ACTA FORESTALIA FENNICA

Time Factor and Investment Calculations in Timber Growing. Theoretical Fundamentals.

Aikatekijä ja investointilaskelmat puunkasvatuksessa. Teoreettisia perusteita.

Matti Keltikangas

Suomen Metsätieteellisen Seuran julkaisusarjat

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Publications of the Society of Forestry in Finland

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TIME FACTOR AND INVESTMENT
CALCULATIONS IN TIMBER GROWING

THEORETICAL FUNDAMENTALS

AIKATEKIJÄ JA INVESTOINTILASKELMAT
PUUNKASVATUKSESSA — TEOREETTISIA PERUSTEITA

MATTI KELTIKANGAS

PREFACE

This study is a part of the larger collaborational research work which three departments of the University of Helsinki — those of Silviculture, Peatland Forestry, and Business Economics of Forestry — have been carring out since 1967. The roots of the study, however, lie further in the past. During the years 1961—64 I had an opportunity to work in the Institute of Agricultural Policy, University of Hesinki, and to participate in an investigation where the economic consequences of clearing forest land for cultivation were evaluated. The results of the investigation and especially the experiences I got in conversations with over two hundred small forest owners on the study farms, made me convinced that the problem of time factor had not been solved quite satisfactorily in the models used for comparison.

In the meanwhile many people have contributed in helping me to clarify my hazy thoughts and to put them out in the form of this analysis. Two persons deserve to be mentioned before any other. They are my first teachers in the field of forest economics: the late professor EINO SAARI and my father, professor VALTER KELTIKANGAS. Their impact on my pattern of thinking has been very deep and lasting. Both of them perused the manuscript in its earlier version and made valuable comments.

During the many years professor PÄIVIÖ

RIIHINEN, my present principal, has provided me with very favourable working conditions in the Department of Social Economics of Forestry. He also read the manuscript.

Some other persons did the same. Professor BERTIL HÅLLSTEN of the Royal College of Forestry, Stockholm, professor ERIK JOHNSEN of the Copenhagen School of Economics and Business Administration, professors FEDI VAIVIO and NILS WESTERMARCK and doctors LEO AHONEN and KUSTAA SEPPÄLÄ all gave their comments before the study was finally completed.

I wish to express my sincere gratitude to all the persons and organizations mentioned above, as well as to all others who have helped me with their advice, encouragement and inspiring opinions.

Helsinki, June 1971

Matti Keltikangas

LIST OF CONTENTS

1. INTRODUCTION

One of the most prominent and most discussed economic phenomena of recent years has been the increasing tendency of business enterprises to use quantitative calculations as the basis of their decision making. Scientific management, management science, managerial economics, operations research — these are a few of the names given to the application of the optimization models of mathematical-statistical methods and economic theory to the solution of productional and marketing problems. Regardless of the name, the method is rapidly gaining ground, keeping pace with automatic data processing, both in commerce and in industry. At the same time, subjects dealing with these applications can be seen to gain ground in the science of business economics research.

This development is also beginning to affect forestry and the research of forestry economics. For the most part, forestry is carried out in association with industrial roundwood improvement or farming. The situations of decision making are similar, in their basic structure, to corresponding situations in any economic activity. Methods, which from experience are known to be efficient e.g. in the manufacturing plant and the marketing department of a forest industry company, are therefore not readily overlooked when the same company is making decisions concerning its logging operations or forest administration. Accordingly, methods used in the planning and supervision of agriculture and cattle husbandry on a farm holding are applied to the treatment of farm forests.

Timber growing in forestry, however, has characteristics distinguishing it from customary industrial production and farming. They give it a special position as a kind of borderline case among the forms of economy, difficult to compare directly with anything else (cf. V. KELTIKANGAS 1969, p. 133). Many authors (e.g. SAARI 1928, pp. 12—13; GRØN 1931, pp. 341—343; PETRINI 1946, p. 11; VAUX 1953, pp. 17—18; WORRELL 1959, p. 430; STREYFFERT 1965, p. 47; SPEIDEL 1967, pp. 31—32) list such special characteristics of forestry and mention among the essential points, the very long period of production (Produktionsdauer, produktionstid) and the arbitrariness of the borderline between the production factor (growing tree) and product (mature timber).

In the Finnish climate, the development of a stand from seedling material to the first cutting that yields marketable timber usually takes 25—50 years (KOIVISTO 1959), and to the final cutting at the end of rotation, 50—150 years. As a result of this slow rhythm of development, human measures aimed at improving the growth of forest or quality of timber cannot be expected to give returns very soon. In most industrial processes the interval from the installation of a production plant or machinery or from the purchase of raw materials to the marketing of the first products runs in terms of days, weeks or, at the most, a few months. Even in agriculture the interval is usually less than a year (cf. WORRELL 1959, p. 183; SAARI 1967, p. 117; V. KELTIKANGAS l.c., p. 133). But in forestry, even at its shortest, it is usually 5—10 years, and even then the majority of the revenue-yielding effects may not be expected until several decades have passed (cf. V. KELTIKANGAS l.c.). Compared with the length of man's so-called productive or active life span (from the 15th year of age onwards), which seldom exceeds 50 years, the income expectation periods in forestry can with reason be considered over-long.

Nor is the time at which the product will be completed so unambiguous and precise in timber growing as in industrial serial production or grain growing. A tree usually continues to grow for several decades after it has reached the minimum marketable size. From this time onwards until the termination of growth, the tree is biologically and technically fit for cutting at any moment. It is simultaneously a »production factor» producing new wood material and a potential,

finished »product». The timber grower — and the prevailing institutions, such as forest legislation — decide when, during this period, the tree is considered mature and ready for sale or consumption at home. The same applies to a whole stand.

The arbitrariness in the timing of the maturity of the product adds a speculative feature to timber growing: this aspect can be better compared with stock deals or speculations — in the neutral sense of the word — with changes in property value than with real production and its combination of production factors (cf. SAARI 1942, p. 8; V. KELTI-KANGAS, l.c.).

The *time factor* is of such central and exceptional importance in timber growing that, when methods of comparing alternatives and calculation models developed for the control of less time-centered activities are transferred and applied to forestry, the greatest difficulties can be expected a priori in the treatment of just this time factor.

The traditional method has been to convert all receipts and outlays (revenues and costs) to be compared into their present values or values of some other convenient date. The conversion is made by discounting and/or by compounding with compound interest and by adhering to the simple mechanical exponential transformation of $x' = k^{\Delta t}x$, where Δt is the time interval. The comparison of the values so transformed has then been built according to the so-called timeless or static models of the general economic theory (cf. e.g. PRESSLER 1859; ENDRES 1923; GODBERSEN 1926, pp. 55—60; HILEY 1930, pp. 131—164; TANTTU 1942, pp. 171—199; S. PETRINI 1946, pp. 22—23; DUERR 1960, p. 119; JØRGENSEN 1964, a and b; EINOLA 1964; BENTLEY and TEEGUARDEN 1965).

In principle, the method does not differ from that routinely applied in investment calculations (see e.g. HONKO 1963, pp. 80—86). The special characteristics of forestry are visible in the difficulty of choosing the rate of interest percentage contained in the transformer $k^{\Delta t} = (1 + \frac{p}{100})^{\Delta t}$ more than in the actual methods of comparison. Or, if the so-called internal rate of return method is used (e.g. HONKO, l.c., p. 85), in the difficulty of interpretation.

In timber growing the discounting period is mostly very long, and therefore the rate of interest, percentage p, becomes decisive. Even relatively small differences in percentage — used in discounting over decades — may lead to widely different present values (e.g. SAARI 1942, p. 9; DUERR 1960, p. 111). If, in addition, the time distributions of expected receipts and outlays are very different under the alternative courses of action, the selection of the interest percentage may suffice to decide the issue. For this reason, the »correct» interest percentage and the rules facilitating its determination are perhaps the essential problem in alternative forestry calculations (BARLOWE 1958, p. 287; DUERR 1960, p. 143). This is indicated by the large number of pages devoted to the subject in textbooks and other literature (e.g. MARTIN 1918, pp. 135—147; ENDRES 1923, pp. 9—34; HILEY 1930, pp. 90—104; GUTTENBERG 1950; DICKSON 1956; AARESTRUP-FREDERIKSEN 1958; DUERR 1960, pp. 143—150; v. MALMBORG 1965; DAVIS 1966, pp. 324—335; JOHNSTON et al. 1967, pp. 125—132).

Earlier literature usually started from the assumption that there is a homogeneous »pure» or »objective» rate of interest, or at least one common to given categories of forest owners. This could presumably be derived from the »general» market rate of interest, with due allowance for the differences caused by uncertainty, liquidity, burden of management and other similar factors (e.g. ENDRES 1923, p. 33). Subsequently, the present stand of general business economics gained ground, viz. that the interest percentage is individual and depends on the situation and case involved. The authors now emphasize that the interest percentage is an alternative cost and should be selected so as to equal the highest rate obtainable from other transactions with identical resources (DUERR 1960, p. 44). Or they place most weight on the interdependence between interest percentage and the target set (HERMANSEN 1964, pp. 313—314).

This change in opinion, however, has hardly helped to facilitate the selection of this percentage or to make it more precise. The insight that the interest percentage reflects the effect of several different factors, makes it understandable that the rates used in calculations may differ widely. On the other hand, the determination of the »correct» percentage in each situation requires that

these effects should also be quantitatively known. Many authors suggest, for example, that compensation should be made for the uncertainty inherent in the results of the measures taken by adding a so-called risk allowance to the »pure» rate of interest a completely risk-free investment would yield. Since the size of these components, however, is left largely to subjective judgement (e.g. WORRELL 1959, pp. 263—267; DUERR 1960, p. 148; STREYFFERT 1965, p. 248), one problem has simply been replaced by two new problems.

Certain analytical methods of more recent date enable a slightly different approach to the problem. The interest percentage — when derived from empirical observations — is a kind of residual factor: the effects of all factors not explicitly considered in the model are cumulated in it. If some of these factors are separated to make new variables it may be expected that the determination of interest percentage is compressed into ever narrower limits and at least its effect on the end result of the comparison is weakened.

For example, in linear programming the demand of the liquidity can be expressed as a constraint on the optimization: the aim is to maximize the present value of future net revenues without the net revenue of any year being below a pre-determined limit. As a result, this aspect need not be included in interest percentage (STRIDSBERG 1959; HERMANSEN 1964, p. 321; v. MALMBORG 1967, p. 57). Similarly, it has been suggested that the risk allowance be replaced by a procedure according to which the alternatives are compared using a two-dimensional result function: either the most probable result and variance (DOWDLE 1962) or the minimum and maximum values of the possible results (MARTY 1964). The ideas of utilizing the theory of games (F. PETRINI 1964, p. 92) and sensitivity testing (MARTY 1964, pp. 13—14) have the same purpose.

Although the selection of interest percentage cannot be decided by these methods as such, they do facilitate it in a way, primarily by reducing the number of factors that need be considered in the selection. The interest percentage itself still remains a problem. The American author FLORA (1966), examined the discount percentage.

Discussing the selection of interest percent-age, many of the authors mentioned above (e.g. GUTTENBERG 1950; DAVIS 1954, pp. 296—297; DUERR et al. 1956, p. 4; JØRGENSEN 1964 a, p. 390) point out that the alternative rate of return may be determined either by alternative investment opportunities or the forest owner's subjective *time-preference*. Time-preference rate is a concept dating back — directly or indirectly — to FISHER's (1906, 1930) already classical theory explaining interest formation. Roughly speaking, it refers to the relative value of the present (marginal) income (= consumption opportunity) compared with a (marginal) income (= consumption opportunity) of equal amount obtainable in the future (e.g. FISHER 1930, p. 61; GUTTENBERG 1950, p. 3).

FLORA, in his investigation mentioned above, tried to discover whether, and under what conditions, forest owners discount at rates of time-preference. The answer to the first question was in the affirmative: time-preference did to some extent affect the attitude to long-term investment of nearly 40 per cent of the New England forest owners he questioned (l.c., p. 53). The most important result of his theoretical and empirical study is, however, in this connection the observation (FLORA l.c., p. 41) that discounting of expected future revenues cannot in all cases be expressed in terms of an exponential function. In other words, when time-preferences are expressed in terms of compound interest the interest percentage is not always fixed but may vary depending on the length of discounting period. Although FLORA's study was based on a small number of forest owners and cannot, unmodified, be generalized to cover e.g. the Finnish forest owners, his result supports the corresponding view earlier advanced e.g. by BARLOWE (1958, p. 288).

The traditional method of comparison, therefore, should be corrected or complemented so as to allow for the possibility of a change in the rate of interest. According to FLORA (1966, p. 51), present value transformation is in fact unnecessary; the comparison may be carried out using so-called discount loci. These are successions of points formed by plotting, in a system of coordinates, the revenues that the forest owner finds equal in value, and that are expected at successive points of time; they might be called indifference curves. The alternative obtaining the

highest discount locus would be the best. This procedure, however, has some inherent weaknesses, of which the worst is perhaps the difficulty of determining the discount loci empirically (FLORA l.c., p. 52) The model is also deterministic, in other words, it does not allow for the effects of uncertainty. Moreover, it is only suited for the comparison of individual revenue items but not of series of revenues (FLORA l.c., p. 52).

As pointed out above, a characteristic of timber growing actions is that the majority of their effects are timed far in the future. From the point of view of comparative calculations, this makes the *time horizon* of the calculations essential (e.g. SHACKLE 1961 a, p. 223), in other words, how distant events, on the whole, are relevant in the comparison.

In traditional forest economics this problem has been solved very simply: the caclulations are made to include, in one form or another, all expected consequential effects of the actions until infinity (e.g. ENDRES 1923, p. 57; GRON 1938, p. 345; BENTLEY and TEE-GUARDEN 1965, pp. 82 and 86; STREYFFERT 1965, p. 284; cf. ENDRES l.c., p. 74; SAARI 1942, p. 7). Even the authors who have doubted whether such a long calculation period is meaningful have usually found it necessary to extend the calculations to the first final cutting following forest improvement (DUERR 1960, pp. 241 and 243; WARD et al. 1966, p. 28).

Usually the arguments for the procedure have underlined either that the major revenue resulting from forest improvement is not obtained until the final cutting (DUERR l.c., p. 243), or that the forest owner could if he wished »realize» the unobtained distant income by selling the whole stand before it reached maturity. If the sales price is assumed to equal the sum of the present values of the net revenue that would later be obtainable from the stand, and if the rate of interest used in discounting is the same as that used in the comparative calculations, the end result is the same in both cases (e.g. HEIKIN-HEIMO et al. 1967, p. 44; cf. WORRELL 1959, p. 411). The inclusion of later rotations has been recommended on the basis of »practical» points of view such as the mathematical simplicity of the formulas, and the fact that, discounted over a very long period of time, the incomes of the later rotations do not much change the present value of a silvicultural action and therefore usually do not essentially affect the end result of the comparison (e.g. ENDRES 1923, p. 74; GRØN 1931, p. 459; TANTTU 1942, p. 199).

A calculation period limited to the first rotation, however, would seem to exceed greatly the length of the calculation periods the forest owners actually apply. Not many empirical studies have been made, but on the basis of less precise observations and experiences the »short span» of the estimates by forest owners, and the contradiction between this and the time horizon used in the calculations, have been underlined in several contexts (e.g. Betänkande . . . 1899, p. 87; LAITAKARI 1923, p. 6; JÄNNES 1939, p. 15; HELANDER 1939, p. 126; WORRELL 1959, pp. 344 and 411; SAARI 1967, p. 122). Not until FLORA (1966) published his study were any real measurement results concerning the variation of the distances of time horizon reported.

According to FLORA (l.c., pp. 46 and 48), nearly one-third (15) of the 50 forest owners studied in the region of New England had a planning horizon at a distance of less than 10 years. Three of these 15 reported that the distance was less than 5 years and one that it was less than 2 years. For 35 the time horizon was a minimum of 10 years distant FLORA. did not extend his measurements any further. These figures would seem to suggest that the time horizons of forest owners hardly differed so radically from those of farmers and other entrepreneurs (e.g. HEADY 1952, p. 475; KLEIN 1952, p. 65; SHACKLE 1958, p. 83 and 1961 b, p. 247; cf. also HONKO 1963, pp. 134—135) as the traditional theory foresaw.

The closeness of the time horizon is attributed, at least partly, to uncertainty and ignorance concerning future events (e.g. SHACKLE 1961 a, pp. 223—224; 1965 pp. 81, 88—89). Increased knowledge and the stabilization of conditions may therefore be expected to move the time horizon further away (KOYCK 1965; WORRELL 1959, p. 411), i.e. to prolong the time perspective (KATONA 1951, p. 52). The possibility of this gradual development does not, however, alter the fact that today, at least with certain forest owners, the time horizon is demonstrably much closer than 80—100 years. Some authors believe that this applies to the vast majority

of forest owners (e.g. Jännes 1939, p. 15). An investment calculation comprising a total rotation of normal length necessarily, in these cases, contains receipts and outlays which the investing forest owner considers irrelevant and does not value at all. This being so, it is justifiable to ask whether an investment calculation spanning the whole rotation period, or its result, is fully relevant for the forest owner.

According to Flora, Worrell's answer to this question is in the negative. Worrell suggests that if the forest owner's time horizon is e.g. 30 years distant the calculations should include only the receipts and outlays of this time interval (Flora 1966, p. 25; cf. Barlowe 1958, p. 305). The proposed procedure, however, has not been universally accepted yet. A time horizon extending to infinity is apparently a deep-rooted concept in the theory of forest economics (v.Malmborg 1967, p. 26).

The methods used in forest economics for applying the investment theory to the problems of forestry, and especially timber growing, would therefore seem to require checking as regards the time factor. No universally acceptable solution has been found for the determination of the rate of interest. On the other hand, the universal applicability of two fundamental assumptions of the traditional procedure, viz. exponential transformation and unrestricted time horizon, have been called into question. It seems that at least these two assumptions should be replaced by others which would permit a wider scope, before the model of comparative calculations can be expected to be applicable, indisputably to all situations occurring in forestry.

The need for this re-consideration of the traditional calculation methods of timber growing became apparent when extensive studies into the profitability sequence of forest improvements were started in 1967, financed by the National Research Council for Agriculture and Forestry. This so-called »sopimus-tutkimus» (contractual research), supervised by Professors Valter Keltikangas, Leo Heikurainen and Paavo Yli-Vakkuri seeks to calculate, on the basis of empirical materials, the profitability sequence of the following measures: natural and artificial regeneration, afforestation, forest drainage, forest fertilization, and management of seedling stands. Especial attention is paid to finding a basis on which profitability can be quickly and easily determined on different sites and in various conditions.

These forest improvement measures, considered as investments, vary greatly in the length of time before their expected future revenues can be realized. The calculations must compare investments with spans ranging from 5 to 100 years. In order to find the appropriate methods and solutions it was therefore deemed necessary to study first the *theoretical grounds of comparison* in relatively great detail.

