination with constructions of wood, stone and wire such as planted pole walls, live slope grids, live wooden cribwalls, vegetated stone walls and vegetated gabions. Choosing the right method depends on various factors such as the position of slope, ground and available material. All the described soil bioengineering measures are being used for hill and slope stabilization in South Tyrol (Italy) and Austria.

46. A question was raised concerning the cost share of soil vegetation measures in road construction. Mr. Gertgraser could not give a figure but stated that it was not more expensive than other mechanical engineering methods for soil stabilization in steep terrain. He added that soil bioengineering measures have the advantage of reducing the visual impact of civil engineering works and that they are labour intensive. It could, therefore, have a potential for employment creation in the future. It was commented that the paper provided practical guidelines on the stabilization and rehabilitation of eroded soils using soil bioengineering methods.

47. Mr. Octavian **Popescu** (Romania) presented *Consolidation of Road Slopes by Means of Forest Vegetation*. The research and experiments performed in Romania concerning road embankment stabilisation by means of forest vegetation has had good results. This is especially true in the areas of preventing soil erosion and, to some extent, preventing land slip. The most efficient techniques in different conditions have proven to be terraces supported by small fences, stone benches, and vegetatively reinforced terraces. A variety of techniques in an assortment of situations was presented with associated results.

48. Mr. Miroslav **Hrib** (Slovakia) presented *Research and Design of Erosion Control and Sanitation Methods on Forest Roads and Slopes*. He presented a study which they had carried out identify and design simple erosion methods which could be applied on slopes and skidding tracks. It had been observed that applying erosion control measures, the erosion was drastically reduced, up to 95 % in some cases. Vegetative methods such as vegetation of slopes or soil beds of forest skidding roads has also been practiced with encouraging results.

49. Mr. Zeljko **Tomasic** (Croatia) presented *Soil erosion on several slopes of experimental skid trail in the four-year period (1992-96)*. Soil loss on skid trails was measured over a four year time period. Total and annual losses were estimated and correlated with site characteristics and skid trail characteristics. Results on various trail gradients were displayed.

**Wood Transport** (Item 7)

Moderators: Bjorn **Akre** & Ed **Aulerich**

50. Mr. Rudolf **Heinrich** (FAO) presented *Recent Developments on Environmentally Friendly Forest Road Construction and Wood Transport in Mountainous Forests*. The importance of recognising a wider range of forest products comprising wood and non-wood forest products including the service functions of forests was emphasized as a prerequisite for sustainable forestry. New surveying and construction methods bearing on environmentally friendly forest road planning and construction were discussed. Different modes of transport in steep terrain, especially low impact systems such as tracked skidders and cable logging systems were emphasized. Recent innovations such as the use of mobile cable systems in combination with wood processors and the research efforts searching for solutions to wood harvesting operations in steep terrain were noted. Aerial systems such as helicopters, balloons and cyclocraft were also discussed briefly. Recent FAO initiatives aimed at promoting environmentally sound forest harvesting practices worldwide were described.

51. Mr. Anton **Trzesniowski** (Austria) presented *Wood Transport in Steep Terrain*. Transport methods suitable for steep terrain were emphasised. The use of various cable logging systems was described. One, two, three, and four cable systems were outlined in sketches. Planning and organization of work in operating cable cranes are very important and are the deciding factor for the success of the work.

52. Mr. Torstein **Lisland** (Norway) presented *Use of Cable Systems on Soft Ground in Norway*. Logging on soft ground can successfully be done during winter time where and when there is stable frost. But as industry demands a constant flow of wood, soft ground areas also have to be logged all year. It is necessary to search for more environmentally friendly logging methods. A series of pilot operations have been carried out by the Norwegian Forest Research Institute. Technology from steep country logging has been modified and certain improvements have been achieved. Damage and costs for different harvesting methods were compared. Full tree, tree length, and shortwood loads were tried. Bundles and single tree loads were tested. Automatic releasing chokers were evaluated.

