Fundamental Options in Silvicultural Management and their Importance[1]

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The general aims of silviculture are forest conservation and forest restoration, but especially the promotion and maintenance of a state of good health and well-balanced structural equilibrium in the forest. The practice of silviculture is a logical consequence of forest utility. It must create appropriate conditions for forest utilisation and produce lasting benefits at a high level for the greatest number. Departing from a pluralistic view on the relationship between Man and Forest it promotes future developments.

The continuity of forest utilisation is to be guaranteed by stabilisation of the individual forest, eventual expansion of forest space and safeguarding of an optimal level of productivity in each subdivision of the area under consideration. The creation of a state of structural and bio-ecological stability is a way to promote actual variability in forest utilisation, not closing the road to unpredictable future developments.

Silvicultural management must realise a compromise between scientific experience, technical ability and human ambitions, all of which are direct objects of interest, research and study. The definition of the immediate aims of silviculture requires therefore a keen perception of the relativity of values leading to

- an open-minded evaluation of the situation of departure;
- the elaboration of alternative solutions to parallel or alternative developments in human society;
- a most careful choice of methods, not to impair possible development by the use of exclusive techniques.

Restrictive partiality in the definition of aims and the choice of techniques must be avoided under present circumstances, characterised by the relative shortage of forest space, increasing consumption of wood products all over the world and quick changes in aspect, importance and quality of forest utilisation. For this reason silvicultural activity must be integrated in a co-

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herent policy directed at the protection of natural resources and the care for environmental stability.

The acceptance of a bio-ecological foundation to silviculture must not imply the neglect of economic production. On the other hand public reaction in densely populated industrial countries, where absolute safeguarding of industrial interests at the expense of social functions and general well-being is no longer acceptable, will be provoked by the unilateral orientation of forestry management toward material production and direct financial results.

The forester as a public servant, who administrates public property and helps promoting general welfare, is in an excellent position to mediate between conflicting interests, provided he is able to evaluate correctly the relative value of each forest function and is willing to maintain a functional equilibrium, giving satisfaction to various demands. He has to reconcile socio-cultural ambitions and economic-financial objectives, that quite often correspond with different political options. He must think and plan on a continually expanding scale of time and space, be conscious of the relativity of silvicultural truth and recognise the dynamics of modern society and of perpetual change, caused by industrial expansion on a world scale, population explosion, technological progress, increasing consumption, environmental degradation and a profound change of socio-political relations.

Responsible silvicultural management must go out from the variability of the forest functions and from the constant modification of their relative value in time and space.

However, a critical approach to actual silviculture is necessary because of the great opportunity for choice at different levels of decision, where the future should be considered more important than the present. It is also advisable to accept the possibility of alternative future situations, that can be made more or less probable by present interventions. Each option is in fact related to a sequence of interdependent phenomena and decisions and each individual choice can help to further desirable evolutions or to weaken unfavourable tendencies. The use of the opportunity for choice is important because it expresses the will to choose the future, not to undergo it.

The Forest

The definition of the forest as a vegetative formation dominated by the presence of trees and woody plants covering the soil more or less completely and producing a desirable raw material, is adequate and creates misunderstandings. It applies well to certain

forest types created or strongly influenced by man, but does not express clearly enough the fundamental characteristics of the forest as an intricate form of life, a natural phenomen and a product of evolution. By origin and within reasonable limits of human impact, the forest is a complex ecosystem with multilateral links between its compounding elements. It is the result of total integration of a multiform biological entity in its physical surroundings, leading to a close relationship of reciprocal influences between the living world and the site on which it develops. Interdependent physical, chemical and biochemical phenomena occur in a closed association of ecological relations and nutritional chains. Trees and shrubs dominate the ecosystem by appearance and volume, by their overwhelming share in total biomass, but especially by their importance for primary production as the real starting point for nearly all nutrition chains existing on the site.

The total space actually covered by untouched forest with a high degree of eco-systematic complexity has been severely reduced. Therefore all remnants of natural forests, as well as the semi-natural formations at a high level of stability must be protected against unilateral exploitation and destruction, because of their value as objects for study and analysis. They provide more complete information on evolution dynamics and energy exchanges, which are the real basis for silvicultural practice, even in its application to the economic forest and to the simplified tree formations of human invention.