The purpose for which results are used also affects the formulation of calculating models. Let us take investment on forest drainage. Comparative calculations and their results are required e.g. by a forest owner when he decides whether or not to make the investment, the State Board of Forestry when it issues instructions on the limits of forest improvement drainage, and by the Water Rights Courts when they have to decide whether joint drainage will produce more gain than harm, or how the cost should be divided between the participating farms. One calculation does not provide the answer for all these users. The calculation model must be formulated separately for each case, »tailor made».

The studies of this »contractual research» seek to obtain information both for forest policy planners and forest owners. The present study will deal only with the latter category and the calculations meeting their needs. The realtionship between the person working out the calculation and the forest owner creates the framework of situations in which the calculations take place. This framework must apparently be specified, before the angle from which the problem is approached can be precisely and meaningfully defined.

Specification of the *decision making process* is the first step in the definition of the problem. It follows that the final precise defining of the problem in the present study is relatively laborious and will swell the paper accordingly. Recent research, however, has so emphatically assigned the theoretical discussion of decision making to the sphere of general economics, (see e.g. Simon 1959; McGuire 1964; Johnsen 1968) that its application to forest economics seems to be a worthwhile experiment (cf. Ahonen 1970).

Research results reported by economists, organization theoreticians, psychologists, sociologists and system analysts in their respective fields are, apparently, opening up new, and promising avenues of approach.

This specification of the decision making process leads to the discussion, in Chapter 3, of the investment calculation as an information-transforming and condensing calculation. The essential theoretical problem will be the way in which the above aspects associated with the time factor adjust the transformation and condensation in practice. In trying to find the answer, particular attention is devoted to the possible objectives of the forest owner — decision maker and their variations.

It follows from the approach selected that the study is of a strongly interscientific nature. The theory of decision making, system theory and psychology are the particular branches of knowledge that are dealt with more extensively than is usual in forestry investment studies. Recent literature on economics shows a distinct and increasing tendency to emphasize the personal characteristics of the individual responsible for economic management: investment also indicates human behaviour in the first place. The

lowering and removal of barriers between sciences helps to enlarge their scope and enrich research. The business economics of forestry can hardly lag behind this progress.

The present study investigates the fundamental of the business economics of forestry. Its main purpose is to create the necessary background for improving the calculations of profitability in timber growing. In several aspects it may be considered a continuation of the work started by Eino Saari (1942), Antti Tanttu (1942) and Valter Kelti-kangas (1960) with their creditable investigations into the profitability of forest drainage.

There are reasons to emphazize the two words »fundamentals» and »background». This volume is intented to be an introduction, laying the theoretical foundations for a series of other volumes all concerning with the same problem: how to choose the right method and the right targets for a forest improvement. Therefore, in the following the reader will not find anything else but a rather general model with a relatively high level of abstraction. All the details peculiar to each type of forest improvement and all material calculations are to be presented and discussed in the later volumes, i.e. in their proper connections.

2. STUDY OUTLINE AND FRAME OF REFERENCE

The *problem* to be investigated *is how the time factor, i.e. the temporal differences between the effects of various alternative measures should be taken into consideration in forestry investment calculations*. The field must, however, be limited, in some way, to condense the presentation.

The predominant form of forest ownership in Finland is a forest holding owned by one person or a married couple. On the other hand, the forest improvements indicated in the introduction are mainly concerned with timber growing. This, from the point of view of investment calculations, is a more problematic group of actions than timber harvesting (cf. STREYFFERT 1965, p. 47). For these reasons, the present study will only be concerned with *investment calculations of timber growing in an economic unit which is owned and managed by a single physical person and of which forest holding is a component part.* Calculations for forests owned by corporations such as companies, cooperative societies, local or central government will be dealt with in a separate paper. The same is true of investment calculations for timber harvesting.

The approach to the problem will be concept-analytical. The purpose is to establish the *mathematical-logical structure of the calculations, and the variables to be included in calculations,* however, in no more detail than is warranted by the available empirical knowledge. The values to be given to these variables in actual situations of calculation are going to be studied in subsequent applied research.

Forestry can hardly be separated from the other economic activities in the units under review. Side by side with the forest holding, these units usually comprise an agricultural farm (cf. Metsälötilasto 1962) with diverse lines of production. Other means of livelihood are also possible sidelines, such as a grocery store, repair shop, digging machine, and a small-scale sawmill. Many forest owners also accept hired work. In all cases the decisions concerning the use of forest are more or less closely linked with the owner's other income-earning and spending decisions.

Forestry investment is therefore weighed not only as a spending problem within forestry itself but often also in relation to alternatives provided by the other sectors of the economic unit, especially by the agricultural farm, and the household. The annual »business» on a medium-sized privately owned forest holding in Finland is often restricted to two or three income and expenditure items,the mean annual net revenue to 2 000—3 000 marks (cf. IHAMUOTILA 1968, p. 68), and annual expenditure to roughly 10 per cent of the stumpage revenues (cf. UUSITALO 1968). For this reason, the separation of timber growing to make an independent sector of the enterprise in most cases appears artificial. It seems that the owner of a farm forest holding does not usually sell timber from his forest just because the stand is mature for cutting, but because he needs money to pay his taxes, to finance his consumption and/or for necessary investments in agriculture, forestry or other sectors. In addition, not all forest holdings yield income every year, and for this reason forestry can seldom be anything but a sideline to the owner, to eke out the real means of obtaining and spending his earnings (cf. V. KELTIKANGAS 1969, p. 124). This makes it necessary to consider forestry on these holdings as a sideline.

This being so, the comparisons of timber growing and other alternatives of the same person's activities should be theoretically conformable. Theoretical conformity here means that the structure of ideas, or model, behind the comparison, often implicit, is always the same and contains the same variables. Despite this, the explicit form of the calculations may vary. A variable may in some cases be of so little importance that it can be excluded from the explicit calculation without altering the result. In other cases, again, operational aspects may make intentional simplification of the model compulsory.

Studies of the calculations of timber growing investment therefore seek to consider them as a special application of the general theory of comparisons and not as a separate problem.

Thus the study is, in a way, divided into two phases. The first phase, which forms the quintessence of the present volume, consists of outlining, *for investment calculations of an economic unit owned and controlled by one physical person, a model or theory which is sufficiently generalized to cover all investments within such a unit,* whether they are in forestry, agriculture, trade or industry. In the second phase the model will be applied to practical forest investment problems. For reasons best seen from the later chapters of this paper, the applications in detail belong to the separate empirical investigations mentioned in introduction. Hence, in this volume only some cardinal problems of application will be shortly discussed.

Although in outlining the theory its general nature, that is to say, *its independence of the character of the investment objects*, is emphasized, it should be borne in mind that a uniting and at the same time resticting factor is *the economic unit.* In the first place, one thinks of a forest owner whose activities comprise things other than timber growing, for example farming and the motor transport of timber, and who makes investment decisions concerning all three sectors. In his decisions on agriculture he is a farmer, in deciding to buy a truck he is a transport contractor. Yet he is one and the same person, no matter which category he is considered to represent – or he may be generally termed the decision maker. The discussion does not seek to be general in the sense that it should include the investment calculations of other types of economic units, say a business enterprise in joint-stock company form.

What is said above is not enough to make the frame of reference for the study. The structure of the calculation is affected not only by the object of calculation (investment) and its internal characteristics, but also and especially by the *purpose of the calculation*, and the *situation* in which the object (investment) is reviewed. It is necessary to individualize these too, since without such an individualization any discussion of the form of the calculation would have no definite basis (VIRKKUNEN 1954, p. 55).

In the literature on business economics, investment calculations are understood to be *auxiliaries to the making of an investment decision.* HONKO (1955, p. 23 and 1963, p. 79) stressed that they serve in analysing the profitability of the different investment alternatives. VIRKKUNEN (1964, p. 60) defines the purpose of investment calculation as the means of finding the most profitable alternative, and this opinion can be considered widely accepted.

The definition, if left like this, is hardly exhaustive. It says nothing of the decision making process which the investment calculation is meant to help. An idea must first be formed of this process before the frame of reference of the present study can be drafted. Not until then can the study outline be precisely and finally formulated.

To start with, the concepts »investment» and »investment decision» must be defined.

21. Investment

Like many other terms frequently used in economic discussions, investment has several different meanings. Words of course are only auxiliaries obtaining their content from the purpose for which they are used. A word can be connected to a given set of phenomena, but the angle of review, and the context in which it is used, determine the characteristics of the set the word refers to.

Different sciences (and their sectors) naturally view things from different angles. It is understandable that the definitions used are at least externally different even when they may mean the same thing. In a study utilizing findings from several sciences this creates certain difficulties: the viewpoints of related sciences must be adapted to form new angles of review, and dissimilar definitions must be reconciled. If the fullest advantage is to be taken of the new viewpoint, a certain change of approach seems to be unavoidable. These statements are not confined to the present concept alone but apply to later contexts also.

Disregarding the lists of definitions given in wellknown textbooks and reference books on the various sectors of economics, routinely used, let us start from the definition perhaps

most frequently seen in Finnish economics. According to this definition (HONKO 1963, p. 13), investment implies an outlay from which returns are obtained over a long period of time and which is usually connected with a number of smaller outlays to be sacrificed later, in other words, it implies the investment process consisting of these outlays made at different times, of their flows as it were. To quote Honko, the word 'investment' is often restricted to imply only the major once-for-all outlay at the beginning of this process, and the later current outlays are considered accessories automatically belonging to the first major outlay.

Both definitions emphasize the outlay character of investment: either an outlay or a series of outlays (flow of outlays). Returns, however, are just as essential a part of investment. Unless the invested outlay yields returns, it is usually not called an investment. Viewed as a process, the investment may be seen as an *integrated series of outlays in association with a series of receipts* (SCHNEIDER 1944, pp. 9—11; cf. also HONKO 1955, p. 28; SCHNEIDER 1962, p. 198; JØRGENSEN 1964a, p. 389). An outlay is usually understood as a cash outlay and a receipt as a cash receipt (SCHNEIDER 1944, p. 11; HONKO 1963, p. 14), that is to say, monetary payments made and received by the economic unit (JØRGENSEN 1969, p. 39).

As it stands, the definition is broad. On its basis, many interconnected series of outlays and receipts timed over a long period might be termed investments although they customarily are given other names, for example disinvestment (sale of property) or borrowing. If therefore the set of phenomena is not to be expanded beyond the customary limits, increased precision is required.

SCHNEIDER (l.c., pp. 15—16) suggests a procedure by which the cases are divided into two groups according to whether chronologically the principal outlays or receipts are closer. The group in which the weight of outlays — regardless of the positive rate of interest used for weighting — is closer than that of receipts, represents the investment of Type I, *investment proper* (egentliga). It follows that those in which the weight of receipts is always earlier than that of outlays, belong to Type II and are not investments proper (uegentliga). JØRGENSEN (l.c.,

p. 40) called the latter type »negative investments» or »financing projects».

HÅLLSTEN (1966, pp. 18—19) proposed that all the cases in which the first payment item is an outlay be called investments. All others would then be financing projects.

From the point of view of the present study, it makes no difference which of the two definitions is selected. In actual fact even the difference between investments proper and financing projects (»negative investments») also depends on the approach. Every investment is necessarily linked up with financing, and what the investing party considers financing (e.g. taking a loan or selling a forest lot) is an investment for the other party (money lender or buyer of the forest lot). A distinction is justified primarily to make sure that the definition of investment should not unduly differ from that usually accepted by the Finnish reader.

From now on, when investment is mentioned it refers in the first place to the kind of an *integrated series of outlays and receipts in which the chronologically first member is an outlay.* The aspects that will be advanced concerning investment calculations can be generalized, without modification, to apply also to calculations used in comparing the other processes mentioned above.

A few remarks should perhaps be added to the foregoing. Firstly, investment foresees a time dimension (cf. 'long period' in HONKO's definition). This premise is here given the interpretation that the receipt and outlay items must be timed on a minimum of two periods of time.

Secondly, the receipts and outlays of an investment are always *changes in total revenue and expenditure of an economic unit.* The investment process can thus be reviewed also from this broader angle: when deciding on an investment, the forest owner in fact *exchanges the expected series of receipts and outlays of his economic unit against another expected series.* The difference between these series, the net changes, makes up the above outlay and receipt series of the investment.

This broader angle is justified e.g. because investment in this way is more clearly attached to the entity of the economic unit within which it will be reviewed. The concept of investment undergoes no change thereby.

22. Investment decision

Investment decision can be made conceptually precise on the basis of the above definition of investment. In the present study, *investment decision is understood to mean the forest owner's deliberate decision to undertake (or not to undertake) a given investment process*, in other words, to assume (or not to assume) responsibility for the series of outlays and receipts which, according to the above, form an investment. The same thing can also be termed to mean the *conscious resolution either to adhere to the expected series of (total) revenue and expenditure for the economic unit or to exchange it, by means of investment, against another expected series of revenue and expenditure*.

It is necessary to emphasize the words deliberate and conscious. An individual (forest owner, decision maker) may also exchange his series of revenue and expenditure, i.e. modify his behaviour, without any preceding deliberation. In other contexts, therefore, any such change in behaviour might justifiedly have been termed a decision (e.g. SIMON 1957, pp. 4—5).

According to KATONA (1951, pp. 31—36) an individual's behaviour is a response to a stimulus. Receiving a stimulus, the individual usually responds in the habitual way: he acts as he has done before in a similar situation, responding to a similar stimulus. Although such *routine* behaviour and routine decision can be more or less unconscious and mechanical, it may follow a response pattern adopted previously, even a complex one.

Sometimes, however, the individual faces a situation for which he has no pre-existing routine behaviour, or for which the existing routine is no longer satisfactory. Once he has recognized the situation, the individual finds a solution and adopts a new response pattern. This is called problem-solving behaviour by KATONA, who considers its result a *genuine decision*. There must, however, be *tensions* which are associated with strong motivations, if the genuine decision is to be brought to birth. It is therefore a relatively uncommon event (cf. KATONA l.c., pp. 47—50, 1953, pp. 309—311).

KATONA emphasizes, however, that there is no clear-cut division between routine and genuine decisions, and that there are inter-mediate forms. A similar approximate classification has also been used by other authors who have studied decision making (e.g., SIMON 1957, pp. 91—92; MARCH and SIMON 1958, pp. 139—140; ALBERS 1961, pp. 220—221; DUERR et al. 1968, p. 761; TÖRNQVIST and NORDBERG 1968, p. 761). SIMON (1960, pp. 5—7) distinguishes between *programmed* and *nonprogrammed* decisions among those made consciously. The latter probably correspond very closely to KATONA's genuine decisions. GORE (1964, pp. 136—142) speaks of innovative decisions and divides the programmed decisions into routine and adaptive (cf. LAUKKANEN 1968, p. 35). TÖRNQVIST (1963) gives a list of six types of decisions, composed of the above two main types and intermediate forms.

If the concepts described above are used, the *investment decision of the present study is very close to a genuine decision*. The pure routine decision can be excluded from discussion, for the use of the investment calculation studied is an indication that the forest owner is making a deliberate decision. In this form the definition of an investment decision probably corresponds more closely to the meaning given to the term in customary economic usage (e.g., JOHNSON et al. 1961, p. 105; SHACKLE 1961a, p. 13; F. PETRINI 1964, pp. 72—73, 230; cf. however RENBORG 1962, p. 20).

The investment decision, when understood as described above, is the end result of the *decision making process*. This process connects the changed conditions acting as incentive, the *stimulus*, with the final choice made between possible alternative responses, the *decision*. The detailed course of the process, however, has been described slightly differently by various authors.

Most authors seem to agree that the decision maker, having received the stimulus and recognized the problem, first *specifies the problem to be solved*, then *searches and generates the possible alternative solutions*, and finally *compares the alternatives* choosing the one he finds best for his particular circumstances (cf. e.g. MARCH and SIMON 1958, pp. 179—180; VIRKKUNEN 1961, p. 606; RAMSTRÖM 1963, p. 43; GOULD 1968, p. 794; LAUKKANEN 1968, p. 32). This can be expressed also by the general problem solving pattern quoted from JOHN DEWEY: the decision maker must find

answers to the questions »what is the problem? what are the alternatives? which alternative is best?» (DEWEY 1910, p. 72). SIMON (1960, p. 2) uses descriptive terms to indicate these three phases: »intelligence activity», »design activity» and »choice activity». LAUKKANEN (1968, p. 32) used the terms »start», »search» and »choice».

This variety of viewpoint arises mainly from the authors' different assumptions concerning the correlations and interdependence of the decision making phases. The phases may be viewed as a chain of successive actions in which the effects between components have one trend: the precise defining of the problem is followed first by a search for alternatives, then comes the comparison of alternatives, and finally the choice or decision is made. On the other hand, the phases may be understood as more or less parallel or simultaneous progressive actions, even with reciprocal correlations (cf. AHONEN 1970, p. 26). For example, progress in the search for alternatives and the results obtai. ned have a »feedback» effect on the formula tion of the problem, and the comparison of alternatives similarly affects their search.

The majority of authors start from the former basis. Traditional economic thinking may have contributed to this; it usually analyses individual behaviour as consisting of choices concerned with an assumed change in a circumstance or circumstances (cf. e.g. FRIEDMAN 1962, pp. 6—7; HEADY 1952, p. 3; VAIVIO 1962, p. 16). But a tendency to simplify the treatment of a complex occurrence may also be contributory. In any case, the main problem in decision making is apparently *how to choose the best of the known alternatives*, the one which will be finally put into practice (cf. RIISTAMA 1966, p. 31).

This so-called *choice thinking* (LAUKKANEN 1968, p. 24; cf. also HIRSHLEIFER 1965, p. 516) especially characterizes the mathematical-statistical models of decision making. Both the decision theory and the theory of games are based on the assumption that the problem and the alternative solutions are known or »given» (see CHERNOFF and MOSES 1959, p. 10; FISHBURN 1964, p. 3; STOLLER 1964, p. 12; BAUMOL 1965, p. 550; DAVIDSON et al. 1957, p. 205). Although some authors (e.g. CHURCHMAN et al. 1957, pp. 105—114; FISHBURN 1964, p. 22) emphasize the im-

portance of defining the alternatives and the problem to be studied, these procedural rules or instructions, which in the first place are meant to be normative, remain more or less dissociated from the choice models. This applies not only to the operational analysis but also to most lists of steps to be taken (e.g. DRUCKER 1959, pp. 392—405; COOPER 1961; NEWMAN 1963, pp. 105—117) in the so-called *planning techniques* (cf. LAUKKANEN 1968, p. 27).

The choice, and the search for alternatives, are firmly interconnected in normal decision making, for the final result of the choice is essentially affected by the range of the alternatives from among which the choice is made. Only in exceptional cases does the decision maker obtain the alternatives »cut and dried». He must usually look for them and develop them himself. Since both pure introspection and the results of psychological research show that individuals have a relatively limited capacity for making observations and treating the information (e.g. JOHNSEN 1968, pp. 362—365), it is improbable that the decision maker will always be able to find, or take up for deliberation, all possible alternative solutions (cf. SIMON 1957, p. 67). In order to be complete, the *explanation model of decision making must also have the mechanism, or submodel, for illustrating the search for alternatives* (Cf. LEAVITT 1964, p. 86; HONKO 1966, p. 86; RAMSTRÖM 1969, p. 107).