53. Mr. Hubertus **Prange** (Germany) presented *Road Development as a Basis for Sound Forest Management Practices under Central European Conditions*. A short overview of the historical use of woodland and forests in Central Europe was presented. Sound forest management practice must reflect forest ecosystems and forest functions. Guidelines were discussed using a forest in the Bavarian Alps as an example. Road development is a guarantee for a sustainable and rationalized forest management system on a sound ecological base.

54. Mr. Dubravko **Horvat** (Croatia) presented *Tractive performances of four vehicles used for wood transportation in mountain forest thinning*. The paper described a comparative study which was carried out on four skidders used in forest thinning in Croatia. The skidders were evaluated on their dynamic performance. The results showed that in mountainous conditions the medium sized skidders showed significantly better performances than the adapted agriculture tractors. A representative of the Romanian delegation emphasized the importance of striking a balance between technical, economical and ecological interests in opening up forests. It was stressed that foresters certainly have the capacity of being good ecologists.

55. Mr. Sanzio **Baldini** (Italy) presented *Harvesting Operations and Sustainable Forest Management*. In Italy, mechanization of harvesting operations is increasing, even though at a slow pace. The special topographical conditions favour the use of small- and medium-sized machines and cable systems.

56. **Summary of discussions** - Following the presentation under this item, the moderator Mr. Akre organized the discussion around the papers presented:

It was stated that excavators with a well-trained operator often proved to be a cheaper and much more environmentally sound alternative than bulldozers on forest road construction work. Asked what skyline system he preferred, Mr. Trzesniowski responded that his preferences depended on the intended user. In Austria, there is a large number of self-employed forest owners with small land holdings and harvesting volumes; their possibility to invest in machinery is thus limited. However, the agriculture-tractor mounted skyline was suggested as a possible option for farmers. For contractors, mobile skyline systems were often used. The well-developed network of forest roads in Austria (45 m/ha) had led to relative short yarding distances with an optimal distance between 300-400 m. The skylines used were, therefore, mostly small to middle-sized yarders with a capacity of 9-12 m<sup>3</sup>/hour.

Since labour is expensive, Mr. Trzesniowski saw an advantage with systems which required minimum man-power. There was a trend towards combined yarding systems with loaders and processors fitted to the machine. He emphasized that

operators had to be adequately trained and that the operations require careful planning in the extraction area and at the landing.

Mr. Lisland explained that lack of work for the skyline was often the limited factor in skyline operations in Norway. He expected the productivity to increase if this was somehow remedied.

Mr. Sedlak stated that the primary issue for a country, in its initial phase of establishing an adequate road network, is to clarify how the forest network should be designed. This consideration should take into account the forest operations practiced in the country and the systems to be used.

57. Mr. David **Mills** (Canada) presented *Software Applications in Forest Road Design, "Softtree"*. He discussed computer software as a forest road design tool. The Softtree product ROADENG was used as an example to explain the process. He firstly described how to convert field survey data into a model representing topography, and secondly how to build a model of a forest road by defining an alignment on the model. Cross-section templates, cut and fill material properties, grades, vertical and horizontal curves can be defined in the location design. Volumes slope stakes and road specifications can be generated from the design.

58. Mr. Petru **Boghean** (Romania) presented *Interconnection of Forest Road Network, Harvesting and Wood Transport*. The wide variety of forest lands in Romania results in a relatively rich level of experience concerning forest technologies, machines, equipment used, and transport technology. The variants and influences of forest road networks upon harvesting technologies and consequences were analysed and presented.