It is indeed rather unsatisfactory that forestry practice and research have been inspired for such a long time nearly exclusively by immediate financial returns and by the efficiency of human interventions in their relation to fixed economic objectives. Most often practice and research do not leave the restricted area of well-intended empiricism, paying more attention to forest utilisation than to the forest itself. This approach to the relationship between action and immediate result, with little interest in the mechanics of influence by silvicultural intervention, has caused losses in material production and neglected the exploration of new roads to growth control, dismissed beforehand as having no practical use. This conclusion applies, among others, to the lack of interest by forest research in the basic phenomenon of photosynthesis, the real point of departure for each type of production in the forest, for all kinds of forest utilisation and for the practice of forestry and silviculture as well. However, the analysis of growth and production, the study of methods and techniques in relation to energy exchange, can create opportunities for increased production,

and lead to new concepts on forest treatment by a better understanding of the underlying phenomena.

The low energetic efficiency of the forest is a rather puzzling fact, subject to many speculations. As an average only 1% of the available solar radiations (0.5% in boreal zones, 1% in regions with a moderate climate and 1.5% in the tropics) is absorbed by the forest and partly transformed into dry matter at a rate of 0.5 g to 5 g/m²/day. Burger and Weck were among the first to give particular attention to the possibilities of increased photosynthetic efficiency by cutting transpiration and respiration losses, modifying the absorption equilibrium in favour of photosynthesis and production of dry matter. This is not a utopian enterprise needing big investments or specialised knowledge. The increase of photosynthetic efficiency can be obtained in the forest by directed selection, by preservating forest continuity and by the maintenance of a sufficient degree of structural complexity. A realistic basis for selection is the variation in energetic efficiency between individual trees and between species.

Analysis of the bio-ecological system on the other hand shows, that actual or potential losses, caused by debatable techniques and methods, are quite often more important than the production increase obtained by costly artificial interventions (e.g. soil preparation, use of fertilizers, weed control). Wiedemann demonstrated that repeated clear-cutting in Germany lead to a loss in annual increment of 0.6 — 1 m³/ha in each consecutive generation. Clear-cutting not only destroys the ecosystem, but profoundly damages the apparatus for energy absorption at the same time. The recycling of biogene elements is disrupted. In the period between forest destruction and stand renewal, energy exchanges proceed at an extremely low level. Many years after reforestation have to pass before energy absorption is satisfactory again. The total period of reduced energetic efficiency, loss of dry matter production and factual loss of growing space gets relatively longer as the rotation between clear-cutting is shortened.

Fundamental options and silvicultural systems need a realistic analysis. It is the only way to find out the merits and disadvantages of repeated clear-cutting or forest continuity, of shorter or longer rotations, of the optimalisation of technical or ecological circumstances in forest management. Notwithstanding the ultimate choice, it can not be denied that the interpretation of forest growth and of silvicultural practice in terms of energy exchanges is of fundamental importance. These exchanges are affected by each intervention in forest development. Although energetic efficiency will probably never become a way of direct approach to forest treat-

ment, it nevertheless is closely related to the type of forest, which undoubtedly is an object of choice.

The Forest Types

Forest types are engendered by a double series of influences

— The given phytogeographical, climatological and ecological conditions.
— The character, volume and frequency of human intervention as a measure for forest utilisation.

The forest type is, in some way, the reflection of the basic relationship between man and the forest. It often expresses clear intentions concerning the use of the forest and the kind of management needed to that end.

From a silvicultural point of view it is possible to distinguish forest types, corresponding with different forms and degrees of human impact.

In the *natural forest*, established and perpetuated by spontaneous natural regeneration, no trace of human influence is detectable.

Human intervention causing a decrease in standing volume, a reduction of the number of tree species, a modification of structure and patterns of mixture but without introducing non native or exotic species, have the development of the *semi-natural forest* as a consequence. Natural regeneration is often spontaneous, but it can be controlled and even be induced by man. In some cases the semi-natural forest remains close to the original natural situation. It can also be in a state of reversible or irreversible degradation or develop into a valuable economic forest with a potential for sustained yield at a high level.

The purposeful combination of native with introduced species and of natural with artificial regeneration in a changing pattern of time and space is the distinguishing mark of the *transition forest*.

The principal role of the native species, notwithstanding their eventual economic value, resides in the stabilisation of bio-ecological conditions; exotic species are mainly introduced to increase the level of wood production in direct response to local or temporary demands.

In the *artificial forest*, created by man by afforestation and reforestation with native or introduced species, the nearly exclusive objective is wood production.

This is also very often the case in the *naturalized forest*, resulting

from the transition to natural regeneration in a forest with an artificial origin.