If the search model is to be fitted into the entity it must indicate when the activity starts and when it ends. The recognition of the problem created by the impulse and its (first) organization are the natural triggers starting the search for solution alternatives, but the end of the search process can be described in several ways. Decision makers may be assumed to search for solution alternatives for a given period of time, after which the search is terminated irrespective of wether or not alternatives have been found. The search may also aim at a given number of alternatives regardless of the time it takes. Both descriptions would concur well with a model of the decision process consisting of a chain of phases. The authors who have explicitly defined the end of the search seem, however, without exception to link this up with the kind of alternative found.

Two explanations have been proffered. According to one, the search is terminated when the expected additional benefit from continued search no longer corresponds to the additional cost involved (SCHLEIFER 1965, Chapter 5; TÖRNQVIST and NORDBERG 1968, p. 15). The other explanation says that the search is terminated when the first or the first few satisfactory alternatives are found (e.g. SIMON 1955, pp. 110—111; 1964, p. 8). Both presuppose that the search and comparison processes are partly parallel, or rather that they form a *loop (of activities):* the alternative(s) found is compared with other known alternatives, or (in the latter case) with the target defined in advance, after which the search for alternative(s) is resumed as many times as required in order that the condition for the termination of search is met.

The expected additional benefit can probably be clearly defined only if a sufficiently exact idea can be created in advance concerning the alternatives that may be found. Since this kind of pre-knowledge is hard to accept as a generally realistic assumption (cf. MARCH and SIMON 1958, p. 14; JOHNSEN 1968, p. 451), the latter of these explanations seems to be gaining ground (see e.g. RIISTAMA 1966, p. 33; JOHNSEN 1968, p. 565; RAMSTRÖM 1969, pp. 110—111).

Similarly, it may be shown that the precise definition of the problem, the search for alternatives and their comparison, together form a more or less distinct activity loop. Especially when the individual is solving a problem essentially different from those experienced earlier, he often re-defines and modifies his task as new information is accrued during the search and the comparison of alternatives. The final problem solved is therefore not always the one for which an answer was originally sought. Formulation of the problem, in its turn, is considered to affect the search and development of the alternatives by determining the properties requiring attention. (See e.g. SIMON 1964, pp. 7—8; DORFMAN 1966, p. 60).

Not all authors confine the decision process to these three component phases. The decision is usually followed by *putting it into practice* (»action phase», GOULD 1968). Especially in larger firms, this involves conversion of the decision into a detailed plan of activity — development of procedural rules or routines (programming) — and *supervision* of its implementation (see e.g. VIRKKUNEN 1961, pp. 607, 616; KILANDER 1962, p. 17; DUERR et al. 1968; HONKO 1969, pp. 188—198). Both actions may be shown to exert a certain influence on later decisions, i.e. the start and course of new decision processes.

Since the present study deals with an individual decision and not decision activity consisting of consecutive decision processes (TÖRNQVIST and NORDBERG 1968) a detailed analysis of the *implementation process* (l.c.) is hardly necessary here (cf. also SIMON 1960, p. 56). The same applies to acceptance of the consequences of the decision. Its importance is emphasized e.g. by JOHNSON et al. (1961), classifying it as a separate phase (»acceptance of responsibility», cf. also CASTLE and BECKER 1962, p. 8). However, the *level-of-aspiration mechanism* and its role in originating the investment decision are worth discussing in this context.

The concept of a »satisfactory alternative» contains the assumption that the decision maker draws up targets for his activity aiming at a fixed amount rather than an optimum. He seeks to obtain something »at least» or »at the most» instead of the largest or smallest amount possible of the characteristic involved (see JOHNSEN 1968, p. 472). The assumption is supported by earlier inferences, and also by the fact that it is mathematically possible to maximize or minimize only one dependent variable at a time (e.g. CHAMBERLEIN 1955, pp. 67—68; HERMANSEN 1964, p. 312). When studies of individual persons' goals suggest very clearly a variety of goals which at the same time are not commensurable (see especially JOHNSEN 1968; cf. also McGUIRE, 1964, pp. 74, 248—249), optimization would seem operational only exceptionally. Optimization apparently has no alternatives other than fixed targets or pure randomness, i.e. lack of goal.

The »fixed-ness» of the targets is usually understood as momentary or periodic (e.g. CHAMBERLEIN 1955, pp. 40—44; CLARKSON 1963, p. 57). Both KATONA (1952, pp. 91—98; 1960, p. 130) and SIMON (1959, pp. 263—264) connect the setting of targets with the so-called *level-of-aspiration mechanism*, a concept they have borrowed from psychology. According to this, individuals (and corporations)

define for themselves aspiration levels which they must be able to exceed (or pass below, if the level is of the maximum type) in their activity. The level of aspirations depends on the individual's own earlier achievements but also on those identical social group members and reference groups with whom he compares himself (MARCH and SIMON 1958, p. 184). If an alternative to fulfil or meet the aspirations can be found relatively easily and soon, the decision maker usually raises the aspiration levels of his activity. The result is the same if he finds that a reference person or group has managed better than he expected (KATONA 1951, p. 92). But if no satisfactory solution seems to be found with reasonable efforts the decision maker begins to lower his aspirations, at the same time trying to find new possible solutions. Alternatively, he may experience frustration and his work gradually loses its target (KATONA l.c., p. 93). (Concerning this process, see also JOHNSEN 1968, pp. 331—344, and COHEN and CYERT 1965, p. 332).

When an individual's targets, therefore, are observed at consecutive dates they are variable, and decision making acquires dynamic features. Modification of targets, however, is not continuous but occurs in phases as the results of activity are visible. It is therefore relatively slow (MARCH and SIMON l.c., p. 183). The standards an individual sets for the results of his work may therefore be termed »relatively» fixed (JOHNSEN 1968, p. 343).

The model of the search for alternatives, based on fixed targets, foresees something like this mechanism for the adjustment of aspiration levels (cf. MARGOLIS 1958, p. 190). If the individual's targets were assumed to be completely static, it would be difficult to explain why the search is terminated in cases where no alternative decision to meet the said aspirations is available. On the other hand, a model which allows the so-called personalistic variables to affect the search process is probably more realistic than one in which these variables only affect the comparison of decision variables.

The start, as well as the termination, of the search for alternatives are explained by means of the level-of-aspiration mechanism. According to MARCH and SIMON (l.c., p. 184), the gap between results achieved and the level of aspirations forms a *stimulus* (LAUK-KANEN 1968, p. 34). When the gap is wide enough, in other words, the intensity of the stimulus exceeds a given reaction threshold, the individual receives and perceives the stimulus and begins to define the problem concealed in the situation. This starts the process of searching for decision alternatives (GORE 1964, pp. 49—62; LAUKKANEN l.c., pp. 42—43, 54). The search goes on until the stimulus has been eliminated, i.e., the expected level of achievement is again in agreement with the level of aspirations, or the individual is frustrated (SIMON 1959, p. 263).

Whether and to what extent this level-of-aspiration mechanism agrees with the individuals' true internal behaviour is difficult to verify. The situation contains a so-called »black box», in other words, a phenomenon or »system» with a structure that cannot be directly observed (see e.g. ASHBY 1956, pp. 86—93; OPTNER 1960, pp. 3—4). Nothing much can be done beyond observing the conditions, and the responses to these conditions, that is to say, »the inputs and outputs of the system». On their basis, it is possible to attempt conclusions as to contents of the black box, in other words, the »intervening mechanism» that converts the inputs into outputs. Whether the resulting models are realistic and which of them are better than the others can only be indirectly estimated, by analysing how well the behavioural predictions they produce agree with reality (cf. MILLER and STARR 1967, p. 16; ENGEL et al. 1968, p. 21).

The level-of-aspiration mechanism, in its details, leans on introspection but primarily on the results obtained in psychological studies of the individual's goal-striving behaviour (see e.g. KATONA 1951, pp. 91—93; JOHNSEN 1968, Chapter 7.6.). The model has been indirectly tested in certain simulated economic decision making (CYERT and MARCH 1963, pp. 84—99, 128—148), but on these points the empirical evidence is still relatively small and not binding.

For the present purpose, however, it is enough that this construction of ideas has not been proved erroneous and that it is the most generally adopted among the explanations of the »satisfactory alternative».

23. Model of decision making

The picture thus outlined above of the component phases of the decision making process, and their interconnections, gives an indication of the principal trend of »Simonian» thinking recently adopted to an increasing extent in business economics and theory of organization. According to it, the decision maker facing a problem usually

1. must personally search for or develop the decision alternatives, instead of being presented with ready-made alternatives,
2. takes a relatively small number at a time for consideration, since he cannot simultaneously perceive and compare very many alternatives (see e.g. SIMON 1955, pp. 99—101; SHEPARD 1964, pp. 263—266; IJIRI 1967, p. 156; JOHNSEN 1968, Chapter 7.8.),
3. accepts as his decision the alternative that meets the minimum aspirations for the measure, without really seeking the maximum results, and
4. if he finds the solution »too» soon or not at all, modifies his aspirations to balance the situation, in other words, learns from the results of his activity (JOHNSEN 1968, p. 519).

It may be necessary to add some detail to this general picture before the purpose and aims of investment calculations are discussed. There is no generally accepted model available for the purpose. Although the above basic lines provide the framework for developing a model of the decision making process, considerable variation is possible in details. Examples that can be mentioned are the models applied by JOHNSEN (1968, pp. 522—525) and RAMSTRÖM (1969, pp. 110—111) in their studies, the former as the basis of computer simulation to help decision making, and the latter as a frame of reference in the study of the »means-ends» hierarchy of Swedish insurance companies. With both authors, the purpose for which the model was used has essentially affected the choice of the details included. The same is true of the structure ENGEL et al. (1968, p. 351) applied in their theory explaining the consumer's behaviour.

The model of decision making process to be
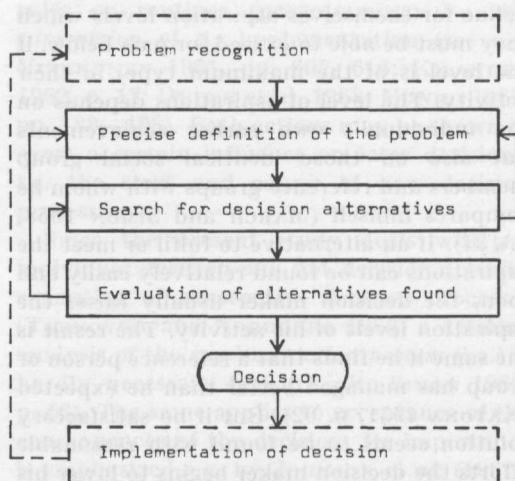
Fig. 1. General course of decision making in a genuine decision process.

presented below has been compiled by fitting together, as far as possible, the materials contained in the three models described, and by taking into account other viewpoints, some of which have already been touched upon in the foregoing. The resulting model, in the present writer's opinion, is at least partly new and differs in many points e.g. from the generalized decision making model AHONEN (1970) uses as a background when he describes the process of forest price formation.

Fig. 1, in the form of a block diagram, illustrates the three component phases of decision making process: *precise definition of the problem, search for decision alternatives, and evaluation of the alternatives found*. It also reveals that, for an activity to be started, *problem recognition* is required, and the decision is followed by the *process of implementation*. Arrows indicate the chronological order of the phases, and the activity links or loops contained in the process. The broken--line arrow uniting the process of implementation and problem recognition suggests the possibility that the results may create a new problem.

The more detailed structure can be seen from Fig. 2, in which Block A specifies the problem recognition. The individual receives information both on the results of his own actions and on the achievements of reference individuals and groups. The acceptance of this information is selective: only a fraction

External information

Idea of one's own
achievements

Idea of other peo-
ple's achievements

Levels of aspirations

Comparison

Tolerances

Problem
recognition

A

Active search
for information

Adjusted idea of
own achievements

Adjusted idea of
others' achievem.

Adjusted levels
of aspirations

Adjusted idea of differences =
requirements for the solution
of problem, i.e. goals

B

Division of goals into genera-
tors and tests

Development of alternatives by
means of generators

C

Formation of expectations about
consequences of alternatives

Testing the acceptability of an
alternative by comparing expec-
tations and test goals

D

Decision =
the alternative adopted

Implementation of the decision
- routines
- control

E

Internal information

Fig. 2. Decision process model.

of all potential information continuously reaching the individual and perceivable to him, is really absorbed. From the flow of information, the individual filters primarily those data which he is »tuned» to receive, while the balance passes unperceived. Information arrives in the form of various signals which the receiver interprets, that is to say, converts into information. On this

point, too, the individual's internal »tune», attitudes, etc., affect the kind of knowledge ultimately perceived. (see ENGEL et al. 1968, pp. 79—112; also SIMON 1959, pp. 272—273).

Information arriving at the destination confirms or modifies the individual's ideas of his own condition and achievements, and of those of the reference individuals and groups. If information creates an essential change in

either, the individual responds by modifying his levels of aspiration. Modification of the level of aspiration again makes him compare the new level with the ideas he has of his own achievements or level of achievement. If the differences are wide enough, i.e. if they exceed the individual's tolerance limits, he recognizes the situation as a problem. (Cf. WRIGHT 1964, p. 156; ENGEL et al 1968, pp. 350 and 360—361).

Interpreted in this way, the process leading to problem recognition is highly individual. »Filtering» the information, interpreting signals, formation of the levels of aspiration, and response level, i.e. tolerance limits, vary, and therefore different individuals may be expected to respond differently to the same information supplied to them. Some, in a new situation, recognize a problem sooner, others more slowly.

After problem recognition the individual initiates action in order to solve or eliminate the problem, and this is called *decision process*. The first thing is usually to *define the exact problem* (Fig. 2, Block B). The above recognition mechanism must be understood to operate mainly on the lower, »passive» levels of the individual's consciousness. When the individual perceives that he is faced with a problem this does not necessarily mean that he recognizes exactly what is wrong. The problem at this stage may be a more or less vague »annoyance» which must be defined, i.e. »identified». At the same time the individual must make sure that the problem is genuine, and not only due to incomplete information, or to information incorrectly interpreted.

To this end, the decision maker first strives to define his idea of the state of affairs, mostly by the active collection of additional information. Definition of ideas results in adjustment of aspiration levels and, later, an adjusted idea of whether the actual state and action essentially differ from the aspirations. If not, the situation is relieved, whereas in the opposite event the process continues.

The problem is now to eliminate the observed gap: the decision maker strives to find a means, either by modifying the existing modes of activity or by adopting an entirely new activity, to restore the balance between achievements and aspirations (cf.

WRIGHT l.c., p. 156). This is the beginning of the phase above termed as the *search for decision alternatives* (Fig. 2, Block C).

By defining his precise idea of the differences between achievements and aspirations, the individual outlines and recognizes the requirements that must be met by the solution sought. They are partly straightforward goals (for example, net receipts obtainable by the action must cover the deficit found in the total net revenues), partly limitations of activity (acceptable action or combination of actions must conform to law and to what is socially expected of the decision maker, it must not entail reductions in the individual's other activities, it must be capable of implementation by a given date, etc.). The distinction between goals and limitations is not really very sharp. The former are usually considered to be more flexible, the latter more or less unyielding. But in many cases — e.g. role expectations — the main difference is in emphasis. Both may therefore justifiably be combined under the same heading »goals» (SIMON 1964, p. 6; DORFMAN 1966, p. 61; cf. JOHNSEN 1968, p. 234 fn.).

When he starts searching for or developing his alternatives, the decision maker chooses a number of the goals to serve as generators which guide the search and development of the alternatives that will be studied. The balance is used to test the acceptability of the alternatives found. (Cf. SIMON 1964, pp. 7—9; WRIGHT 1964, p. 65). The division into generator and test goals is individual (SIMON l.c., p. 9), but is probably largely based on various »rules of thumb» or heuristics. (See e.g. SIMON 1960, pp. 29—30; CLARKSON 1963, pp. 349—352).

The same applies to the search (generation). Among the heuristic methods used, CYERT and MARCH (1964, p. 295) mention the method of starting from the neighbourhood of the cause of the problem and/or the activities conducted to date, and gradually extending the search. The use of the »means-ends» chain is also wellknown (SIMON 1957, pp. 62—66, 99—100; 1960, p. 27; RAMSTRÖM 1969, p. 116). Unless there seems to be a feasible alternative among the generators selected, the individual may adjust the division or the aspiration levels of the decision.

After the decision maker has found or generated one or more alternatives to meet the requirements used as generators, he begins *to evaluate* their acceptability in the light of test goals (Fig. 2 Block D). To this end, he first formulates for himself the expectations concerning the results from each alternative and then compares these result expectations with test goals (levels of aspirations).

If the tested alternative meets all requirements made of the solution and was not found »too easily», it becomes the final solution or the *decision*. When several simultaneous alternatives are available for study, and all prove to be acceptable, the individual chooses the best one. If the solution was found without trouble the individual may adjust (»step up») his levels of aspirations and continue the search. Also if none of the tested alternatives meets his requirements he returns to continue the search and the generation of new alternatives. Delayed solution, however, may make him adjust his goals and their division into generators and tests. In most of these cases, the decision maker now alters his search heuristics or expands his search. For example, having started to search for the solution in the sphere of the existing activities, he may gradually take into consideration entirely new forms of activity (MARCH and SIMON 1958, pp. 179—180; KATZ and KAHN 1966, p. 279). If so, the problem itself may be said to undergo a modification.

Once the decision has been made, activity continues in the form of an *implementation process* (Fig. 2, Block E). Its details need not be specified in this context.

The model described is intended to show the course of a genuine decision process in its complete form. When individuals adopt standard procedures, various modifications, mostly reductions, will arise. The heuristics referred to above indicate them. In perfectly routine decision making (in making a routine decision) the course is shortened: stimulus received from internal or external information is identified, and the solution is automatically found from memory where it has been »programmed» as a result of earlier decision processes (cf. ENGEL et al. 1968, pp. 352—354; BASS 1965, p. 378; GOULD 1968).

24. Investment calculation

Using the above model of decision process as the frame of reference, the reasons for drawing up investment calculations and their aims can now be analysed in greater detail. When investment calculation is considered to be part of the investment decision it must be possible to derive its function from the latter. The calculation must be adapted to the model of decision making.

The first thing is to see *whose* calculation is analysed. The following alternatives are possible:

— decision maker, in this case the forest owner himself,
— adviser helping him, i.e. a consultant,
— an interested outsider who takes no direct part in decision making.

The interested outsider is usually interested in the decision maker's practical steps. His objective is either to foresee the decision maker's (forest owner's) decisions and the subsequent actions, or to find such factors affecting the decision making (parameters) as might be controllable.

By way of an example, there may be an authority commissioned with planning such measures as would promote afforestation of arable land. This person is interested to know the factors or the changes in factors which have an influence on the farmer's afforestation decisions, either positive, negative or neutral. He may try to discover the possible or probable effects of afforestation rewards, free-of-charge seedlings, exemption from tax, etc., by calculations which simulate the true decision making by the farmers/forest owners under review.