59. Mr. Panajot **Koci** (Albania) presented a paper *Road Network Development in Mountain Forests, Ecological, Technical, Economic and Social Aspects in Albania*, co-authored with Messrs. Mihallaq **Kotro** and Avram **Haxhi**. Reference was made that 36 % of the country is covered by forests. The forests cover 1 million ha with a standing wood volume of 82 million m<sup>3</sup> and the majority is located in the North, North East and South East of the country in mountainous terrain. Presently, the forest road network has an extension of 3.500 km which corresponds to an average road density of 3.4 m/ha. In addition to the low road net density, often the absence of sufficient mechanization cause considerable difficulties to carry out silvicultural treatment operations, as well as wood harvesting in old growth forests. Recent studies suggest that 70 % of the forests in Albania could be managed sustainably with a road net density of 15-20 m/ha permitting wood extraction distances fo 100-200 m manually, 250-300 m by ground dependent machines and 400-600 m by cable systems. The extension of the forest road network will permit to make best use of the ecological,

economic and social functions of the forests.

60. Mr. W. **Warkotsch** (Germany) presented *A Configuration Selection Procedure to Optimise the Cost of Longhaul Pulpwood Transport in the South African Forestry Industry*. The long distance road transport (longhaul) of pulpwood is typically the single largest cost associated with delivering pulpwood to a mill. The costs of owning and operating large truck-tractor trailer configurations, in turn, comprises the largest portion of this cost. To optimise the costs associated with longhaul pulpwood transport, therefore, it is necessary to select the truck configuration which will minimise costs. Varying pulpwood lengths and density, and forest road conditions, negate the selection of a single truck configuration ideally suited to all operations. This paper places longhaul pulpwood transport in the South Africa forest industry into perspective.

61. A question was raised whether the model put too much attention to the maximization of profits of the end user at the expense of the contractors. Mr. Warkotsch responded that the optimization of the whole chain of operations, from stump to end users, had to be considered. Furthermore, an optimized transport system which results in cost cuts benefits for parties involved.

62. Mr. Rudolf **Heinimann** (Switzerland) on behalf of Mr. John **Sessions** (USA) presented *Variable Tire Pressures for Forest Roads: A Synthesis of Concepts and Applications*. The relatively slow speed of vehicles on forest roads permits the possibility of using reduced tire inflation pressure which may bring the benefits of reduced surfacing requirements, longer transport seasons, and reduced road and vehicle maintenance. He presented a synthesis of the concepts and applications of variable tire pressures for forest transport vehicles and provided a framework for estimating the costs and benefits of using such a system.

63. Mr. Rudolf **Heinrich** on behalf of Mr. Oscar **Bustos** (Chile) presented *Optimization of Load Distribution on Forest Trucks*. Many forest industries have problems with a deficient load distribution on their trucks. The effect on the soil produces changes in its structure and increases maintenance costs. He presented an approach using a physics model to find an optimal position for a load of logs.

64. Mr. Jozef **Bartoska** (Slovakia) presented *Some Ecological Problems of Timber Transportation by Trucks in Slovakia*. Existing problems and possible solutions in various areas of timber transportation in the forestry management of the Slovak Republic were presented. He addressed the areas of environmental emissions; pollution of the environment by fuels, lubricants, and hydraulic

fluids; and damage to carriageways of forest roads caused by excessive axle loads. He presented the research programme of the Research Station of the Forest Research Institute Zvolen in Oraveky Podzamok.

65. Mr. Joachim **Wippermann** (Germany) presented *Long-distance transport of timber by trucks*. In Germany, the yearly transport volume of timber ranges from 22 to 30 million tons, the smallest part of it (3 %) is carried by inland navigation, 20 % by the railway system and 77 % by transport on roads. The long-distance transport on the roads, managed by independent companies, usually runs over 10-100 km (maximum distance of 300 km), mostly by short truck and semi-trailer up to 27 m truck-lengths, with maximum weight of 40 tons. Additionally, there is a fleet of trucks on public roads for transport of about 8 million m<sup>3</sup> chips for the board industry, as well as for the pulp and paper industry.

66. In the United Kingdom, the cross loading of short timber (about 2 m) on trucks was no longer allowed because of the risk of sliding logs. Asked whether they in Germany had managed to tackle this problem, Mr. Wippermann answered that the machine he had referred to in the presentation was only a prototype and that they were only in the initial stage of evaluating this method. He added that the modern standards for long-distance transport in Germany should either be 5 x 3 m, 4 x 4 or 3 x 5 m.