A last group consists of the *marginal forest types*, that do not possess the basis characteristics of the real forest and mostly take the aspect of simplified, artificial ecosystems. They can represent an important economic value, although their continuity is not always guaranteed and their sustained yield not assured. Coppice forests, tree farms, plantations, poplar cultures can be considered as marginal types.

The forest types under consideration show a variable level of bio-ecological stability, a gradual modification of principal functions and important differences in value production, (volume and quality).

Approaching the unmodified natural situation more and more, a sequence of interrelated characteristics and phenomena is detectable which circumscribe the substantial value of natural oriented forest types, their functional significance and the set of silvicultural consequences:

— Increase of bio-ecological stability.
— Growing structural complexity.
— Higher potential for multiple utilisation.
— Stabilisation of material production, although quite often at a level of sustained increment appreciably lower than that which can eventually be obtained over a short period by concentration of means and effort.
— Intensification of stand treatment, especially in the economic forest, not necessarily requiring higher levels of investment.

More artificial forest types have qualities, willfully induced or the unavoidable consequence of human intervention:

— Highly simplified forest structures, posing less treatment problems and possessing a higher degree of surveyability.
— Reduction of biological substance and genetic reserve, eventually leading to an apparent or potential loss of productivity to be restored by artifical intervention.
— A clear limitation of functions, as most artificial forest types are conceived as a response to demand for quick financial results and the appeasement of acute, temporary and local needs.
— A lower degree of treatment intensity as interventions are projected against their immediate financial consequences in

order to cut down on management expenses and to meet the rising costs of reforestation.

Even in the field of material production the choice of type is to be understood as a potential choice between mass production of an industrial raw material and the promotion of better tree quality, between the satisfaction of temporary local needs and the stabilisation of production, between functional specialisation and functional plurality, between maximal return over a short period and sustained yield with no time limit.

The choice of forest types and their dispersion illustrate in last analysis the present state of society and the visions on future social development, on the evolution of forest utilisation and on the modifications directly linked to changing needs and demands.

Forest Utilisation

Till the end of the 18th century the european forest fulfilled a predominantly social function. Its economic value was low on account of the restricted possibilities of wood transformation, the lack of general prosperity and the regional importance of markets for raw material and processed products.

Forest utilisation, based on customary law, tried to provide local populations with wood for direct consumption (fuel wood, manufacture of tools, construction materials), with vegetable food and with animal proteins to be obtained by collecting, hunting or the organisation of forest grazing.

The industrial revolution of the 19th century ended this situation by recognising the economic importance of the forest and its most obvious product, wood, as a material for industrial transformation.

Systematic exploitation rapidly increased the human impact on the forest and changed its structure and composition profoundly. Growing tension between production and exploitation lead to silvicultural management considered as a set of rules, techniques and patterns of intervention, aiming at the systematic organisation of human utilisation of the forest. The principal goal at the moment was to secure and guarantee the supply of an expanding industry with a maximal quantity of raw material.

In the 20th century the situation underwent new modifications provoked by three groups of influences:

1. Technological explosion and accelerated industrialisation on a world scale, producing an immediate rise of the level of consumption and prosperity in the regions directly affected.
2. The profound modification of the pattern of living, due to

the increase, the concentration and the growing mobility of populations with an accelerated loss of space and the urbanisation of agrarian regions as side effects.

3. Environmental degradation and manifestation of an ecological crisis situation, causing forest destruction and forest restoration at the same time and bringing about fundamental changes in forest utilisation.

For this reason silviculture and forestry seem to find themselves to-day confronted by the need for choice between social and economic utilisation of the forest, especially in densely populated industrial countries.

Generalisation of the multiple-use system is in fact no solution in all cases, because of the unequal utilisation-value of the forest and the differences in population pressure and regional needs.

A way to harmonise conflicting aspirations and to develop several forest functions to an acceptable level, is the attachment of as many simultaneous functions as possible to suitable forests, and to recognise the necessity for functional specialisation in less polyvalent forest areas at the same time.

The acceptance of a strictly limited number of simultaneous functions, eventually of a single function leads to the concept of functional forest types and their suitable dispersion.

It reduces fundamental silvicultural options to functional organisation of space in general and of forest space in particular.

The following functional forest types are considered for practical purposes in Belgium:

Well-being

1. The park: Exclusive social function inside the agglomeration.
2. The forest park: Predominant or exclusive social function at the periphery of agglomerations.
3. The recreation forest: Dominant social function and limited economic function within reach of the agglomeration.