In order to foresee the results and to find control parameters, it is essential to know the process of the decision maker's solutions, phase by phase, and how they originated. What kind of decisions ought to be made — from the point of view of the forest owner himself or the interested outsider — is a secondary question.

The forest owner and the consultant, on the other hand, participate actively in the decision making process and see the problems accordingly, but not identically. The forest owner is interested to know how he should proceed, in other words, which, from his

point of view, would be the »correct» procedures and »correct» solutions in the different phases of decision making. His investment calculations are intended to provide either a direct solution or information on which to base the solution.

The adviser or consultant in his turn tries to help the forest owner make the decision. He has been hired for this purpose. Investment calculation is for him the tool he uses to do the task he has been given and has accepted. The detailed aim of the calculation is determined by the specification of the task delegated to the consultant in each particular case.

The present study will review the investment calculation as one *made by the consultant*. The question it will try to answer is: what kind of structure and content must such a calculation have in order to meet the expectations.

The selection of this angle of review is justified for the following reasons:

1. Few Finnish forest owners are capable of working out investment calculations concerning timber growing. Where the forest owner bases his decision on calculations they have usually been made by a hired consultant or other expert. The same is largely true of the forest owner/decision maker as a farmer, although those capable of independent calculations are apparently much more numerous among the farmers.
2. The aim will be to develop the theory to meet the needs of the »contractual research» mentioned earlier. When the research worker tries to calculate guiding figures which could help the forest owners to decide the issue, he is working in much the same way as a consultant. Neither of them makes the calculation for his own personal ends or with a view to leading the forest owner's decision into a course desirable to an interested outsider. Both may at least be assumed to be doing their best to produce a calculation that will accord with what the forest owner expects their results to reveal and, on the other hand, with what the results can reveal. An analysis of a consultant's calculations may suggest a framework for the calculations of the research worker.
3. Analysis of the structural framework of an

investment calculation made by a consultant enables conclusions as the interested outsiders' possibilities of simulating the forest owner's decision making process.

It may be pointed out that a consultant, an adviser commissioned to provide services to the forest owner alone, is very uncommon in Finland, unlike e.g. the USA, where independent »consulting foresters» form an essential sector of the forestry professionals. In Finland, the responsibility of assisting farm forest owners in decisions on both forestry and agriculture falls on various instructors, advisors and the like. They are officials employed by counselling organizations largely financed and supervised by the State. Since these organizations often have connections with the political interest groups of farmer/ forest owners, this assistance can hardly ever be entirely free from external influences: in making their decisions, the forest owners are probably influenced, at least to a certain extent, towards taking the course desirable to the said interested outsiders (state, interest organizations).

Disregarding the question of whether or not this type of counselling is desirable, an investment calculation made by a consultant independent of all outsiders, is certainly a useful subject for study. It contains structural regularities that help to indicate the type of difficulties that might be created by the other advisory organizations and to determine the most purposeful way to organize the counselling.

From now on, the investment calculation referred to in this paper will be regarded as one worked out by a consultant. Before launching this subject, the *assumed division of work between decision maker and consultant in making the decision* must be defined: what kind of division of work is possible and meets a useful purpose.

241. Jobs delegated to the consultant

The problem the forest owner/decision maker presents to the consultant for advice, may in principle cover the whole decision making process as it was defined in the foregoing. In other words, the commission may start from a precise definition of the problem and finish with the final choice of the step to

be taken. However, it is probably rarely presented as a single commission, leaving only the responsibility for the final solution to the forest owner himself. It is apparently more common for the commission to be divided into several problems: the collection and analysis of information to shed light on the situation, the generation of solution alternatives, determination of the results to be expected from the alternatives, and evaluation of the alternatives (cf. MORRIS 1963, p. 201). The decision maker, after each phase, decides how the process should be continued. The consultant's commission may also be confined — explicitly or implicitly — to one of the phases. The forest owner, for example, may ask the consultant for advice as to which of a given number of alternative stands it would be best to fertilize.

The extent of the commission delegated to the consultant probably depends above all on which of the phases the decision maker thinks can suitably be delegated to another person. The deciding factor in the estimation of suitability is the nature of the specialized knowledge demanded by the job.

This criterion can be used to divide the problems of the decision process into two groups. For example, the generation of action alternatives and the formulation of their expected results involve, first and foremost, the finding of objective, impersonal *facts*. Setting aspiration levels represents *value judgements*, in which the individual's own feelings are the decisive factor. The former are often called factual or empirical, the latter ethic and value problems. (SIMON 1957, Chapter III; cf. SCRIVEN 1968, p. 86).

For example, the argument that afforestation yields income not to the forest owner but to his children or grandchildren, is empirical, whereas one according to which the forest owner in his work ought to consider what is best for his children and grandchildren, is in the first place ethic.

Answers to factual problems are, at least in principle, verifiable by empirical observations, either directly or with the aid of logic inference. On the other hand, theorists disagree as to whether normative statements (see e.g. LIPSEY 1966, pp. 4—7) can be reduced into empirical statements, and whether therefore value judgements also can be objectively derived from facts, that is to say, verified by observations (see JOHNSON 1960, p. 29; LIPSEY l.c., p. 5 fn; SCRIVEN l.c., pp. 86—87; HUDSON 1969).

In this connection it is not necessary to go into the details of this philosophical problem. Whatever the ultimate truth, science cannot, at the moment, offer a method by which the reduction of value judgements into empirical problems could be completely realized. For practical reasons alone, the ethic and value proposition solutions associated with decision making must be separated from those relating to facts (cf. LIPSEY l.c., p. 5 fn.).

The above does not mean that the consultant might not have to answer questions related to ethic and general value judgement problems. The formulation of value judgements is apparently often experienced as a heavy mental strain, especially if the original goals are very contradictory (JOHNSON l.c., p. 29). Recourse to another person for help is as natural as in collecting the information associated with the actions. It is essential, however, that in answering such a question the consultant should work on a different basis from that used in solving factual problems.

The solution a consultant suggests to an ethic problem may be interpreted in two alternative ways. Either it will be the consultant's personal value judgement, or it will express the opinion he has of the values and norms prevailing in the decision maker's reference group. In both cases it represents *information* which, according to the above model, may affect the formulation of the decision maker's aspiration levels (see p. 16). Whether, and to what extent, this influence is decisive or secondary depends ultimately on the decision maker and his independence.

Provided the foregoing is accepted, the following conclusions can be drawn concerning the division of work between the decision maker (forest owner) and the consultant.

Setting the aspiration levels is a task that is hardly ever delegated to another individual. Even when the decision maker asks for advice on his goal problems, it may be taken that he is looking for *additional information* on other people's value judgements rather than a final definition of aspiration levels. *When the consultant's commission is defined it is best to present and treat questions of aspiration levels and other integral phases as distinctly separate part-commissions.*

When the decision maker formulates his aspiration levels he must make them known to the consultant in one way or another. Only after this can the consultant compare them with achievements or with results to be expected from the different alternatives. This information transfer requires time, trouble and expense, and may frequently involve disturbing error factors (cf. EDWARDS 1954, p. 24). On the other hand, there may be no justification for expecting the consultant to carry out the comparisons — once the quantities to be compared are known — very much better than the decision maker. Therefore this procedure may be unnecessary. *The decision maker should be satisfied when the consultant furnishes him with the facts concerning his achievements and/or the effects (results) of the alternatives considered, in a form that enables their direct comparison with the relevant aspiration levels.* He can, and often does, carry out the comparison himself.

Information on the consequences of the alternatives (»expectations» in the above model), in their primary form, are hard to compare with the aspiration levels, and this for two reasons. Firstly, the individual's achievements and the direct effects of the alternatives are usually measured and expressed in terms of dimensions different from those in which the individual perceives his aspiration levels or his objectives. Direct results of forest improvement are changes in growing stock volume and cutting quantities. The forest owner's objective may be, for example, a certain present value of net income and a simultaneous certain minimum liquidity. Testing the acceptability of activity alternatives requires that the original information — the expected consequences of the action — be first transformed into a form corresponding to the goal dimensions (aspiration levels). In other words, the consequence vectors must be projected onto the goal (i.e., aspiration) space.

Secondly, the direct use of original information is impaired in many cases by the fact that the action leads to a large number of direct effects. This is true even after the elimination of those that, from the decision maker's point of view, are unessential or nearly insignificant. Furthermore, the individual's ability, frequently untrained, of simultaneously perceiving and comparing information related to the alternatives is limited. According to many psychological studies, it comprises only 5—10 components and dimensions (see e.g. SHEPARD 1964; JOHNSEN 1968, pp. 362—365; cf. POLLACK 1968, p. 335). The number of effects must be reduced, in other words, information must be *condensed* (by combination of vectors) before it can be checked by the decision maker.

The testing of the acceptability of alternatives, which has also been called »evaluation of alternatives» (e.g. TÖRNQVIST and NORDBERG 1968), is therefore divided into three components: (1) transforming the information composed of the expected consequences of the action, (2) condensing it, and (3) verifying the acceptability, by comparisons with aspiration levels, of the information now in comparable and controllable form. It may be asserted on the basis of the above that the decision maker (forest owner) when he asks the consultant whether a measure is »profittable» or which of the given alternatives is »best», *in the first place* expects that the consultant will

1. with the aid of his expertise form the detailed expectations of the effects of each alternative,
2. transform and condense the information composed of these expectations into one or, at the most, a few parameters, and
3. present the information so treated to the decision maker who, with its aid, finally decides the acceptability of the alternatives.

The consultant, however, is not only consulted for a comparison of given alternatives but often already during the search for alternatives (e.g. MORRIS 1963, p. 201). In principle, the possible procedures meeting the generator goals (requirements) may be innumerable. As already pointed out, the decision maker, by whatever means he may use, seeks among them, finds and takes up for detailed consideration only a few (cf. SIMON 1964, pp. 8—9; TÖRNQVIST and NORDBERG 1968, p. 13). In his search the decision maker may resort to observation and imitation of others, to his own ability of innovation (heuristic methods), or to expert advisers (cf. JOHNSON et al. 1961, pp. 29—40; LAUKKANEN 1968, pp. 58—83). The present study deals with the last-mentioned possibility.

When approaching a consultant, the decision maker expects him to know, and be able to evolve, a larger number of chances of solving the problem efficiently than the decision maker could himself. The expectation is based on the consultant's training and experience. The concept of expertise goes with detailed and extensive knowledge of the field of alternatives. Since both research and the specialist training emphasize a systematic exploration and a wide knowledge of this field, this expectation by the decision maker may be considered well justified.

The commission, however, does not only consist of the mechanical transferring of information, since more solution alternatives can easily be found than the decision maker wishes, or is able, to take into consideration. A forest owner who asks for suggestions about forestry investments to increase his revenue would not be well served by a list of all possible combinations of fertilizer types, fertilizer quantities and fertilizing methods with the relevant cost and yield calculations, one by one. The information would be too abundant, and most forest owners would be »drowned» in it, incapable of forming an overall idea of the possibilities required for decision. The consultant, therefore, must choose: from among all the solution alternatives that come to his mind, he must screen those that he expects will be worth presenting.

When the objective is to find action alternatives which, in addition to generator goals, would also meet the decision maker's other, so-called test goals, elimination is efficient enough only if the consultant knows all the decision maker's principal aspirations (aspiration levels) and can by this means define the alternatives worth proposing.

If the consultant were able to get a clear picture of the decision maker's aims it would obviously be beneficial to extend the consultant's commission to cover the final verification of the acceptability of the alternatives. The practical course would be: Having clarified what is expected of the solution, the consultant would search for possible alternatives, test their acceptability, and inform the decision maker of his final result, on the basis of which the decision maker would adjust his goals. If necessary, i.e. if the goals were modified, the procedure would be repeated.

However, only a number of the individuals' goals, or the requirements made of the solution of the problem, can be easily and precisely expressed (are operational). The forest owners often seem to omit mentioning goals they find »self-evident» or »less honourable», or which for other reasons are not recalled when the commission is outlined (see DORF-MAN 1966, p. 60).Knowing this, as decision makers, they usually check and supplement the testing themselves. This being so, the consultant is well-advised to use the objectives he has been able to define, according to the decision maker's suggestions, only as a guide in defining the field of alternatives, and in his search for alternatives. He then submits several alternatives for the decision maker's consideration, i.e. testing, and does not just present him with one »correct» alternative.

Depending on the situation, the transformation and condensation of information per alternative, delegated to the consultant, may therefore also involve cutting down the number of alternatives submitted for consideration, that is to say, condensation of the information concerning the alternatives as such.

242. Investment calculation by the consultant

If the above outlines of decision making and the consultant's role are accepted, the investment calculation under review may justifiably be defined as follows: *investment calculation is calculation in explicit form, in which or with which information on the direct consequences of investment alternatives is transformed and condensed to serve in the testing of the acceptability of the alternatives.* The purpose is to transform and condense the information into a form in which it can, more easily than in its original form, be compared with the requirements made of the solution.

On this basis, the consultant's investment calculation may now be considered in detail. The present problem was limited above to the investment calculation. The words investment calculation from now on, unless otherwise stated, refer to a calculation by a consultant, and to the objectives foreseen in it.

As mentioned before, in two types of commissions given to the consultant the information usually requires treatment, i.e. process-

ing. He may be requested to propose suitable investment alternatives which meet the requirements given, or to describe the consequences of one or more given alternatives in a form suitable for testing. In the former case the consultant must choose, from among the alternatives he either finds or already has in mind, those he wishes to present to the decision maker. If the consultant seeks to carry out the selection with a view to the decision maker's objectives, he must first give the effects of the alternatives a form suitable for testing. In other words, he must do as he does in the latter case. Hence the transformation and condensation of the effects of investment alternatives so as to render them fit for testing may be considered the essential task. In the following, the investment calculation is considered primarily *as a means used to transform and condense the information (information mass) composed of the directly expected effects of one investment alternative.*

It should be noted that, according to the opinion adopted here, investment calculation starts from existing information. The consultant has formed his expectations concerning the effects of the investment alternative studied, especially *those he finds of importance to the decision maker* (forest owner). Since each tangible act apparently has a theoretically infinite number of consequential effects (in and around the object), the formation of expectations is in fact the seeking, selecting, and eliminating of unessential points. The result, i.e. the composition of the information included in the calculation, is affected, among other things, by the type of consequences to which the consultant has been used or trained to pay attention, and by the *consultant's views of the decision maker's goals.*

To know the structure of the calculation it is not, however, essential to know how the information is composed, or what it contains in each individual case. It is enough to know what kind of information the investment calculation is intended to handle. The present paper, therefore, will disregard problems the consultant is confronted with when he composes the information, and will be confined to an *analysis of the transformation and condensation of existing information.*

As stated earlier, the problem is two-fold: the consultant must transform the directly expected effects to correspond to the decision maker's goal dimensions and condense the information into fewer elements. These two tasks are closely interconnected, and are usually carried out simultaneously. Nevertheless, in principle they are different.

Transformation moves or projects an individual effect vector from one subspace to another (for example, cutting quantity expressed in terms of technical measurements is transformed into money income from the cutting). The result can, if desired, be restored into information of the original form, provided the transformer (in example, unit price) that was used is known.

In condensation, information is combined: a resultant is formed, in one way or another, from separate vectors (individual cutting income items are summed). If condensation must be annulled — the result re-divided into its components — it is not enough to know the method of combination used (addition), but also n-1 of the combined n vectors must be known. However, the number of elements in the information should not be changed, and so the purpose of condensation would not be fulfilled. In condensation, therefore, *some of the original information is intentionally lost.* In transformation, the quantity of information is preserved but its »quality» is changed.

The division of work between decision maker and consultant as accepted earlier, assumed that the consultant's primary duty is to search for and transmit empirical factual information. If the total commission includes component problems which may be considered ethical or are otherwise associated with value judgements, the consultant is expected to handle and solve them separately. In extreme detail, the separation of objective and subjective problem material would imply, among other things, that the consultant, while transforming and condensing the information — at least in the early phases — should confine himself to *methods based either on generally acceptable regularities or on evaluations by the decision maker.* The consultant should not suggest his own values.

In practice, however, this strict requirement of objectivity must be relaxed. It was indicated above that the information supplied to the decision maker for testing the acceptability of an alternative must not contain too many elements. Otherwise the decision maker is hardly able to make use of the

DECISION MAKER

CONSULTANT

Requirements for the solution

Search for alternatives

Alternative to be studied — — — Alternative to be studied

Idea of the decision maker's requirements

Formation of expectations

Investment calculation

Expected effects + information to be treated

Transformation

Selection of the method of transformation

Transformed expectations

Condensation

Selection of the method of condensation

Transformed and condensed expectations

Supplementary modification if deemed necessary

Expected effects from alternative in comparable form — Final processed information
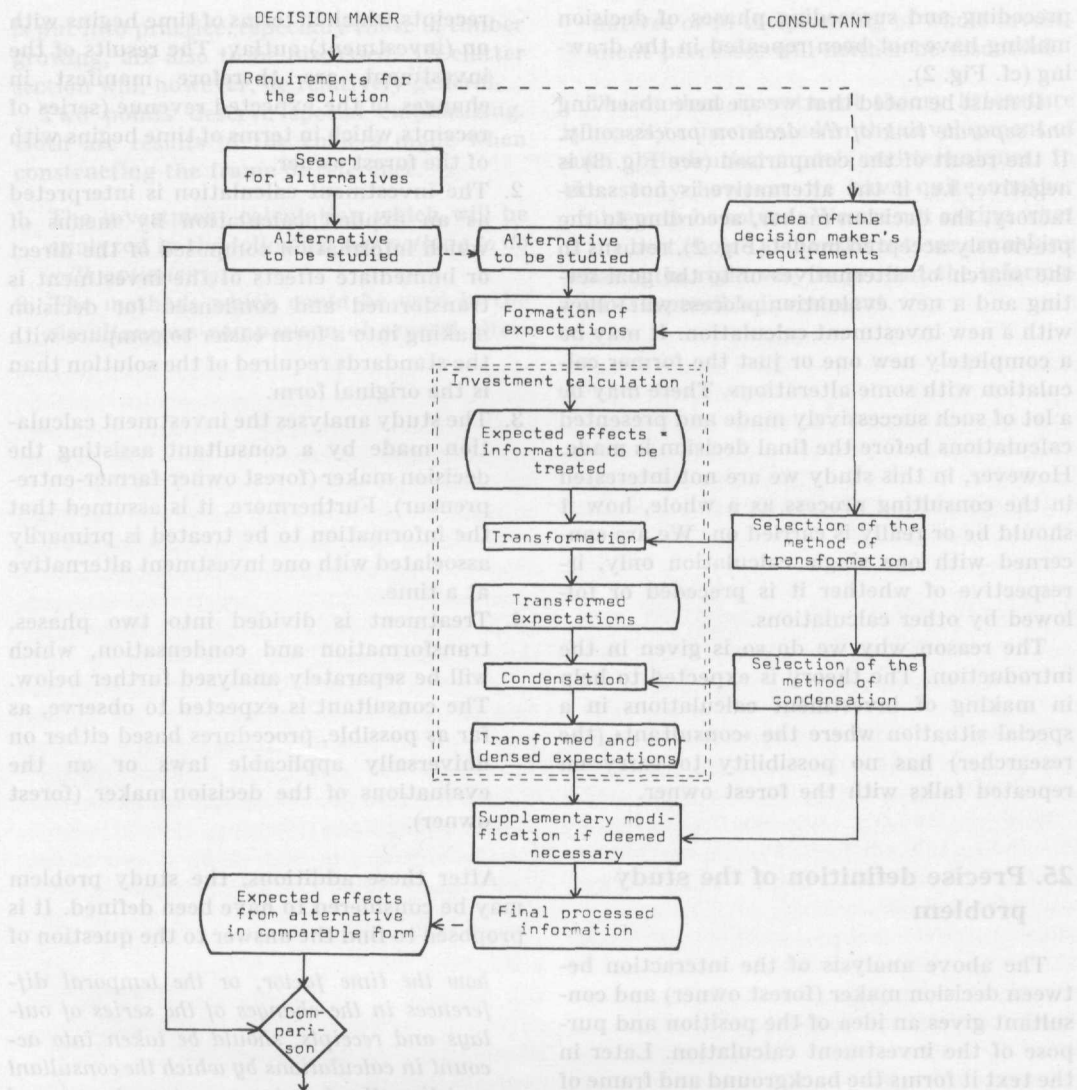
Comparison

Fig. 3. The position of investment calculation in the decision making process when the consultant's duty is limited to the evaluation of the investment alternative.

information, and the expediency of the work division might be questionable. There is probably therefore more justification for the following view of the situation: in treating the information, the consultant tries, as he is expected, to find and use methods that are objective in the above sense of the word, *but he supplements them where necessary with his subjective deliberation and valuations* unless he can by other means achieve a final result of sufficiently few elements and dimensions.