67. Mr. David **Lieberman** (Israel) presented *The importance of forest roads in Israel for the existing forest patrimony and its next extension*. This paper deals with the problems concerning the need of forest roads in the forest plantations in Israel. The Israelian forestry patrimony is about 85.000 ha out of which 45.000 ha are forest plantations of *Pinus Halepensis*, *Pinus Brutia* and natural forests, with shrubs and maquis covering 42.000 ha. Presently, some 5.500 km of forest roads exist representing 64 m/ha. Forest roads are required for the establishment of forest plantations, for soil preparation, wood harvesting and fire fighting in the forest. The roads are designed to take into account requirements of environmentally sound practices.

#### **Conclusions and recommendations** (item 8)

##### **68. Recommendations to member countries:**

- In order to guarantee sustainable forestry, as part of a long-term forest strategy, countries should support the planning, construction and maintenance of forest road networks. While satisfying production needs, consideration should be given to environmental, social and recreational requirements. Fire prevention and control play an important role.
- In order to meet the above mentioned recommendation, governments should

encourage the preparation of suitable codes of practice and support the training of all professionals in forest technology, in environmentally sound planning and in road construction methods. It is especially important that suitable training for forest contractors and operators is available.

- The forest authorities should ensure that there is a balance between the needs of the forest industry and the environmental and social groups.

**69. Recommendations to the Joint Committee:**

- An interdisciplinary framework to consider ecological, technical, social and economical needs should be developed.
- Promote research work on evaluation criteria and indicators on sound decision-making on forest road design, construction and maintenance.
- Promote frequent seminars and workshops on environmentally sound forest operations and wood transport.
- Develop an efficient information-exchange programme, i.e.:
  - proceedings
  - special reports, and a
  - permanent computer network.

The proceedings of this seminar should be published. If possible this publication should be in the FAO-Forestry Paper Series.

**70. Recommendations to IUFRO - IUFRO should:**

- (a) Encourage the establishment of common research programmes in the following problem fields:
- road network planning-methods;
  - project evaluation and ranking methods considering impact assessment; multi-objectives and multi-criteria decision-making;
  - process models explaining environmental impacts;
  - re-engineering of existing road networks;
  - the use of environmentally friendly vehicles for wood extraction and wood transport.
- (b) Organize additional seminars and workshops on:
- practical aspects of road construction;
  - road network planning based on case-studies;
  - planning, design and operation of cable systems.

- (c) Establish adequate networking activities to support the above listed efforts.

#### 71. **Conclusions**

The meeting concluded:

(a) The environmental pressures are now such that forest engineers must acknowledge them and while in many countries this has already been taken into account we must improve the standards of work done in the forest to attempt to meet these needs. It is necessary to involve the public in assessing these standards. We must, by concentrating on water quality and using biotechnology to revegetate slopes, improve our practice of road construction. We believe that gradients should be restricted to that which meets sensible drainage needs, and to ensure that good quality surfacing material is used. Overall, there is a need to consider the public aspirations for improvements in the environmental considerations of forest operators.

(b) The use of computer aided road planning and design is a major improvement, but is not a substitute for careful survey and location on the ground.

(c) In many countries there will be a continuing demand for additional access roading for forest management, and the maintenance of existing roads continues to be a problem. The use of roads for fire prevention and control is an important factor.

(d) Technical education of forest professionals should include environmental, ecological, economic and social factors.

**Any other business** (item 9)

72. No other business.

**Adoption of the report of the seminar** (Item 10)

73. The draft report, prepared by the secretariat, was adopted with some modifications which have been incorporated in the present document.

74. The Chairman, Mr. Marian Ianculescu, thanked the participants and the organizers for their active contribution to the successful outcome of the seminar. He expressed the hope that the recommendations formulated by the seminar could be followed-up for the benefit of the industry and its employees and declared the meeting officially closed.