Production

4. The multiple-use forest: Variable proportion of social and economic function.
5. The production forest: Dominant or exclusive function.

Protection and conservation

6. The forest reserve: Exclusive internal or external protection.

Functional zoning of forest space creates its own problems, but it does not provoke profound modifications, nor does it restrict any function in a dangerous way, if put through or considered over sufficiently large area.

This can be illustrated by a practical model for Belgium with nearly 10 million people living on a little more than 30,000 km², with a forest area of 625,000 ha, annually producing 2.5 million m³ of wood.

Forest type	*Optimal available surface*	*Production repercussions*
Forest reserve	25,000 ha	− 400,000 m³
Recreation forest	100,000 ha	− 400,000 m³
Production forest	500,000 ha	+ 700,000 m³

A good organisation of the actual forest area of Belgium, could allow a theoretical gain in annual wood production of at least 200,000 m³ because of the possibility for unhindered concentration of production on 500,000 ha. For the calculations a total loss of useful increment in the forest reserves and of 50% in the recreation or multiple-use forest is accepted. Of the remaining 500,000 ha of forest to be used exclusively for production, nearly 200,000 ha are now in a state of relative degradation, easily permitting an annual increase of 2 m³/ha.

On the rest of the production forest area a total annual increase of 300.000 m³ is not excluded.

The importance given to functional division of available space is in direct relationship to the importance of produced value, composed of material production and of the social services rendered.

The Value Production

Under all circumstances where wood production is the dominant or exclusive objective of forest management, it is normal to express the profitability of the enterprise, the effect of interventions, the volume of capital investments and labour input in relation to the money-value of the produced raw material.

The analysis gets complicated when management aims simultaneously at material production and at rendering of services, especially as no common evaluation norm can be found for both forms of forest utilisation. It seems in fact difficult to express in terms of direct financial profit the value of recreation, pure water and clean air, prevention of erosion and protection against avalanches, floods and landslides although their value is very real.

Moreover, the financial evaluation norm does not always permit the fundamental distinction between material production and the provision of services, as wood production in some industrial countries is also developing into a public service with an evident negative financial return.

Between 1950 and 1975 the selling price for standing timber was affected by a tendency to drop all over Europe and its stabilisation was an exception. During the same period however costs and investments (wages, materials, social provisions etc. rose to an index-level of 240 to 280. Notwithstanding steadily increasing wood consumption, the divergent evolution of prices and costs caused a serious diminution of the financial return on the forest enterprise to far below the normal level for attractive investments if not to become clearly negative.

Ertl and Hasel calculated, that in West Germany the net financial product of the state forests increased from 54 D.M./ha in 1951 to 108 D.M./ha in 1956 to decrease regularly from there on to reach a level of -55 D.M./ha in 1968. This evolution represents a quick change from a net profit of nearly 26 D.M./m^3 in 1956 to a net financial loss of 12 D.M./m^3 in 1968. (Table 1).

TABLE 1: Evolution of financial profitability in the state forests of West Germany (Ert, 1970, Hasel, 1971).

Year	*Gross product* DM/ha	*Management expenses* DM/ha	*Net product* DM/ha	*Net product* DM/m^3
1951	189	135	54	14
1956	316	208	108	25.5
1961	307	267	40	9.3
1966	334	321	13	2.8
1967	271	310	–39	–8.4
1968	265	320	–55	–12

Under such conditions it is understandable that owners lose interest in their forests, the more so as they are confronted with chronic labour shortages and a high level of investments for eventual mechanisation. The ultimate consequence of such a development toward low financial return from the forest enterprise as soon as general prosperity reaches a certain level is, that wood production becomes a public service, to be rendered by the executive branch, eventually at a direct financial loss. It develops into a measure to promote economic expansion and social stability. It is to be judged by the same value-norms as are used to assess the expenditure on road construction, the organisation of public education and the creation of infrastructural facilities.

These recent changes in conditions and approach modify the significance of the forest and affect the position taken by society towards forestry. The conservation of certain forest areas for their cultural or scientific value, for their scarcity or their irreplacability has become acceptable. The development of the social forest function is justified by actual necessity, as well as by the volume and character of predictable future demands. The level of investment for material production and social well-being is the expression of the intentions of human society and of the degree of financial sacrifice it is willing to make in both cases.

The gathering of information on requirements and needs outside the field of material production is therefore necessary.