After these supplementary assumptions,

and restrictions concerning the situation studied, the position of investment calculation in the decision making process can be interpreted as shown in Fig. 3. It indicates information exchanges (broken lines) between consultant and decision maker, the consultant's steps towards completing the commission received, and the exact place of investment calculation in the commission. Since the consultant's role in this context was assumed to be restricted to the evaluation of the alternative submitted for consideration, the other

preceding and succeeding phases of decision making have not been repeated in the drawing (cf. Fig. 2).

It must be noted that we are here observing *one separate link of the decision process* only. If the result of the comparison (see Fig. 3) is negative, i.e. if the alternative is not satisfactory, the decision maker, according to the previously accepted model (Fig. 2), returns to the search of alternatives or to the goal setting and a new evaluation process will follow with a new investment calculation. It may be a completely new one or just the former calculation with some alterations. There may be a lot of such successively made and presented calculations before the final decision is made. However, in this study we are not interested in the consulting process as a whole, how it should be or really is carried on. We are concerned with one single calculation only, irrespective of whether it is preceded or followed by other calculations.

The reason why we do so is given in the introduction. The theory is expected to help in making of investment calculations in a special situation where the »consultant» (the researcher) has no possibility to carry on repeated talks with the forest owner.

25. Precise definition of the study problem

The above analysis of the interaction between decision maker (forest owner) and consultant gives an idea of the position and purpose of the investment calculation. Later in the text it forms the background and frame of reference for the analysis of the study problem. With its aid, the original problem can, or even must, be precisely defined.

In the first study outline, the primary aim was to investigate how the time factor should be taken into account in investment calculations concerned with timber growing in an economic unit which is owned and controlled by one physical person and which includes a forest subunit. Subsequently, a number of assumptions and conclusions have been made to confine and simplify the problem further. The most essential may be repeated here:

1. Investment in the present study refers to such an integrated series of outlays and receipts which in terms of time begins with an (investment) outlay. The results of the investment are therefore manifest in changes of the expected revenue (series of receipts which in terms of time begins with of the forest owner.

2. The investment calculation is interpreted as an explicit calculation by means of which information composed of the direct or immediate effects of the investment is transformed and condensed for decision making into a form easier to compare with the standards required of the solution than is the original form.

3. The study analyses the investment calculation made by a consultant assisting the decision maker (forest owner-farmer-entrepreneur). Furthermore, it is assumed that the information to be treated is primarily associated with one investment alternative at a time.

4. Treatment is divided into two phases, transformation and condensation, which will be separately analysed further below. The consultant is expected to observe, as far as possible, procedures based either on universally applicable laws or on the evaluations of the decision maker (forest owner).

After these additions, the study problem may be considered to have been defined. It is proposed to find the answer to the question of

how the time factor, or the temporal differences in the changes of the series of outlays and receipts, should be taken into account in calculations by which the consultant assisting the forest owner transforms and condenses the information he has evolved or obtained on the expected effects of investments in timber growing in the forest unit, so that this information will be in a form the forest owner can directly compare with his objectives.

As agreed previously, the solution sought is a theory of how to take into account the time factor in the investment calculation made by the consultant. This theory is to be presented in a form which, unmodified, is applicable to all investments, and not only timber growing investments, of the economic unit concerned. Some of the problems arising when the theory

is put into practice, especially those in timber growing, are also to be discussed. Th elatter section will, however, be relatively general.

Two points deserve special emphasizing. Both are results of the choices made when constructing the frame of reference.

1. The investment calculation which will be analyzed in the following *has nothing to do with optimizing.*
2. The methods which could be used in the simultaneous comparison of several alter-

natives or in the planning of whole investment processes will neither be discussed.

The modern investment theory litterature is heavily concentrated in the development of such optimization models and techniques. In this study however we have quite another problem to be solved. We are not asking what is the best choice of investment; we are asking what is the right way to present the information of a possible investment.

3. DEVELOPING THE THEORY OF INVESTMENT CALCULATION

The frame of reference outlined above connects the investment calculation with two concepts which have not been precisely defined yet: the »direct effects» of the investment, and the »individual's objectives or goals». They must now be given an unambiguous content. Their connection with the third, so far undefined pair of terms — »receipt» and »outlay» — must also be determined. From the point of view of the plot of this study, it is best to define the receipt and outlay concepts last.

31. Direct effects of investment and the individual's objectives, and their relationship to time factor

Let us first borrow some concepts and models of the system theory (cf. ASHBY 1960; SEALE 1966, pp. 1—20; PULLIAINEN 1967, p. 20; PALO 1967, pp. 19—21). The universe surrounding the individual may be considered to consist of various *elements* — i.e., things, materials, animals, plants, people, money, buildings, machines etc. — and their *attributes* and mutual *relationships* which, in addition to various interactions, contain all size, quantity, ownership, value, power etc. relations. Those elements, attributes and relationships discussed here, which may be termed as relevant for the individual, are called the indivudual's *environment*.

Closely interconnected elements, with attributes and relationships, are perceived as such or as groups; for example, a building, machines and the people operating the machines form a factory, individual trees a stand, a number of calculations on paper constitute bookkeeping, etc. These entities are called by the general name *system*.

Defining a system against other elements and relationships is more or less conventional and depends both on the defining person and also on the angle of approach. An element or relationship may simultaneously belong to several systems, parallel or hierarchically graded. A tree, for example, can be viewed as part of a stand, a forest unit or a larger forest region, but also as part of the scenery, part of the watershed, part of the outdoor recreation surroundings, etc. All elements and relationships, in principle, are related to elements, attributes and relationships outside their respective systems. Usually, however, the system is perceived as an entity whose outward relationships are relationships of the entity. The network of elements and relationships within the system is not recognized at all, either because detailed perception is not considered necessary, or because the content of the system is not known. In the latter case, the system is a so-called black box (see p. 17).

Even in a fairly small group of elements the number of relationships between elements is very high. If this fact is viewed against the limited human capacity, as indicated before, of perceiving and handling simultaneous relationships (SHEPARD 1964, pp. 257, 263—267; JOHNSEN 1968, pp. 362—365), it is evident that the individual can only recognize a very small proportion, at a time, of all the elements and relationships surrounding him. Perception of systems is a means of reducing the number of the relationships to be recognized, yet the number of the remaining relationships easily exceeds the individual's capacity. For this reason the relationships the individual, for one reason or another, considers essential, are screened from the crowd. The individual's recognized environment is therefore necessarily a very simplified idea of the network of elements, their attributes and relationships which »in reality» surround him.

The picture an outsider perceives of the individual's environment is also subjectively reduced. Although the persons concerned may, by discussions, be able to bring their views considerably closer, it is questionable whether they ever are able to perceive a situation in exactly the same way.

An investment, whether it is made for establishment of a business enterprise, purchase of a machine, purchase of a supply of

raw material, clearing of land for cultivation, construction of a forest truck road, exchange of securities, or any event whatsoever that can be interpreted as investment, always involves changing the condition of a system — the individual's livelihood, factory, production line, farm, forest unit, property, and the like. Primarily the changes take place in elements and relationships within the system, but they appear outwardly as changes in relationships between the system and the environment or its component parts — elements, attributes, relationships and systems, in other words, as *system output*. This is further reflected in the mutual relationships of the parts »at a distance» from the system.

As stated above, defining a system is arbitrary and therefore subjective. Even the same individual may find various solutions to a problem, depending on how essential certain elements or relationships seem each time. Differences between two individuals are even more probable. The consultant is unlikely ever to perceive the investment, or the system for which it is intended, in exactly the same way as the *decision maker*.

In the field so delineated, the »direct effects» of an investment are difficult to define exactly, unless the definition is somehow connected with a given person. For this reason, in the present study,

the direct effects of investment refer to the system output obtained through investment made in the system, as perceived by the observing party — the decision maker himself or the consultant.

The definition must be reconsidered after elucidating the concept of the »*individual's goal*».

Goal-oriented behaviour, both in economics and psychology, is usually explained as arising from the individual's needs or wants which he seeks to satisfy. The definition of a need says that it is a goal-oriented mental or inner force in man (RAINIO 1955, p. 14, cf. VERNON 1969, p. 1). Several opinions have been advanced concerning the detailed nature and origin of this force.

The model of the decision making process (cf. p. 19) serving as the frame of reference agrees perhaps most logically with the theory that the individual, in his physical and psychical activities, seeks to maintain homeo-stasis or a homeostatic development, and whenever homeostasis is disrupted he feels the need to restore it by suitable behaviour. For example, reduced temperature of the skin surface (»cold») creates a need to restore the temperature, and thirst, or the need for liquid, develops when the liquid balance of the body is disturbed (MORGAN 1956, p. 84; NUMMENMAA et al. 1963, p. 432). A need is therefore preceded by an external or internal stimulus disturbing homeostasis.

The *physiological needs* make up the lowest layer of needs. Having to meet a need repeatedly, the individual quickly picks up the actions which regularly lead to the desired result, and more generally, the conditions in which this takes place. These conditions create new *secondary*, or *learned needs*. From childhood onwards a man's motives become diversified, and various social and egocentric needs arise alongside the original physiological needs. (MORGAN l.c., p. 84; NUMMENMAA et al., l.c., p. 432; LEAVITT 1964, p. 27; ENGEL et al., 1968, p. 118).

The literature contains a large number of detailed classifications of needs. Authors have based their systematizations on slightly different views concerning the minuteness of the classification and the mutual importance of the actions characterizing the needs. ENGEL et al.'s (l.c., p. 67) six classes may serve as an example: physiological motives, safety motives, belongingness and love motives, esteem and status motives, and self-actualization motive. MADSEN (1959, p. 330) has sixteen classes: the primary motives of hunger, thirst, sexuality, caring, heat, pain-avoiding, excretion, oxygen, rest and action, the emotional motives of security and aggression, and the secondary motives of contact, achievement, appreciation and possession. RAINIO (1955, p. 21), a Finnish social psychologist, distinguished seven basic needs which he traces back, hierarchically, to one basic need, the need of survival.

Besides the social and egocentric »basic» needs, the individual's process of learning creates a further differentiation of needs. As a result of the repeated satisfaction of a need the individual may learn that hunger is best satisfied — in given conditions — with pea soup; afterwards the need the individual directly recognizes may be that of pea soup or perhaps, more precisely still, of Super X pea

soup. Rainio (l.c., p. 45) calls these learned needs (or goals) *individual needs* as distinct from the basic needs common to all (see also Nummenmaa et al., l.c., pp. 85—86).

The study of motives, however, is difficult because this is a typical black box phenomenon. The only thing that can be observed in certain conditions is the behaviour, and the impulse or impulses which seem to produce it. How the impulses in the human mind are transformed into behavioral reactions, and especially why a given impulse in different cases produces different responses, must be explained by means of variables, so-called organism variables, which cannot really be observed but can be inferred from impulse-response connections (Nummenmaa et al., l.c., pp. 60 and 80; Engel et al., l.c., p. 61, Johnsen 1968, p. 307). This leaves a very broad margin for the researcher's subjective interpretations.

Although the above is by no means an exhaustive review of the results of motivation study (cf. e.g. Nummenmaa et al., l.c., Johnsen l.c., pp. 302—331; Vernon 1969), it may provide an adequate background for the following more or less postulate-like conclusions concerning the individual's goals.

An individual's activity — when it is goal-oriented — is affected by one or more internal or organism variables, which may be termed needs or motives. (Many other terms have also been used.) So far, however, psychology has been unable to offer any universally accepted explanation for the origin and intercorrelations of these variables, or a method for the direct measurement of the variables.

If psychology is unable to explain the »ultimate» motives of an individual's activities, it is logical to assume that the individual himself cannot either. In other words, *the goals an individual recognizes as his goals in a given instance, must be accepted as his real goals*. The named goal may be an intermediate goal, a means of achieving another more distant goal. But if the individual does not perceive the situation like this, no outside observer is justified to assume other goals. This is especially the case when the observer is assisting the individual in the decision making and not forecasting his actions.

The expressed needs of an individual are diverse, and vary depending on the person and situation. Some goals are connected with commodities and services, others less tangibly with activities. The object may consist of the dirct results, or the indirect effects of an activity, or the activity itself. The goals must be defined broadly enough to cover all these possibilities.

The system-theoretical model described above provides the framework for a definition to meet this criterion.

In addition to element, relationship, system and environment, we may introduce the concepts *state of environment* and *state of individual*. They refer here to a precise qualitative and quantitative description of the attributes and relationships of the elements (systems) in environment and within the individual as perceived by the individual.

The direct effects of an investment were defined above as changes in the relationships between the object system and its environment. Similarly, it is feasible and appropriate to *interpret the individual's goals as changes he seeks to produce in his own state and/or that of his environment*.

The efforts towards change may be directed to one or more elements, systems or relationships of the environment and within the individual. The goal may also be any change of state without a defined target. The number and type of goals is determined separately in each case, e.g. according to the stimuli which led to the recognition of the goals, and according to the type of effort that the individual, responding to various stimuli and combinations of stimuli, has learnt to use in order to change the state. On the basis of what was said earlier, however, it may be assumed that there is usually more than one goal, and that the total number does not exceed what the individual is capable of perceiving and handling at the same time (cf. Johnsen 1968, p. 373).

The goals set are therefore subjective, not only as concerns the level or extent of the change desired, but also as concerns the kind of the goals. In order to define the calculation situation precisely the individual must get a clear picture of the goals, separately in both these aspects, for himself and the consultant. On the other hand, the individual's and the consultant's ideas, of the individual's environment and investment are hardly ever completely identical, although they may be brought closer by exchange of ideas. The individual is unlikely to be able to transmit to the consultant a complete picture of the

changes he desires (cf. also p. 25). For this reason it is justified to add to the definition of these goals »*as the observing party — decision maker or consultant — recognizes them.*»

Both the above definitions of effect and goal, and actually the whole model, are incomplete for the purpose of the study in that they contain no *time factor*, the most essential part of the problem.

Investment and its consequences are not simultaneous. Every change in the object system and its environmental relationships has its given temporal sequence compared with the other changes. Also the reflection of system output elsewhere in the environment takes place with a shorter or longer time lag.

These viewpoints can be included in the model by giving the concept »state» a time dimension: the individual, environment, systems and elements are in a given state *at a given moment*. The environment, for example, chronologically seen, consists of a *number of consecutive states of the environment*. The environment, in a way, moves from one state to another with time.

The direct effects of investment, the investment output, is therefore composed of changes in relationships which, in addition to characteristics indicating quality and size, also have a »date». In principle, the »date» can be understood either literally as a given exact *point of time* — a moment when the change seems to take place at a single leap — or a *period of time* in the course of which the relationship gradually becomes new. Some effects of investment (e.g. the purchase of a power saw) clearly represent the former type, others again the latter (e.g. the wear and tear of the power saw). Neither interpretation, therefore, can be excluded a priori.

Again, however, the individual's limited capacity of perceiving and handling information must be recalled. Man may be able to imagine, in principle, an almost infinite number of different points of time, but if he must perceive them simultaneously, the limit is very soon reached. Since a man cannot, in the classification of attributes, consistently use more than 7 (5—9) classes (LUCE and RAIFFA 1957, p. 37; cf. JOHNSEN 1968, p. 373), it is hardly presumable that time should be an exception. In other words, an individual is unlikely to use many more than 7 »dates» of sigifnicance. Everyday experience and intro-

spection also provide evidence: for events, people use time epithets (»today», »tomorrow», »next week», »in October», »next year», and so on) of an increasing looseness as the interval from the event grows. »After two years» is almost without exception a broad class rather than a precise point of time. In the following, therefore, it will be hypothesized that the individual, when forming an idea of investment output, divides the time, appropriately for each respective case, into a limited number of periods, and groups or »dates» the events in his mind according to these periods which presumably are hardly more than ten.

Hence *investment output is composed of a series of changes timed according to a given time classification — which depends on the respective case and observing party — that is to say, of the output of the system in which investment is made* »as the observing party concerned perceives it».

Time is similarly connected with the individual's goals: *the individual seeks to produce »dated» changes and times his goals within the time period classification indicated*. The goals, too, are therefore grouped into one or maximum 5—10 time classes.

The goals were interpreted above as changes of the existing states. The addition of timing necessitates a precise definition. In the following, *state changes are understood as those changes taking place in the states of individual or environment at different dates as compared with the states that would prevail if no investment were made*.

The question of the time dimension of the series of states, the distance of the so-called horizon, will be discussed later. It may already be said, however, that like any limitation of the environment, its temporal limitation also is arbitrary.

32. Limitations of investment calculation

The definitions of the direct effects of investment and the individual's (forest owner's) goals connect these concepts closely to the subjective ideas of the respective observing party. The party (e.g. the consultant) compares the effects of investment, such as he recognized them, with the individual's goals, again such as he recognized them.

The two quantities compared have been defined as changes inside an individual, i.e. in his mind, or in his environment. These changes, however, do not necessarily or generally involve identical elements ,systems or relationships. The essence of comparison, and of investment calculations, is to determine what changes the investment output will produce in the elements, systems and/or relations the individual seeks to change.

The person who compares — the individual himself or an outsider — forms in his mind an idea of relationships, elements and systems by means of which this output is reflected to the other parts of the individual's environment and to the individual himself, especially however to goal variables. This idea is applied to determine the reply to the problem.