75. Messrs. Efthymiou, Heinemann and Heinrich expressed deep appreciation and thanks to the Romanian hosts for the excellent organization of the seminar, as well as for the generous hospitality in their country.

**ANNEX**

**Report on the study visits**

**Friday, 21 June 1996**

Seminar participants visited the Craiului forest in the forest ranger district Zarnesti, Piatra located within the Forestry Branch of Brasov. Information was provided on the forest tree composition, forest regeneration and forest engineering and harvesting operations. In particular, reference was made that wood harvesting was undertaken on an area of about 100 ha covered by mixed beech and spruce forest stands, as well as pure spruce forest stands.

Wood has been harvested by applying selective cuts in mixed forest stands and clearcuts in pure Spruce forest stands. Both natural regeneration and afforestation were applied in selective as well as clearcut areas. In areas with no suitable and sufficient natural regeneration, afforestation is carried out in the first 2-3 years.

In the forest area visited, there existed several valley roads often built close to rivers. For extracting the wood, forests have been opened up by skid-trails to permit wood transport by agricultural tractors or other specialized ground based vehicles. Before 1990, also cable systems have been used for wood transport.

The area is a main tourist and recreation resort, particularly in winter for skiing. Due to the social functions of the forests in this holiday resort, special care must be taken in forest regeneration, silvicultural treatment and sanitary felling operations in order to maintain the protection and recreational functions of the forests. Clearcuts are prohibited in this area.

It was noted that there were high productive forest stands (medium annual increment of 8 m<sup>3</sup>/ha/year in old oak forest stands located above 1.100 m above sea level.

The participants had also the opportunity to make a visit to the Transylvania University of Brasov, Faculty of Silviculture and Forest Engineering where the Dean, Professor Gheorghita Ionascu provided information on the history and curricula of the Faculty. The University was established in 1883 near Bucharest and had been moved to Brasov in 1953. The Faculty consists of three Departments, namely Silviculture, Forest Engineering and Forest Management and offers undergraduate and post graduate courses.

Finally, participants had a chance to see the old city of the town of

Brasov, including a visit to the Black Church listening to an organ concert, visiting a museum consisting of a primary school and printing facilities, as well as the St. Nicolas Church and the Bran Castle.

**Saturday 22, June 1996**

The Seminar participants visited in the vicinity of Sinaia in the Forest Branch of Ploiesti, the Bogdan Valley, a watershed catchment area of 507 ha with a torrential stream.

In the beginning of the 20<sup>th</sup> century the area was reforested and torrential protection works were carried out along the stream over a distance of 15km. Different forest engineering and biological stabilization works were observed, such as stone made retaining walls and check dams, gabions, ditches and terraces, as well as wicker work fences to protect the soil from erosion and reduce the amount of debris material. Some of the engineering works showed minor damage caused by bigger stones and debris material transported by high floods. The torrent control stabilization works were necessary in order to protect the national road and railway Bucharest - Brasov, as well as the forest road Floresti - Valea Prahovei and others from destruction caused by high floods and debris material.

In Urlatoarea the participants visited an area with natural regenerated mixed forest stands of 140 years old fir and beech. The forests were located at an altitude of 880 m. The forest growth was very good, averaging per ha and per year was . The average wood volume was 722 m<sup>3</sup> per ha, the average BHD 50 cm for beech and 56 cm for fir with tree heights of 32m and 35m. For regeneration purposes selective cutting have been applied cutting primarily dead and damaged trees.

At Poiana Stanii located in 1300 m above sea level, fir and beech forest stands have been seen. The beech forests reached their upper vegetation limit. An average increment of 4.8 m<sup>3</sup>/ha/year was reported in 100-150 years old beech forests.

At the end of the excursion a farewell dinner was offered by the Romanian hosts in a spectacular mountainous forest surrounding.