As far as forest recreation is concerned ample information already exists. In the "Stadtwald Frankfurt" 20,000 to 30,000 persons visit daily a forest area of 5,000 ha and Ruppert even observed 100,000 visitors on peak-days in 1960. The Cantareiro-forest near San Paolo received 1.3 million visitors a year over 179 ha, corresponding to 20 daily visitors per ha (Mello & Lima).

In the U.S.A. the number of forest visitors increased by 52% between 1960 and 1965. During that same period the federal authorities augmented forest space available for recreation by 72% and up to 130 million ha or 0.6 ha recreation forest area per inhabitant against only 0.06 ha total forest area and 0.3 ha total space per inhabitant in Belgium.

In Belgium 771,354 persons visit recreation areas on peak days. They represent 20% of a population of 3,856,670 living in towns with more than 15,000 inhabitants, where environmental pressure is well felt and the need for recuperation and open-air recreation evident. They travel an average of 60 km (grand total 1,152,000 km) with 192,000 motorcars needing 100,000 l of fuel for the trip.

The care for well-being through the development of social forest utilisation is a just and necessary measure of compensation for increased environmental pressure following quick industrialisation. It prevents ultimate economic loss and loss of prosperity.

Such a conclusion results at any case from the thorough analysis in Germany by Buchwald. He found that in 1939 about 2% of the active population was not at work on account of illness.

In 1950 the level of 3.8% was attained and it rose to 7.3% in 1967. In the same year (1967) 12% of the active population ended productive activity at an average of 12 years before the normal age for retirement. Health control in schools indicated that 50% of all children were suffering from chronic diseases.

Equally important are the results of the analysis of the relative

value of forest recreation and material production undertaken by Bichlmaier in a forest area of 68,000 ha near Munich.

Attributing to each controlled forest visit a value of 2 D.M., he concluded that the total benefit represented by recreation reached 22.8 million D.M. a year as against 5.6 million D.M. for wood production or 335 D.M./ha for recreation against 82 D.M./ha for material production.

The development of the social forest function corresponds to a direct social need and an indirect economic requirement. Its contribution to general well-being and social stability deserves attention and a reasonable level of investment. Such a thesis is more easily accepted by public authorities and political decision makers than by foresters, who are often reluctant to accept the idea of multifunctional management and polyvalent forestry. They do not so rapidly agree with the conclusion of Ertl and Hasel, confirmed in a way by Abetz and Speidel, that from an economic point of view, the forest enterprise passes through an extremely difficult period in industrialised countries on account of full-employment, high wage levels and rising management costs. It is therefore necessary to analyse silvicultural ways and means in a realistic and non-prejudiced state of mind to assess correctly the value of alternative solutions and to interpret the actual situation in terms of general human interests.

The Practice of Silviculture

Options regarding the fundamental characteristics of the forest, forest types and their dispersion, forest utilisation and value production, influence silvicultural concepts and lead to modifications of silvicultural practice. Alternative silvicultural solutions concur in fact with alternative types of forest utilisation and with alternative definitions of the objectives of forestry. The choice of silvicultural methods and techniques is clearly co-determined by socio-economic circumstances and by the general line of thought on forest policy. It reflects in a way the actual state of mind in human society and expresses its vision of the long-range future.

The choice of species

In many european countries the choice between native and exotic species, between hardwoods and conifers still has a real importance.

This choice is closely related to options between the priority accorded to bio-ecological forest stability or to supplying material products to a prosperous and demanding human society.

Between 1960 and 1975 total wood consumption on a world scale increased by 28%; but consumption of paper and cardboard increased by 118%, and in Europe by 139%. The situation is growing critical in Europe where a timber surplus of about 5 million m^3 in 1960 developed into a general deficit of 66 million m^3 in 1975 and into a deficit of 139 million m^3 in the E.E.C. countries alone. Under such pressure, there is no doubt about the necessity for conservation and even for extension of the coniferous area. It is equally clear that the introduction of conifers in natural hardwood regions is unavoidable, especially to reafforest new sites.

This however is not the heart of the problem. From an silvicultural point of view it is more important to question the way in which conifers are used and to postulate that the introduction of conifers must not provoke a loss of soil fertility or site productivity, nor should it endanger the continuity of forest presence and forest utilisation.

Therefore a position is taken, not so much against the exaggerated use of conifers, as against the automatic sequence of decisions and phenomena that often start with the introduction of conifers following the line:

Artificial regeneration	Homogenous stand
Systematic clear-cutting	Uniformity of forests
Short rotations	Decreasing resistance
Extensive treatment	Loss of ecological stability
Dominance of technicality	Loss of biological substance
Restricted management objectives	Modest genetic reserve.