In principle, formation of this idea and its application may take place implicitly. For the decision maker himself this may be the most common way. In the present problem, however, as outlined above, the concern is limited to *explicit calculations* by which the *consultant* processes information on investment output to make it serviceable for the decision maker (forest owner). The limitations these basic assumptions impose on an explicit calculation must, therefore, be considered separately.

An *explicit calculation* presupposes that the variables contained therein are operational, i.e. that these attributes and relationships can be measured and expressed numerically. This standard is not met by changes in the individual's (internal) state (cf. p. 32 above, comment on the lack of measuring methods for organism variables). The individual may report that he is hungry, in other words, has an internal force or need, termed hunger, requiring satisfaction. But he cannot express the intensity of this feeling or force except by stating the quantity of food he expects will suffice to satisfy the need (»I am so hungry that I could eat . . .»). Such an indirect yardstick gives the consultant an indication of the individual's (forest owner's) relative needs but does not express the absolute degree of their intensity.

It follows from the foregoing that the consultant cannot trace the reflex effects of the output back to the changes in the decision maker's internal emotions. He must try to find the environmental changes. If the decision maker has adopted goals involving a change in his internal state, the consultant must try to find the environmental elements or relationships the decision maker can easily combine with his internal goals.

Some of the investment output may lead to a change in the individual's internal state without intermediate phases. Examples are e.g. various esthetically experienced changes in the object system of the investment. They need no calculations; the investment output alone is enough, provided it is explicitly expressed.

The investment calculation, therefore, cannot contain even most of the changes which might be compared in each case. For a universal definition, the *investment calculation* must be considered a *partial calculation*. The investment output contained in the calculations, and the calculation results, at least often if not regularly, are only a part of the information necessary or relevant for the decision maker's solution.

The coverage of the calculation is further reduced by the following feature characteristic of calculation situations. Some of the environmental relationships are so-called *conditional relationships:* their implementation depends on the individual's (decision maker's) later solutions. The consultant can calculate the reflex effects of investment output on such a conditional relationship with the aid of general technical, biological and economic regularities, but from then onwards he must know how the decision maker will choose to continue in the future. In one way or another, the consultant must obtain this information from the decision maker. Otherwise he must stop his calculation at this relationship and let the decision maker personally complete the processing of the balance of the information.

This way of viewing the investment calculation has two limitations which must be expressly emphasized:

1. *Investment calculation is inseparable from the requirement that it must be operational, and therefore it usually cannot contain all information relevant for decision making.*
2. *The structure of an investment calculation depends essentially on the situation in which the calculation is made and particularly on the definition of goals in each particular case.*

33. Outlays and receipts in investment calculation

The limitation of investment calculation to operationally definable changes in the object system of the investment and in the environment requires increased precision of some of the definitions above.

Not all direct effects of investment, i.e. the investment output (actually the output of the decision to invest) will be discussed in the present investment calculations. Only those representing *quantitative changes of commodities, services and means of payment owned by or available to the forest owner-decision maker* will be analysed. Investment output may contain many other, intangible consequences, difficult to measure, such as the influence of forest drainage investment on the forest owner's relations with his neighbours, or various esthetic changes in the environment with a direct effect on its amenity. The decision maker gives them particular attention before deciding to invest.

The information the consultant can transform and condense in the investment calculations is composed of a number of positive and negative changes in the forest owner-decision maker's receiving and relinquishing of commodities, services and means of payment. For instance, information connected with investment in a farm tractor may contain data on the price, consumption of fuel etc. (or a change in consumption if an old tractor is to be replaced with a new one), changes in the labour input needed, a change in the quantity of products completed (if a tractor is to be used only for productive work on the farm), and sales income to be obtained when the tractor is scrapped. If the decision maker buys all fuel etc. and all work (i.e., production inputs) and sells all products, each of these events implies a subsequent monetary payment. In other words, the decision maker either hands out or receives money and other means of payment. This being so, the calculations may be based on, and the »physical» events as »direct» results of investment can be replaced with, *the positive and negative changes expected in the monetary assets, or »cash»* (SAARIO 1965, pp. 47—49) *of the decision maker.*

This procedure — reduction of investment output into receipts and outlays — corresponds to the content earlier given to the concept of investment (cf. Chapter 21). A characteristic of the investment of an economic unit of the kind now studied is, however, that the forest owner often does not buy all the production inputs (input increases) required or sell all his production (production increases), consuming at least a part thereof. In calculations priority is given to transactions in terms of money. »Inputs in kind» (e.g. the work done by the forest owner and his family) and »receipts in kind» (wood for household consumption; potatoes, milk, cereals etc. used in family household) are given suitable prices. This conversion may be considered the first phase in transforming and condensing information to make changes of varying *kind* »commensurable».

The selection of the coefficients (»prices») used in conversion and especially the terms of objective conversion are essential problems for the theory of investment calculations. The present writer has discussed these problems transiently in another context (M. KELTIKANGAS 1969, pp. 84—85). The particular purpose of the present study, however, is to analyse the conversion calculations connected with the time differences between the changes. Therefore the »timeless» conversion problems will be left unconsidered here.

For the same reason the problems the consultant faces in delineating the object system of the investment and hence also its output will be disregarded. For example, effects of an investment in a forest motor road are usually confined to the particular productive work, timber harvesting, for which the road is constructed. Especially by means of the necessary production input transfers the investment may produce changes in the decision maker's other activities in or even outside the same forest unit (cf. SAARI 1942, p. 29). The consultant is supposed to have taken the essential aspects into account when he determined the changes expected in the decision maker's monetary resources, as indicated above.

Thus, it will be assumed in the following that the information processed contains only changes in money, or more correctly, expected changes. If the decision maker, without the investment, can except a series of monetary payments »to and from cash», or a *cash flow,* the results of the investment are visible in that some payments (»to or from cash») fall out, diminish or grow, and their number increases.

These cash receipts and cash outlays will be called *cash flow components* in the following: the former are positive and the latter negative components.

The changes mentioned above are, accordingly, changes in the decision maker's (total) cash flow, in brief *cash flow changes*. Those increasing the »cash», or money available to the decision maker, are positive and those reducing it are negative cash flow changes.

The expectations making up the information to be transformed and condensed are, according to the terminology just accepted, cash flow change expectations. Each is connected with information on the trend (+ or —) of the cash flow change, its date, and the degree of uncertainty of the expectation. When cash flow changes are presented in chronological order, they are called a *series of cash flow changes*. These terms will be used in the following.

Cash flow changes directly produced by the investment are usually not the only cash transactions. A number of secondary payments (cash flow changes) usually follow, and by their means the »direct» effects of the investment are converted into the changes the decision maker desired. An analysis of these secondary results is best started by a short outline of the structure of ideas used by FISHER (1930, cf. also HIRSHLEIFER 1958; HONKO 1959, pp. 40—42).

FISHER's opening statement is that an individual's psychical experiences in his mind, i.e. the individual's inner events, represent the ultimate income. Outside events are of importance to the individual only insofar as they are means to inner events. This ultimate income is termed by FISHER the *psychic income* or enjoyment income (l.c., pp. 3—4).

The psychic income is subjective. An outsider is completely incapable of measuring it directly. For this reason FISHER also defines an »objective» income concept, *real income*. This is composed of the final outside events such as »the music of radio, the use of clothes, the eating of food, the reading of the newspaper», etc., which create inner enjoyment (l.c., pp. 5—6).

Even real income is not a highly operational concept, for these outside events have no common denominator. It would be awkward to operate with a list of heterogenous events. Besides, an outsider would not even come to

know them all. For this reason FISHER (l.c., pp. 6—7) takes one further step and measures the real income with the cost it requires, with the *cost of living*.

The real income so expressed in terms of money differs from the »most usual» concept of income which FISHER calls *money income*. According to his definition it is the money received by the individual less reserves for a re-investment. Money income may exceed the cost of living (i.e., consumption), and the individual saves the difference and increases his property or capital. But it may also be smaller than consumption, in which case he covers the difference by consuming or »eating» his capital (l.c., pp. 10—11).

However, FISHER does not accept capital changes in his concept of income and therefore rejects monetary income. Psychic income to him is true income, and other concepts are intended for its operational approximation. Income, therefore, is only an outside event which almost simultaneously is realized in events implying psychic income. Capital, and capital changes, promise *future* psychic income, and they may be considered income only after the realization has taken place (cf. SAARIO 1945, p. 28). In this way FISHER arrives at his operational definition *realized income = consumption*. (FISHER l.c., pp. 25—28; cf. HONKO 1959, pp. 40—42). (An outlay, according to FISHER, can always be interpreted as negative income.)

The interconnection between the concept of cash flow changes in the present study and the concepts used by FISHER is the following. The cash flow changes mean changes in the »cash» or money available to the individual at a given time. The increases in the cash are either consumed during the same period, i.e. converted into real income increases as FISHER puts it, or they are saved. Decreases in the cash are covered by reducing consumption during the period in question and/or by drawing on existing savings, or by borrowing. If saving, according to FISHER, is interpreted as postponement of consumption to later date(s), cash flow changes may be said actually to result in changes of individual consumption (FISHER's real income) during the same and other periods. The distribution of these changes between periods depends on how the individual decides to use or cover, i.e. finance, the cash flow change.

The above reminds one of the definition of interrelationship between money income and real income but is not identical with it. The unconsumed saving in cash flow change is money which during the period really occurs as cash, no matter whether spent on buying new pieces of property, lent to others or left as cash. The unconsumed money income — according to FISHER's definition — is a quantity obtained when the calculative reserve equalling the reduction in the value of property is subtracted from this saving to be used for reinvestment.

Of the other two concepts defined by FISHER, the psychic income equals what was above called changes in the individual's internal state. It may be interpreted as synonymous with the term more generally used in economic theory, *need satisfaction*. (See e.g. BOULDING 1955, pp. 680—681; COCHRANE and BELL 1956, pp. 79—80; SCHNEIDER 1962, p. 2). The nonoperationality of these concepts was already discovered in the preceding chapter.

The present study will do well to accept from FISHER's concepts only the *real income measurable in money* which, for the sake of clarity, will be simply called *consumption* in the following. *The effects of investment are first manifested by the decision maker's cash flow changes, i.e. changes in cash receipts and cash outlays, and second by consumption changes.* Effects of investment experienced as »in kind» inputs and income are directly comparable to consumption changes. Relationships between a series of cash flow changes and the corresponding series of consumption changes are, however, so-called conditional relationships: they depend on decisions concerning the use of income. It is theoretically possible that the individual in some cases will refrain from using the cash flow changes to create consumption changes. If so, the series of cash flow changes is not accompanied by a series of consumption changes.

34. Time factor in the transformation and condensation of a series of cash flow changes

On the basis of what was said above the transformation and condensation of information can be reduced as follows:

The consultant has either been informed of, or determined himself, n separate cash flow changes which are to be the »direct» expected monetary effects of investment, each »dated» according to the date, or actually the period t, when it is expected.

Each expected change in cash flow is to some extent uncertain, but this extent and its effects will be discussed further below.

In consecutive order according to their timing, adding together those with the same »date», these cash flow changes form a series of cash flow changes

$$(1) \quad \Delta I = \Delta I_1, \; \Delta I_2, \; \ldots \; \Delta I_m$$
$$= \{I_t\}, \; (t = 1 \ldots m).$$

Similarly the forest owner-decision maker whom the consultant assists, has a goal set

$$(2) \quad G = \{G_i\}, \; (i = 1 \ldots q),$$

composed of one or more changes the decision maker wishes to make in the states of his environment. Each must be understood to have its »date» in the same way as the cash flow changes. A number of these goals may be of a type not directly, or only very secondarily influenced by cash flow changes. The balance forms a subset.

$$(3) \quad G' \subset G,$$

which also contains one or more changes sought.

Goal variable as used in the following will refer to elements and relationships the forest owner-decision maker wishes to change. *Change goal* is used to indicate the extent of change desired in the goal variable. The term »goal» contains both attributes implicitly.

The consultant's duty is to help the decision maker to form an idea of the extent of the change in goal variables corresponding to cash flow change series ΔI. To this end the consultant forms for himself an idea of the decision maker's goal subset G', or at least its goal variables. The same applies to the correlation and correlation chains combining cash flow changes with the changes in goal variables. With the aid of these correlations he transforms and condenses, in the investment calculation, the series of cash flow changes into changes measured in goal variables. The consultant, however, is unable to transform and condense the information finally if a

number of the correlations are unknown or too conditional. He then takes recourse to auxiliary variables or *auxiliary goals* which are operational and which he assumes to be closely connected with the decision maker's goals. In other words, he replaces G′ with G″, which is the operational equivalent of G′.

To do his task, the consultant must therefore know the *forest owner-decision maker's goals, auxiliary goals if any, and the said correlations. These together determine the form of the investment calculation used.*

For general instructions as to the form of investment calculations, regularities should be sought in the goals of the individuals and in correlations between goals and cash flow changes.

Both problems are at least partly empirical; no final answer can be found by deduction. Deduction, however, helps to outline *possible* goals and the associated *possible* forms of calculation relatively well. After the limitations imposed above, the questions can be re-worded:

1. What are the possible, operational goals obviously correlated with cash flow changes?
2. What is this correlation like in each case?

The literature on economic theories provides a plentiful material, both of observations and ideas based on pure reasoning, from which answers can be sought.

The *profit* is a goal that has become classical. Profit has been defined very differently in the course of time (McGuire 1964, p. 48). It may be considered to date back to the usage adopted in accountancy in the 17th century and preserved to this day, according to which profit is the net increase in the assets of an enterprise which has arisen during the fiscal period (before distribution of dividends). (Cf. Honko 1959, pp. 119—122; Saario 1965, p. 175). The underlying idea is apparently that enterprise is property whose value the owner seeks to increase continuously. Many, perhaps most of the later concepts of profit have apparently arisen from attempts to evolve an operational interpretation which in each respective calculation situation, theoretical or tangible, would sufficiently correspond to the original idea. Or from attempts to build up a criterion which would express the increase an individual transaction has brought

about in the result of the enterprise in a whole fiscal year.

The introduction of the concept of profit in the above sense is connected with another accounting usage, the separation of the economy of an enterprise from that of its owners. While enterprise and owner in 17th century accountancy still formed an indivisible whole, by the late 19th century it was a general custom to consider the enterprise an independent institution, separate from its owner (Honko l.c., pp. 118 and 128). In this way profit came to represent the goal for an impersonal enterprise.

The effect of this procedure is seen in economic theory in that the individual's earning activities (production) and his household activities (consumption) have traditionally been separated. The economic result and its use become separate problems, the former discussed in the isolated sphere of an impersonal enterprise and the latter in one of consumption linked with the individual. They are separated by a borderline across which the enterprise hands over dividends to its owner, and less frequently also refunds him for work or raw material inputs received. How the money and/or produce received — or taken, if seen from a different angle — by the owner is used is of no direct interest to the enterprise. Nor does the household economy inquire about the ways by which the dividends were obtained.

When this model prevails the dividends, especially their amount, become the common interest of owner and enterprise. The profit is considered to indicate how much dividends the enterprise can distribute without changing its assets or capital value. The higher the profit the higher the dividends. With a good profit, it is also easier for the enterprise to meet the owner's dividend expectations without jeopardizing continuity. Profit growing, therefore, is desirable for both economies.

The strict separation of earnings and consumption is, however, artificial in so-called one-man enterprises, which are the sole object of this study. Earning and consumption run parallel and each involves the other. The cash to and from which the payments flow is the same, and decisions are interconnected. For this reason, economists have also sought to develop theories according to which the solutions in earning activity are derived from the

entrepreneur's decisions concerning consumption, or are at least made simultaneously.

Most of these theories (see e.g. HIRSHLEIFER 1958; FLORA 1966; HÅLLSTEN 1966), in one way or another, are based on the study by FISHER mentioned in the preceding chapter, and on the ideas it presents. The most essential of these are the assumptions that the individual's goal is *consumption* (in FISHER's terms, real income measured by cost of living, cf. Chapter 33), and that he invests in order to modify the time distribution of consumption (FISHER 1930, pp. 112—116; HIRSHLEIFER l.c., p. 330).

Accepting income, FISHER rejects property or capital changes as the direct goal of an enterprise. Increase in the value of property is not income; income consists of the consumption items that can be expected from property and on which the value of property (the capital value) is based (FISHER l.c., pp. 12—15; cf. Chapter 33 above).

In FISHER's opinion, however, the individual's ultimate goal is not consumption but psychic income. Consumption is a means or a channel to achieving psychic income, but it is not the only one. FISHER admits this incidentally in a footnote, saying that the individual, in addition to obvious income, may also obtain other »less tangible and more subtle» psychic incomes in the form of prestige, power, sense of possession etc. accompanying »great» wealth (FISHER l.c., p. 27 fn). Yet he does not draw the conclusion one might expect: *in some cases, both consumption and property may be important and desirable to the individual, simultaneously and independently.*

In addition to these, recent investigations have devoted attention to certain other goals closely or loosely connected with income and income changes. In his thorough analysis of the goals and goal setting in forestry HERMANSEN (1961, 1964) especially mentions *liquidity* which may be interpreted both as convertibility of property into money and as continuity of income available for consumption (e.g., v. MALMBORG 1967, p. 31). He also mentions *certainty* which has different interpretations.

If it is accepted that goal assumptions and usages (conventions) in economic theory and practical accountancy cannot have originated and been preserved without any foundation of reality, then it may be concluded, even from the foregoing brief discussion, that *an individual's goals (G') may in different cases contain at least the following: changes in consumption, changes in property or assets, changes in liquidity, and changes in the certainty of expectations.* Depending on the situation, they may occur individually or several at a time.

Of these goals, only change in consumption has so far been defined umambiguously and operationally. Property, liquidity, and certainty are less tangible and conceal a number of different operational interpretations. Their analysis is best carried out together with that of the interdependences of the relevant goals and income changes.

341. Change in consumption as goal of investment

Let us first study the cases in which the decision maker's indicated goal is to increase consumption, i.e. the share of returns spent on buying consumer goods and services, in one or several periods. The goal set G' then contains the consumption change series

4) $\Delta C = \Delta C_1, \Delta C_2 \ldots \Delta C$
$$= \{\Delta C_t\}, (t = 1 \ldots s),$$

either alone or together with other goals. The timing accords with the moment of purchase, although the actual using up of a commodity, and the formation of psychic income, may take place later or be divided over a number of periods (consumer durables).

The consultant may be informed of the goals either by a trend being indicated — »the decision maker wishes to increase consumption in period *t*» — or from an exact aspiration level: »consumption in period *t* should increase with *a* marks». In the latter case, the form might be »by a minimum of *a* marks». If several periods are involved, the changes desired may be equal or varying. The possibilities are many, and each deserves to be discussed separately.

Let us start with the goal for *one period*. The investment calculation is then based on a series of cash flow changes

$$\Delta I_1, \Delta I_2, \ldots \ldots \Delta I_m$$

in which a number of the members, cash flow changes of successive periods, are positive, others are negative, and yet others = 0. The

consultant must find a numeral indicating the consumption increase possible with this series of cash flow changes in a goal period t. The mode of conversion, i.e. the form of the calculation, is determined by the intercorrelations of the series of cash flow changes Δ I and the goal variable Δ C$_t$.

What was said in Chapter 33 can be repeated with additional precision. A positive cash flow change Δ I$_t$ is *spent* either to increase consumption during the same period or to obtain cash flow changes in other periods. The latter is possible

— by keeping the money in cash for later consumption,
— by lending the money or reducing existing debts, or
— by investing the money in other income-yielding financial or real property.

Accordingly, a negative cash flow change must be *financed* either by reducing consumption during the same period, or

— by drawing on existing cash savings,
— by liquidating other existing property, or
— by borrowing.

The last three items imply a postponement of the negative cash flow changes to later periods. The alterations a cash flow change ultimately produces in the payments and consumption of the different periods depends, therefore, on the individual's decisions in spending and financing. In other words, the relationships between Δ I and Δ C$_t$ are conditional.

If a consultant wishes to do the job, he must either know how the decision maker is going to proceed in the different cases, or make assumptions which he presents explicitly as a condition for the final result of the calculation. For the latter method to meet its purpose, i.e. to lead to information serviceable for the decision maker, the assumptions should not essentially differ from reality.

In the present case the first problem to be solved is the consumption of the other periods. To give an example, a forest owner-decision maker who wishes to buy a car after three years will increase the spending on his consumption during that period by an amount equalling the price of the car or the down pyament. Does the consumption increase in

this one period implicitly involve the aspiration that consumption in other periods must not change or in any case must not diminish? Or is the consultant expected to calculate how much the consumption should be reduced in other periods to achieve the desired change in the consumption of the given period? Both are possible and closely connected with the financial facilities of the decision maker. In the former case, investment is financed by »capital» alone, the investor's own or borrowed, and in the latter case by »income» (i.e. by reducing consumption) or »income» plus »capital» (cf. SAARIO 1965, p. 21; V. KELTIKANGAS 1965, p. 465).

A definite answer to these questions can be given only by the decision maker himself. It may be concluded from the above, however, that the former alternative (increased consumption in one period and unreduced consumption in the other periods) is possible only for a person who has adequate liquid assets and/or credit compared with the total cash flow changes to be financed.

The decision maker's possibilities of financing and investing also have a decisive effect on the conversion of cash flow changes. To illustrate this, let us assume that the series of cash flow changes consists of only three changes, the negative Δ I$_1$, and the positive Δ I$_2$ and Δ I$_4$. The goal is consumption change Δ C$_3$, which in this case contains the expectation that the consumption changes in periods other than the third are 0. All periods are supposed to be 12 months. The series of cash flow changes

$$- \Delta \ I_1, \ + \Delta \ I_2, \quad 0, \ + \Delta \ I_4$$

should therefore be converted into the form

$$0, \quad 0, \Delta I_3{}^*, \quad 0$$

where Δ I$_3$*, all spent on consumption, corresponds to Δ C$_3$*.

The change $- \Delta$ I$_1$ can in this case perhaps be financed by a loan of equal amount, to be repaid from the positive cash flow changes of the later periods 2 and 4. On the other hand, if the decision maker has bank deposits or other liquid assets he may use them to finance this change. The expected cash receipts for the deposit (or other assets) in later periods will not flow in, and some of the cash flow changes of periods 2 and 4 are tied down to finance the

cash flow components obtained to replace them.

Of these two ways of financing – ΔI_1, the decision maker will presumably give priority to that one which leaves more of ΔI_2 and ΔI_4 disengaged or free to be spent on consumption, that is to say, where the cost is lower. The cost of financing, in addition to the customary *rate of interest*, includes also other special outlays connected with borrowing or liquidation of assets. The work involved, and the convenience or inconvenience of the transactions, probably also affect the result of the choice.

Accordingly, that part of the two positive cash flow changes (ΔI_2 and ΔI_4) not tied down in the financial arrangements must be converted into a cash flow change of period 3. For the former it means an advance in time, feasible by saving cash money, by depositing the money in the bank, or by investing it in some other object, from which it can be withdrawn at the desired time. The latter cash flow change (ΔI_4) must be moved back in time. This is possible, for example, if the decision maker takes a loan in period 3, repaying it with the balance of ΔI_4. Or he may liquidate some of his assets in period 3; the expected positive cash flow changes are replaced by the new assets obtained with the same balance of ΔI_4. The choice is again decided by the result expected from each alternative procedure, the cost of the transaction, and the trouble involved.

Investment calculation in this case can be built, for example, as following:

The table *presents a series of cash flow changes with a financing and spending plan.* For this plan — explicitly presented to the decision maker — to be accepted it must presumably meet a primary requirement briefly indicated above: *the calculation must not contain such assumptions essentially affecting the result as are unrealistic from the point of view of the decision maker's individual financing and investment chances.*

There are normally definite limits to the amount of money the decision maker can borrow. By most lenders the borrower is required to have a certain amount of equity capital or, alternatively, sufficiently solvent securities. Equity capital and environmental credit therefore set a more or less definite ceiling limit for everybody's borrowing capacity. If the decision maker has already exhausted his chances of borrowing, it is unrealistic to include a loan in the financing plan.

Viewpoints connected with the interest and term of the loan are just as essential. Money has no uniform »price». The rates of interest vary depending on the amount of the loan, the type of security (the borrower's overall chances of being granted a loan, and the degree to which they have been utilized),the term of the loan, and the form of its repayment (see e.g. FISHER 1930, pp. 206—207; HIRSHLEIFER 1958; HONKO 1963, Chapter 6). In actual fact, an individual's borrowing capacity is the function of the rate of interest payable: the closer the ceiling limit, the higher the rate payable for every additional loan (cf. JØRGENSEN 1967). Moreover, interest is payable annually if not more frequently. Adding the interest to the capital is not customary, nor is it legally permissible e.g. in Finland. Regular reductions are also among the usual terms for loans of a certain type.

Most of these statements are inversely true of lending. The rates of interest in the sample calculation, i, i' and i'' may all be different. Replacing them with one and the same rate would be an approximation, and the larger the differences between the rates of interest,

Series of cash flow changes	$- \Delta I_1$	$+ \Delta I_2$	O	$+ \Delta I_4$
loan	$+ \Delta I_1$	$- i \cdot \Delta I_1$	$- i \cdot \Delta I_1$	$- (1 + 1) \cdot \Delta I_1$
Sum	O	$\Delta (\Delta I_2)$	$- i \cdot \Delta I_1$	$+ \Delta (\Delta I_4)$
deposit		$- \Delta (\Delta I_2)$	$(1 + i') \cdot \Delta (\Delta I_2)$	
2nd loan			$(1 + i'')^{-1} \cdot \Delta (\Delta I_4)$	$- \Delta (\Delta I_4)$
Sum	O	O	$\Sigma = \Delta I_3{}^*$	O
possible change in consumption			$\Delta C_3{}^*$ $\downarrow$ $\updownarrow$	
Goal			ΔC_3	

and above all, the longer the time intervals to which they are applied, the greater would be tis relative importance to the end result of the calculation.

Purchase and liquidation of other property is also associated with a number of restrictions and characteristics which, if overlooked in the calculation, may make the result irrelevant for decision maker. Objects of business transactions, or investments can usually not be divided arbitrarily into small parts; as a rule, they are relatively large entities of units, such as a car or a forest tractor. The cash flow changes occasioned by them are therefore »high-stepped» compared with the loan. Exchange of ownership rights involves many expenses (such as the registration of a car or taking out the title deeds for real estate) which borrowing of money does not. Receipts from investments also vary a great deal.

On the basis of the foregoing it is obvious that *drawing up a relevant calculation requires very detailed knowledge of the decision maker's facilities and the situation.* A calculation based on assumptions of a general nature (e.g. uniform rate of interest and unlimited availability of credit) may be acceptable in certain cases, whereas in others it produces information that misleads the decision maker. *In such a case, it is definitely better if the consultant does not transform and condense the series of cash flow changes.*

In the above case the decision maker desired a change in the consumption of one period while consumption of other periods was to remain unchanged. The same findings and conclusions, however, can be generalized to apply to the other alternatives of the goal set outlined above.

If the decision maker permits the consumption of other periods to decrease when necessary and plans to finance the transaction, either wholly or partly, by reducing the consumption of the next few periods to come, the number of the possible financing and spending plans will increase. Planning will involve more degrees of freedom, and the possible forms of solution in the sample calculation, in addition to (0, 0, +, 0), are (—, 0, +, 0), (—, —, +, 0), and (0, —, +, 0).

The same is true of the cases in which the decision maker divides the goal of consumption increase over *more than one period.* If these goals are no precise amounts of money,

the number of possible solutions is almost infinite. Using the cash flow change converting methods described — or just the loan market — the original series of cash flow changes can be modified, in principle, into innumerable variations. Only by fixed goals can the set of possible alternatives be reduced. The more numerous the free goals permitted, the more numerous degrees of freedom in the planning, and the more markedly subjective the character of the resulting investment calculation.

This chapter can perhaps be summarized as follows:

1. *If the forest owner-decision maker has goals related to change of consumption, the investment calculation must contain a plan of how to finance and use the cash flow changes.*
2. It is usually possible to work out several plans leading to the goal. The *acceptability of the calculation* presented to the decision maker *is decided by whether the suggested measures are sufficiently realistic.*
3. For the calculation to be relevant, the consultant must know the *decision maker's possibilities of financing and using the cash flow changes* and respect them.
4. If the consultant does not know the decision maker's possibilities, it may be better *not to transform and condense the series of cash flow changes* than to base the calculation on assumptions of a general nature.

342. Change in assets as goal of investment

It was indicated above that property viewed as a goal is not unambiguous, and that the concept should be precisely defined. It is useful to start the study from the *possible reasons* which may prompt the forest owner-decision maker to strive after property or assets and *increase in assets.* The term change does also cover reduction of property and its qualitative changes, but they will be disregarded here since a desire to reduce property is apparently rare, and a qualitative exchange of assets is usually already eliminated when the decision falls on investment.

The possible factors leading to increase in assets may be divided into two main categories: the forest owner may desire it either looking forward to the cash flow changes the property will yield in later periods, or in order to obtain the *power, status, security, joy of*

ownership, etc., brought about by property, and values that are extremely difficult to measure and verify (cf. p. 39).

The situation under the alternative »looking forward to cash flow changes» is usually the following. The decision maker knows from experience that certain assets, such as bank deposits, yield regular and approximately uniform (positive) cash flow components with a known ratio to the property, usually its value (such as interest on deposits). An increase in this type of assets means in every later period a set increase of money available for consumption. The relationship is fixed and the increase in asset passes for a criterion, which often replaces the separate goals of changes in consumption during several periods.

It may be concluded from the foregoing that this replacement is probable only in cases in which the property may be expected to yield approximately equal cash flow components and in which, on the other hand, the decision maker desires equal consumption changes in all periods under review (cf. preceding chapter). The less uniform the time distribution of income from property, the more loosely does property increase reflect the change in consumption facilities, and the more poorly does the criterion indicate what it was assumed to indicate.

But if the motive is authority, status, security or some other more direct effects of ownership, the information value of increase in assets is even more dependent on the relevant individual and case.

The individual's status and the esteem he enjoys have been shown to be determined, among other things, by property and income (ESKOLA 1964). Property may comprise only the visible real property or also the components more or less invisible to outsiders, such as money, various receivables, securities, and so on, and the taxation value may be an important, if not the most important component factor.

Real property is here understood to comprise, in addition to the »income-yielding» components, all the various consumer durables the individual has: residential housing, motor cars, household machines, etc. Since the purchase of consumer durables above was interpreted as consumption, it may be assumed that at least in certain income brackets a considerable part, if not all, of the increase in

social esteem is connected with the individual's consumption.

Economic power, on the other hand, may be more closely correlated with financial assets than real property. Motives of this type are probably more common in the topmost income brackets.

These examples may suffice to prove that *property increase in different contexts may refer to different things.* The decision maker's goal may be to increase real property or financial assets or both, he may be concerned with the quantity or value of his assets or the gross increase in assets may be more relevant than the net increase, and so on. In the following, only the *increase in the (total) value of assets* and its derivation from a series of cash flow changes will be discussed. It may be useful to state here that this characteristic is not a criterion valid in all cases in which the decision maker indicates his desire for a change in assets.

Even the term total value does not make the goal unambiguous. Value has several interpretations in economics (see e.g. AHONEN 1970, pp. 10—14). The two customary interpretations which will be discussed here, and which are distinctly different from one another, are the *utilization value* and the *exchange value*.

The exchange value of an asset (say, a building) is the price paid on sale or purchase. The exchange value of assets is the monetary sales income obtained when all property is sold.

If the owner, instead of selling, uses the asset (the house) for his own purposes, he may expect to obtain some net receipts and other positively or negatively experienced effects. When the owner defines the amount of money which (at the moment of evaluation) is worth the net receipts and other consequences he obtains from the asset by utilizing it himself, he indicates its utilization value.

The utilization value of property is decisively determined by the purpose for which the owner intends to use it and his evaluation of the consequences of the use. In other words, the utilization value is subjective. The exchange values are arrived at by mutual agreements between different individuals, buyers and sellers. The underlying basis is, however, the buyers' and sellers' idea of the utilization value of the asset bought or sold. For forest

property, the value concepts and value formation process have been described in detail by the present author in an earlier paper (M. KELTIKANGAS 1964). Cf. also AHONEN 1970, pp. 10—17.

If the motive for desiring change in the value of assets is to obtain prestige, status or general esteem and appreciation by outsiders this, most naturally, is represented by the exchange value, the value that is apparent to any outsider. Utilization value is a subjective and individual valuation, and a change in it might better correspond to the decision maker's ideas if the background motive is e.g. the pure »joy of ownership». Both value concepts are possible, even though the exchange value is probably the one the decision maker mostly has in mind. In the following, the relationship of the series of cash flow changes to both these values will be discussed.

The ownership of the object of valuation — whether classified under real or financial property — means a right of ownership to (and liability for) the receipts and outlays connected with the object immediately or later, and/or other, intangible effects. Disregarding the latter, it may be said that the owner who places a high value on the object in actual fact sets store by the income, or the series of cash flow changes obtainable (cf. FISHER 1930, pp. 12—15). The property increase occasioned by investment equals the difference between the values of the cash flows.

Assuming further that the value of the series is the sum of the values of its individual members — not a self-evident yet generally used simplification — the effect of the series of cash flow changes on the value of property can be measured by the present value of the series of cash flow changes, illustrated in a general form by the following equation:

$$(5) \quad V_0 = \Delta I_0 + a_1 \Delta I_1 + \ldots + a_m \Delta I_m$$
$$= \sum_{t=0}^{m} a_t \Delta I_t$$

Coefficients a_t indicate the valuation ratio or time preference which, seen from the subject's point of view, prevails between cash flow change ΔI_t and the corresponding valuation change, i.e. present cash flow change. *The selection of these coefficients is the crucial problem in value determination.*

It is customary to relate each coefficient to

time. If the measuring unit is one year (a pure convention in itself), we can write

$$(6) \quad a_t = (1 + i_t)^{-t}$$

Equation (5) above will then acquire the form

$$(7) \quad V_0 = \Delta I_0 + (1 + i_1)^{-1} \Delta I_1 + \ldots + (1 + i_m)^{-m} \Delta I_m$$

and we will have to choose the interest rate i_t which is to be applied in the *discounting,* or present value determination, of each income change ΔI_t.

If it is assumed that $i_1 = i_2 = \ldots = i_m$, the equation can be further condensed into the form

$$(8) \quad V_0 = \Delta I_0 + (1 + i)^{-1} \Delta I_1 + \ldots + (1 + i)^{-m} \Delta I_m$$
$$(8a) \quad = \sum_{t=0}^{m} (1 + i)^{-t} \Delta I_t$$

which is the familiar basic formula for the present value of investment (cf. HIRSHLEIFER 1958, p. 345).

In this formula, the transformation and condensation of information (series of cash flow changes) is carried through in its complete form: each individual element of information (cash flow change) is transformed into its present value, after which the series of transformed elements (present values of cash flow changes) is condensed into a single number (present value of total investment).

To estimate the serviceability of the method, attention must be devoted to the two assumptions leading up to the formula:

1. The value of the series of cash flow changes was assumed to equal the sum of the values of individual cash flow changes.
2. The rates of interest used to discount the individual cash flow changes were assumed to be equal, i.e. independent of the distance in time.

What are the conditions in which these assumptions may be expected to be valid?

In his perception of the utilization value, the individual may think of the consumption the object will ultimately make possible. The present value indicates the value which the individual at the moment of valuation attaches to the items of consumption into which he intends to convert the future cash flow

change. This assumption is the focal point both for FISHER (1930) and the authors who have developed and applied his theory (for example, HIRSHLEIFER l.c., p. 330; FLORA 1966; HÅLLSTEN 1966, pp. 20—24; cf. M. KELTIKANGAS 1969).

In the studies mentioned, a uniform rate of interest is considered an exception rather than the rule. To determine the present value, therefore, it is usually necessary to know the individual's subjective time preferences and his possibilities of shifting the cash flow changes by borrowing, lending or investing (cf. HIRSHLEIFER l.c., p. 350; FLORA l.c., pp. 22 and 51—53). It is therefore necessary to determine the a_t's and i_t's separately for each cash flow change.

In another context the present writer condensed the conclusions concerning prerequisites of the discounting procedure into the following form: »One must assume straight-lined time indifference maps to fulfill the requirement of independence of the size (of income), and a common, universal possibility of lending, investing and borrowing unlimitedly at the same rate of interest to achieve independence of the person. If, in reality, there are »mixed form» (i.e. partly curvilinear) time indifference maps, it is quite possible, and even probable, that i will have different values not only for different persons and different sizes of income but also for different lengths of t.» (M. KELTIKANGAS 1969, p. 89.)

Should the calculation situation not meet the said conditions, the solution, or the determination of present value, ultimately depends on the decision maker personally. On the other hand, if the decision maker has set consumption goals for his activity he has, in a way, already solved the problem: the consumption goals of the different periods may be considered to indicate the decision maker's ideas of the mutual value, or exchangeability, of these goals. It would therefore not seem necessary to ascertain a separate present value based on consumption.

In determining the present value of investment the decision maker, however, may replace consumption by cash flow changes as such, their saving and re-investment. The rate of interest must then be considered to depend solely on the financing and investment possibilities, without being affected by consump-

tion-based time preference. Where the goal is a change in the value of assets, associated with goals of simultaneous consumption change, this interpretation of present value may apparently be considered more realistic than the former.

The rates of interest in lending and borrowing, and even more the rates of return for investments, however, are not independent of time. For loans of different terms, interest is generally required and paid according to different rates, and investments of different durations yield different returns. Here, too, the possible uses of the discount formula depend essentially on the decision maker's subjective calculation situation. The error possibly arising from the use of a simplifying assumption, however, is of smaller relative importance in cases in which cash flow changes are not discounted over long periods, than in the determination of the present value of more distant net receipts.