This sequence results from a definite pattern of behaviour starting with the choice of species, that can easily be changed to reduce consequences. In extreme cases it mortgages the future, does not pay attention to past experiences and reveals an optimistic attitude toward the technical ability to prevent production losses and forest destruction.

Catastrophic forest destruction in Europe was always linked in the past, not so much with the introduction of conifers in natural hardwood regions in itself, as with the ensuing homogenisation of the forest, the lack of interest in forest treatment, repeated clear-cutting, shortened rotations and artificial forest renewal as a system.

Lemmel relates the increase of the area completely defoliated by caterpillars from an average of 1771 ha a year for the period 1800-1870 to 7,538 ha a year for 1870-1935 with the expansion

of the coniferous area and the progressive forest homogenisation in Germany.

In the homogenized coniferous stands of the German Mittelgebirge, wind damage amounted to 62% of total wood production in 1941 and to 72% in 1942 (Heger). Calculations by Weck prove that in the German state forest insect damage in the homogenous conifer-stands reached a level of 20% of total production between 1900 and 1939. Control of growth and growing stock over 180,000 ha of Saxon state forest indicates that, parallel to progressive homogenisation, yearly increment dropped from an over-all average of 6.1 m^3/ha for a growing stock of 189 m^3/ha in the period 1875-1883 to 2.5 m^3/ha for a growing stock of 170 m^3/ha for the period 1924-1929 (Tab. 2).

TABLE 2: Evolution of growing stock and incremen tin the Saxon State Forest (Weck).

Period	*Growing stock* m^3/ha	*Annual increment* m^3/ha	*Increment %*
1800-1830	152	4.7	3.09
1847-1853	177	6.1	3.45
1875-1883	189	6.1	3.23
1904-1913	185	4.6	2.49
1924-1929	170	2.5	1.44

Recent wind and storm damage over thousands of hectares in the Luneburgerheide tends to prove the limited stability of homogenous coniferous stands of artificial origin and the higher degree of resistance of the native hardwood forest.

Analogous phenomena are found all over Europe.

In the Belgian Ardennes a severe hoarfrost in 1938 caused a loss of 10 to 60 m^3/ha in homogenous spruce stands. In 1953 snow damage amounted to 250,000 m^3 in the same area, equivalent to about 13% of total annual wood production in Belgium. It lead to a direct financial loss of 180 million B.F. and important accessory and subsequent losses through stand degradation, drop of increment, insect damage, disturbance of markets, management plans and cutting schemes.

These and other calamities, the quick spreading of forest fires, damage by *Fomes annosus* in homogenous spruce stands, undeniable site degradation and loss of productivity, disrupting of recycling chains following homogenisation and clear-cutting, direct and indirect material losses, the high cost of later conversions, sanitary interventions and reforestations explain a certain degree of scepticism about the uncontrolled use of conifers and the in-

appripriate extension of even-aged, homogenous stands in Europe. There is apprehension, not directed against the choice of conifers in itself, but against the absence of precautions in their use and the chain reaction the original choice can provoke. Conifers are needed. They can and should be used, but with care, preferably in mixture and exceptionally in homogenous stands.

Restricted use of conifers can lead to a potential restriction of production in the immediate future that is acceptable if it ultimately helps to promote the continuity of forest presence and the realisation of sustained yield.

It further should be realized that many roads to the introduction of conifers and the creation of mixtures exist:

— Planting of conifers in a pioneer vegetation of native hardwoods.
— Simultaneous planting of hardwoods and softwoods in afforestations.
— Conversion of poor hardwood stands, by the introduction of conifers in coppice stands and in forests with coppice and standards.
— Conversion of homogenous conifer-stands by group regeneration or/and underplanting with hardwoods.

The choice of treatment

A broad vision on forest functions and their relative importance influences the concept of forest treatment, as the displacement of functional points of gravity leads to alternative management aims and to modification and adjustment of techniques.

The one-sided orientation of forest management toward mass production, exclusive economic utility and maximal financial profit, nearly always leads to the abolition of silvicultural interventions with no direct financial benefit. A state of mind develops to consider silvicultural interventions, especially thinnings, in the first place as harvesting measures with some kind of an accessory treatment effect only as far as the development of growing stock and the regulation of yield and increment are concerned.

The option for exclusive economic-financial rentability permits far reaching simplification of treatment, often considered as a rationalisation of forestry and silviculture. The rationalisation applies in fact but to the choice of management aims and is therefore only accaptable as far as the aims of management are acceptable and unchanging. Treatment has a broader basis in the polyfunctional forest.

The main objective of silvicultural interventions is here the maintenance of the forest in a state of structural stability and optimal productivity so as to guarantee forest presence, permanent material production and continual rendering of various services.

The acceptance of functional versatility implies a less absolutistic approach to forestry. The admission of the relativity of values and the possible shifting of functions in time and space however creates also obligations:

1. Treatment must realise or perpetuate a functional equilibrium that in many cases leads to severe restrictions in the choice of methods and techniques (e.g. no clear-cutting in recreation forests, ecological stability is furthered by mixture and structural complexity, recreation is served by maximal border lines).
2. The plurality of actual and future forest functions and the possibility of their continual shifting, stress the primary importance of ecologically stabilised forests, suitable to alternative utilisation types and fit to absorb, quickly and easily, all modifications in requirements and aspirations.
3. In the polyfunctional forest, economic production is not to be neglected and is not necessarily of secondary importance. It takes a specific aspect and is more directed toward tree quality and the conservation of valuable and eventually slowly growing species.
4. The acceptance of the possible variation of functions makes short-time economic realisations nearly impossible and leads to the almost automatic exclusion of short rotations and the abolition of clear-cutting as a system.
5. More attention is given to permanent production as preferable to temporary maximal production. The stabilisation of value production is realised by making the higher inherent quality of the product compensate for a decrease in volume output.

A new approach to the fundamental aims of silviculture in the industrialised countries of Europe leads to consider wood production more and more as a phenomenon that accompanies forest treatment, but is not its sole nor its main objective.

The choice of regeneration

The question of forest renewal has been passionately debated by generations of foresters in constant argumentation over natural and artificial regeneration. To-day this question has lost part of its reality, because the choice of regeneration method is induced and

even dictated to a certain degree by socio-economic conditions and specific management circumstances, that leave silvicultural management no great opportunities for choice. Artificial regeneration is the rule when new sites are taken over by forestry and in the case of homogenous stands of exotics, which can not be retained to full maturity, corresponding with maximal reproductive capability, for biological, economic or technical reasons.

The obligation to make use of artificial regeneration may even be generated by the chosen silvicultural treatment as short rotations, high stand density, homogeneity, low thinnings, restricted treatment intensity are a bad preparation for natural regeneration.

Also illustrating the relationship between the type of forest regeneration and socio-economic conditions, is the fact, that renewed interest in natural regeneration is a direct outcome of labour shortage and the increase of reforestation costs above the level where even a modest degree of direct financial profitability can be expected. This recent evolution, purely socio-economic in origin, gains momentum, because the preference for natural regeneration is well received by ecologically-minded groups and by conservationists, who interpret is as a manifestation of good-will on the part of forestry. These reactions in turn help to improve conditions for better silvicultural management and reinforce the merits of the original choice that brought about this change in mind and mentality. The choice between the two types of regeneration should remain open because of their respective advantages. It should however be kept in mind, that, where the choice can be made freely, it implies a series of options with far-reaching consequences, that illustrate the view of the role of forestry and of the forest in modern society: -

Artificial regeneration

Homogenous, even-aged stands of conifers.
Low intensity of early stand treatment.
Preference for low thinnings.
Short production period.
Functional specialisation and predominance of economic function
Forest replaced by plantation or tree farm.
Principal management aim is the realisation of economic equilibrium.

Natural regeneration

Uneven-aged, mixed stands.
Dominance of autochtonous (native) species and systematic con-

servation of local races, of biological substance and of genetic reserve.

Individualisation of individual tree of stand and treatment at an early stage.

Long and even uninterrupted production periods.

Polyfunctional forest utilisation.

Dominating interest for continuity of multilateral value production.

Principal management aim is the realisation and maintenance of bio-ecological equilibrium.

Even a superficial analysis of the problem proves that the choice of the regeneration method or the purposeful creation of conditions directly leading to one type of regeneration and excluding all others, correspond with fundamental options concerning the destination of the forest and the organisation of its use.

Conclusions

Industrialisation and general prosperity, increasing density and progressive concentration of the population, continual loss of space and growing complexity of social structures provoke fundamental changes in forest utilisation and modify the demands and requirements of human society on forestry. Silviculture as a scientific discipline and as a practical activity must recognise this situation and conceive measures to guarantee permanent and polyvalent utilisation of the forest by a growing number of interested groups and individuals.

To realise its objectives, silvicultural management can fallow different roads that are not always an object of free choice. It can proceed to the systematic establishment of several simultaneous functions on every sub-division of the forest area or try to realise functional zoning or division of available space, assigning to each forest function an area of dominant development related to its actual or future importance.

The choice between these two possibilities is influenced by available forest space and dispersion of the forest. In regions with a permanent lack of space functional zoning is nearly impossible; it is more indicated where great reserves still exist or can be created. Both alternatives do not exclude each other as a matter of principle. They can be realised simultaneously in a restricted number of cases.

Moreover, it is not the choice of alternative which is most important, but the correct evaluation of its consequences. Polyvalent forest utilisation, meaning the simultaneous practice of

different and possibly conflicting activities, requires the stabilisation of the forest and its structuring, even if the modification of functions is a phenomen to reckon with. A realistic approach toward functional plurality accepts the possibility of mutual hindrance, because maximal development of a desirable function is not always possible without restriction of other, less important ones.

The multiple-use system creates specific conditions for material production, as it requires the stabilisation of the forest, of yield and of growing stock. The restriction in space of cutting practices furthers early individualisation of treatment and growing interest in stand and tree quality. Multiple-use helps to promote mixture and structural complexity, rejects clear-cutting as a system and directs treatment toward simultaneous care for tree, forest and site.

Functional division of forest space results in the development of specialised forest types, some extreme or exclusive in character.

Zoning is realistic where big reserves of forest and space exist. It allows the development of certain forest functions without limitations of any kind, as in the case of accelerated production of a maximal amount of fibre in the shortest possible possible time in artificial stands of conifers. Functional specialisation furthers simplification of silvicultural management, increases the opportunity for rationalisation and mechanisation and eventually permits reaching maximal financial profitability for a short time. The evaluation of its characteristics, advantages and drawbacks is related to the vision on future development of human society and on the services and goods to be expected from forestry and silviculture.

Strict functional zoning of forest space can have an important impact and seriously jeopardize future:

— It leads to a clear distinction between silviculture and tree growing as separate forms of human activity.
— It implies the eventual creation of different executive branches for the administration of economic forests and for those with a predominantly social, cultural or scientific function.
— It leads to financial losses on an integrated level, because functional exclusively provokes the disappearance of valuable secondary functions to be developed as exclusivities in their own right and at great expense on other sites.

Society imposes permanently growing demands on both wood production and on social forest utilisation.

The care for public well-being is already a co-dominant line of forestry policy in industrialised countries in full evolution toward a post-industrial situation and a society of leisure, dominated

by the need for mutual services. The economic function of the forest is well developed or prevails in countries, where the wood industry takes command because of the economic and political force it represents, and also in less-industrialised or non-industrialised countries with a low consumption level, a great reserve of cheap labour and a growing population, considered as a potential market for wood products. The perpetuation of such a dualistic and ambivalent situation on world level can only accentuate existing inequalities for a long time to come.

To soften tensions and to reduce insecurity about the future it is advisable, in each field of human activity, to create diverging situations, allowing alternative future situations to be reached by reinforcing favourable influences and keeping less profitable evolutionary tendencies in control. A secure initial position for sound silvicultural activity and future forest management consists in the creation and the promotion of polyvalent forests, the acceptance of pluralistic management objectives and the rejection of dogmatism and schematic procedure in the organisation of forest utilisation.

A pluralistic concept of silviculture recognises three basic aims, to be reckoned with at every stage of development:

The perpetuation of the forest requiring interventions for protection and conservation that are of direct importance for environmental stability and represent an indirect economic value.

The organisation of social forest utilisation aiming at the production of a direct social value, that is of indirect economic importance and promotes ecological and social stability as well.

The safeguarding of material production at the highest level of sustained yield, both in volume and value, in response to direct economic demands and indirectly serving a social purpose.

The positive evolution of modern society must be favoured and in conditioned by an equilibrium between prosperity and well-being, a just distribution of power and wealth, the acceptance, the promotion and the harmonisation of a broad variety of human ambitions and aspirations.

Each field of human activity must collaborate to produce generalised prosperity and well-being. This is also the case for forest management and silvicultural practice as protectors and administrators of an extremely rich and constantly renewable natural resource.

To enjoy this valuable good in an optimal way, to maximize its beneficient effects to present society, to assure its polyvalent utilisation by future generations is a mission, a moral obligation and a big challenge that no forester can refuse to accept.