The ratio between cash flow changes and exchange value is more difficult to determine. If the exchange value is understood as the equilibrium price on the market for the object concerned, its amount is governed by the subjective utilization value considerations of several different individuals. The object of purchase and sale, even in this case, is a series of cash flow changes, but it may seem different to different persons. In the determination of present value, one may imagine that each cash flow change is bought and sold separately (cf. AHONEN 1970, p. 30). If so, however, each a_t and i_t must be selected separately, one price based on the supply and demand of close-range cash flow changes, and another price similarly for distant cash flow changes. In reality, however, there are no such markets, and no such supply and demand prices, for the object of sales and purchases usually is a series of cash flow changes. (It should be recalled, moreover, that the price formation of a property object is governed also by effects other than monetary.) No objectively determinable ratio of cash flow changes and exchange value, independent of individuals on the market, can therefore be given. If the consultant wishes to determine the property value change as a change in market value, he must find some other means than the series of cash flow changes to help him (cf. AHONEN l.c., pp. 11 and 66).

On the basis of the above it may be summarized that *if the consultant wishes to transform and condense the series of cash flow changes into a criterion indicating the change in the value of assets, this word having the meanings given above, a perfectly objective method is hard to find.* The decision maker may conceive the value change in many different ways, and none of these seems to have a relationship to cash flow changes independent of person.

If the consultant uses the present value as an approximate method, the interest rates used to convert individual cash flow components should be selected so as to correspond to the decision maker's respective value concepts and relevant chances of shifting cash flow components.

All these conclusions were concerned with the transformation and condensation of a series of cash flow changes to present value. The forest owner-decision maker does not, however, necessarily time his goal in changing the value of assets always to present time or to the first period. It is equally possible that he desires a certain increase in value by some more distant period, and during the course of several periods. The conclusions drawn above are applicable also to these cases.

343. Change in liquidity as goal of investment

The liquidity of an enterprise usually refers, in terms of business economics, to the capacity of the enterprise to pay its current expenses and if necessary, its short-term debts (cf. HONKO 1963, p. 88). The concept can be applied as such also to the economic unit of the present study. An individual's liquidity refers to the *individual's ability at a given date to settle the payments required for consumption and other activities, and interest and reduction of debts — including, if necessary, immediate repayment of a recalled loan.*

The ability to look after one's liabilities punctually presupposes that there is money in cash when required, or that money can be quickly obtained. The decision maker's liquidity is composed of two factors: the correct timing of receipts and outlays, and quick convertibility of property into cash.

The above can be put as follows: the financial means must be available for every planned change in consumption. In this meaning,

liquidity is a principle rather than a quantitatively measurable goal. It is *realized if investment calculation is worked out as suggested in Chapter 341 in the form of a plan of how to finance and use cash flow changes.*

The liquidity requirement in a stricter form may demand the ability to finance all, or a fixed minimum share, of the consumption changes by the positive cash flow changes the investment produces at the same point of time. A requirement or goal of this type can be taken into account in the drafted financing plan by imposing limitations on the decision maker's chances of raising loans.

Improved or weakened convertibility of assets into cash can also apparently be interpreted in two ways: either it refers to the extent to which the timing of receipts from property can be modified, or to the possibility of selling a part of the assets. The former is associated with the number of conditional relationships; the more frequently and the faster the decision maker can modify his plan concerning the use of the object of property and, consequently, the expected series of cash flow changes, i.e. the more closely the expectations depend on the decision maker's later decisions, the more liquid the object of investment. Liquidity understood in this way is hard to combine with any quantitative criterion which could be derived from the series of cash flow changes itself.

But if the saleability of the assets is under consideration, and this is probably the most common interpretation, the question of the exchange value of property must be reconsidered (see preceding chapter). The object may be sold in toto or in parts, and in both cases the immediate sales possibilities and the price fetched depend on external market factors. Neither of them can be directly derived from the series of cash flow changes. Other routes and calculations must be used to show them.

344. Uncertainty involved in the time factor, and how to consider it in investment calculation

Reference has been made above in many contexts, though only passingly, to a factor which in practical decision making and in investment calculations probably raises the most and the hardest problems (cf. HEADY

1952, p. 439): the diverse *uncertainty* of the decision situation.

As mentioned in Chapter 31, investment is succeeded by a number of changes in the state of the decision maker's environment. If the action itself is indicated by A and the changes in state by B, it may be said ex post facto that A was succeeded by B and that there were intervening relationships $A \rightarrow B_i$. In advance, ex ante, this is however not known. The decision maker (or consultant) may only form *expectations* concerning the changes in state that A is likely to produce.

These expectations are not born out of nothing. The individual bases them on what he knows about the subject from earlier experience, from information received or obtained from others, and from his own thinking. Experience and information may be connected with similar earlier events or events so close to them that analogous conclusions are possible. The quantity and quality of the information available, together with the decision maker's personal character, decide how certain or uncertain the decision maker's idea of these relationships shall be.

This »subjective» uncertainty of idea or opinion which is a result of the decision maker's lack of earlier experience and information, is almost inseparably associated with the »objective» uncertainty of the relationships. Few relationships are firm and deterministic. The majority are probably *conditional* in that A is succeeded by B_i, provided a number of other environmental variables are simultaneously in a given state. When these variables are allowed to vary, i.e. to obtain different values, the relationship $A \rightarrow B_i$ will also vary. It follows that the larger the number of uncontrolled variables, i.e. variables for which no value at all or only a wide range of variation can be determined, the larger is the number of values possible in $A \rightarrow B_i$ relationship. Since all variables can hardly ever be controlled, the relationships with which the consultant operates are mostly mean values or »typical» values from a random set of variables with wider or narrower range.

When such a mean value, i.e. a typical or probable value, determined from earlier experience, is serving as the basis of calculation, the result contains an element of uncertainty, that is to say, an *incorrect solution is possible*. Whether, and in which way, the individual

making the decision takes this into account, depends both on his frame of mind and on the relative importance and probability of the incorrect solution. If the potential error in the cash flow change might, when put into effect, jeopardize the individual's whole property or subsistence the uncertainty is probably experienced as a much more essential factor than in cases in which the potential loss remains at a fraction of the individual's total earnings. It is also obvious that the potential error is taken much more seriously when its probability is one to ten $(P = 0.1)$ than when $P = 0.0001$.

It follows from the foregoing that uncertainty of the expected series of cash flow changes may be a relevant piece of information for the decision maker. The commission given to the consultant may be considered to include the demand that, in connection with his findings, he must somehow express the *degree of uncertainty*.

How to measure the uncertainty of individual cash flow changes and how to combine the data to obtain the desired characteristic are questions that will not be discussed in the present paper. It may suffice to mention that possible criteria (and the decision maker's goals) recommended for various situations include e.g. not only the variance of the results (MARKOWITZ 1959; DOWDLE 1962), range (BOULDING 1950, p. 118), but also the use of maximum and minimum values instead of the most probable value (e.g. LUCE and RAIFFA 1957; MARTY 1964). If the degree of uncertainty is not a relevant data the calculations can probably be carried out using the most probable expectations.

From the point of view of the problem studied, the connections between uncertainty and time are most essential. Many authors seem to agree that the uncertainty of expectations increases as they extend into the future and that the increase is faster than rectilinear (e.g. SHACKLE 1958; FLORA 1966). A general agreement exists as to its causes: the further in time the expectations are extended, the larger the number of variables affecting the relationship which have time to change, and the wider becomes the potential variation range of the said relationship.

The development, however, is not equally fast and complete for all relationships. Some of the variables change slowly, and may even be

considered practically constant. These are e.g. many factors governed by the laws of nature. Another extreme group of variables consists of individuals' decisions and the relationships closely connected to them, which in Chapter 32 were called conditional. Changes in this group are often neither slight nor gradual, and may produce considerable changes in environmental states.

An additional factor is the uncertain delineation of the elements and relationships to be considered relevant in the decision maker's environment (cf. Chapter 31). The more distant the future involved, the more probable it is that many factors now disregarded by the decision maker as irrelevant will become relevant. In other words, the sphere of elements and relationships in the environment is widened and its composition changes with time. Since the decision maker's ability, as often pointed out above, of recognizing simultaneous relationships is very limited and the individual's idea of his environment even at the present moment is restricted (cf. Chapter 31), he has no chance of widening his model of thinking by continuously adding new variables as they become relevant. Hence the element-relationship networks recognized by the decision maker in the course of time begin to represent an ever diminishing part of the total set of variables which may decisively affect not only the goal variables but also the elements and relationships recognized by the decision maker.

This restriction of his field of vision also means that the decision maker becomes increasingly uncertain of the validity of his expectations. Information available to him — including that evolved by inferences — becomes the less complete the more distant the future period in question. In this way the chances of forming a definite opinion, e.g. concerning the range of a given relationship, gradually disappear. SHACKLE (1965, p. 89) expresses the same thing by saying that »illumination of the future by the present fades gradually, however rapidly», and that »there is a thickening mist».

In a given phase, which may vary depending on the individual concerned, this uncertainty — it might also be termed lack of knowledge — reaches a threshold after which the decision maker is unable or unwilling to form expectations. This »point» has usually been

termed the *time horizon* or just horizon (e.g. SHACKLE 1958, p. 83; 1961, p. 223; M. KELTI-KANGAS 1969). HEADY (1952, p. 474) and FLORA (1966) are among those using the term planning horizon.

The time horizon is the time limit beyond which the decision maker perceives no precise expectations of his environmental conditions. It also limits the formulation of the decision maker's goals, provided they are interpreted as in the present study, as changes the decision maker desires in the expected states of his environment (cf. Chapter 31). *Relevant goals appear only within the time horizon.*

The above does not mean that it is possible to determine a fixed time limit to which the forest owner-decision maker's formulation of expectations extends and beyond which the future is in no way imaginable. The fact is, rather, that the distance of this time horizon varies both according to person and according to situation. If observations concerning the planning by enterprises and communities can be generalized to portray the thinking of individuals, they seem to indicate that the more general, i.e. the more slowly changing, the object variables are, the longer will be the period of time during which plans and expectations can be formulated (cf. e.g. HONKO 1963, pp. 134—135; PITKÄNEN 1969, p. 33). Planning of details seldom extends beyond one or two years, that of general lines of activity may cover 5—10 years, whereas any planning extending beyond 10 years is only approximate forecasting of the future developments.

MCKEAN's explanation of the origin of the time horizon is also worth quoting: »Beyond some date, the gain from preparing hazy estimates is less than the cost» (MCKEAN 1958, p. 75).

The role of these statements for the forest owner-decision maker's goals, according to the above, may now be estimated as follows:

1. *One of the first steps in drafting an investment calculation is to fix the time horizon relevant to the situation concerned.*
2. The decision maker is likely to perceive consumption change goals for only a limited number of periods (cf. Chapter 31). *The time limit is fixed by the relevant time horizon, beyond which cash flow changes are*

of no value for the decision maker's consumption unless, by financial arrangements, they can be converted into cash flow and consumption changes within the time horizon. In such a case, however, absence or uncertainty of expectations applies equally to the decision maker's borrowing and investment chances beyond the time horizon.

3. According to the model applied, the goals concerned with change in value of assets must also fall within the time horizon. The following rule is valid: *a change in property value at the time horizon is determined as exchange value, since absence of expectations makes any utilization value based on cash flow changes beyond the horizon conceptually impossible.*

4. CERTAIN CARDINAL PROBLEMS IN PRACTICAL APPLICATIONS

The theory, which was formulated above concerning the investment calculation by a consultant assisting the forest owner-decision maker, and the inclusion of the time factor in such calculations, can now be reduced into the following form.

1. An investment calculation, according to the model of decision making process used as the frame of reference, is primarily a *calculation transforming and condensing information*. Information composed of the directly expected effects of investment is, as far as possible, transformed and condensed in the investment calculation into one or more criteria by means of which the forest owner can conclude, more easily than from the original information, whether the studied investment alternative fulfils the goals set.

2. The decision maker expects, in the first place, that the consultant will continue the transformation and condensation of information only as far as factual knowledge permits, and will leave to the decision maker all solutions concerning value judgements. If the information available does not permit the information to be condensed into a single criterion the consultant cannot avoid presenting the decision maker with a set of criteria containing perhaps several elements. From the decision maker's point of view, this is preferable to complete condensation into a single criterion on the basis of conventional assumptions, perhaps leading to loss of relevant information (cf. JOHNSEN 1968, p. 468).

3. The information to be transformed and condensed in an investment calculation is composed of changes resulting from investment in the forest owner-decision maker's expected cash receipts and cash outlays, or cash flows. Such an investment calculation must be understood as a partial calculation. It excludes all those investment effects relevant to the decision making which cannot be expressed in terms of cash flow changes. (Conversion of physical events into cash flow changes is here interpreted as a preliminary phase of investment calculation).

4. The form and structure of the calculation are determined, case by case, by the forest owner-decision maker's goal setting.

5. If the decision maker's goals are changes in consumption, in other words, if he desires a change in his income available for consumption at one or more given dates or periods, the investment calculation must contain a plan of how to finance and utilize the cash flow changes. Otherwise the information obtained from the calculation is not what the decision maker needs and is searching for.

6. If the goal is a change in the value of assets, customarily termed profit, the present value of the investment can, with certain reservations, be used as its criterion. The present value must be calculated on the basis of an interest rate concurring with the realistic chances of financing and investment in each case.

7. If the decision maker desires simultaneous changes in consumption and assets, the calculations must be carried out by both of the above two methods.

8. Time preference is associated with changes of consumption, i.e. their mutual time valuations. If the above procedure is followed, the decision maker's time preference is evident from his goal setting. In this case, it will be unnecessary to combine time preference and selection of discount rate. (Cf. the remark by FLORA, 1966, p. 51: ». . . in order for persons to rank competing investment opportunities, it is not a necessary assumption that future costs and returns are discounted to a base year; rather, they can be evaluated in terms of the highest-ranking discount locus which each activity can achieve».)

9. Only those investment effects are included in the calculations which in each case remain within a relevant time horizon. For example, in determining the present value, calculations may consider a sales income (or its change) obtainable from property or an investment object but not the cash flow changes beyond the horizon, or the utilization value of an investment object at the horizon

based on them. If the consultant is ignorant of the precise distance of the time horizon, he can work out his calculation so that it expresses the result as a function of the distance of time horizon.

10. These procedural rules make up the framework within which the investment calculation should be held. Leaving this framework means that the calculation and the validity of its results are weakened. When the possibilities of simplifying additional assumptions are deliberated — for example, the use of one, uniform interest rate although the true rates of the different periods may vary to some extent — the loss of validity must be studied separately in each case. Care must be taken not to exceed the decision maker's tolerance limit on this point. Since situations are different it is hardly possible to find a general rule applicable to all cases.

The above conclusions concerning the structure of investment calculation are not totally new. Similar ideas — perhaps differently expressed and often accociated with other type of problems — have been propounded by several earlier authors (cf. e.g. SAARI 1942; HONKO 1955, 1963; MCKEAN 1958; HERMANSEN 1964). A difference, in the present writer's opinion, is first and foremost the *approach, viz. the interpreting of an investment calculation as transformation and condensation of information, continued no further than is objectively possible in each case on the basis of available data.* The more or less sporadic viewpoints which have usually been presented as limiting reservations under traditional methods, have in this way been included as essential components of the theory itself.

The evolved theory differs from the traditional concepts of forestry mentioned in the introduction, in that it is more extensive. In a way traditional present value calculations may be considered a special case under the investment calculation now presented.

The theory is general in so far as generality was foreseen in the definition of the study purpose. It applies to all those investment calculations the consultant may have to make while assisting a farmer-consumer who, among his other possessions, owns and controls a forest unit. The question as to the extent to which the viewpoints presented are applicable to other types of economic units, will be discussed by the present writer in another context.

Although the theory has been evolved especially with a view to investments in timber growing and consequently is a *theory of investment calculations in timber growing*, the practical applications are accompanied by special problems, passingly referred to above, which vary to some extent according to the case and the situation to which calculation applies. The majority of these problems are most suitably discussed in connection with various application studies. Some of the most substantial, however, deserve a brief mention here.

Forest improvements

As indicated in the introduction, the ultimate stimulus to this investigation was provided by the problem of the profitability sequence of forest improvements. Hence, the following discussion of the problems connected with the application of the theory approaches them from the angle of forest improvements. For this reason it may be useful to define in some detail the relationship between timber growing and forest improvements.

Timber growing is here used as a general name for all attempts to influence the development of the growing stock in a stand or forest, that is to say, its increment, volume, and/or quality. The most customary of these steps can be roughly classified as follows (cf. JØRGENSEN 1964b; EINOLA 1964; STREYFFERT 1965):

— thinning and final cuttings
— regeneration
— forest improvements proper, i.e. steps to improve the growth capacity or the quality of forest, such as forest drainage, fertilization, cleaning and thinning of seedling stand, pruning, etc.
— expansion of forest property by purchases or its reduction by sale,
— supplementary investments in administration of forest unit, buildings, machines, etc.

Thinning and final cuttings are those that most directly affect the revenue. When he decides whether or not to cut his forest the forest owner decides when, and in what amounts, he wishes to take the cutting income from his forest. Postponement of cutting is

not only a change in timing, but usually also a quantitative change in the volume of timber accrued and/or the amount of income obtained, for the forest grows and timber prices fluctuate. Especially in thinning cuttings the effects of the decision may be projected onto the timing and amount of later cutting incomes.

Regeneration is intended to ensure the growth of new forest after a final cutting. If natural regeneration is desired the steps are started years before the final cutting. Apart from preparation of the soil surface, they depend on the timing and type of final cuttings. But if forest is artificially regenerated the real work is timed for the years following the final cutting. It comprises preparation of the soil surface and planting or seeding. In all cases it may be necessary to protect the development of seedlings in the early years and to ensure the regeneration of forest by various later steps, such as the removal of weeds and brushes.

Forest regeneration by seeding and planting differs from afforestation, classified under *forest improvements proper*, primarily in that there is no final cutting to precede afforestation. The same independence of the decision to cut the existing stand is also a characteristic of the other steps of this category. In other words, a stand may be fertilized, a seedling stand thinned, a swamp drained, a birch stand pruned, and so on, without preceding cuttings in the stand to be treated.

These are the three categories of silvicultural steps usually called to mind when investments in timber growing are discussed. *Forest sales and purchases* are less frequent, and are investments of an entirely different magnitude. In principle, however, quantitative changes in forest property also mean changes in the expected cash flows in the same way as the qualitative changes in a forest.

Supplementary investments cover e.g. having a forestry plan made for the forest unit, lodgings provided for workers, and the construction of forest truck roads. They differ from all the foregoing in that their influence on timber growing is indirect. In many cases it is difficult to ascribe a supplementary investment to timber growing alone, for it may serve, say, timber harvesting and agriculture at the same time.

In the following, *forest improvements will refer primarily to the steps classified above under forest improvements proper, and to such regeneration of forest in which a »reduced-yield» stand is treated* (cf. SAARI 1968, concerning the term »reduced yield»).

According to the earlier definition of investment, only a part of the listed timber growing steps and forest improvements are investments in the strict sense of the word. For example, regeneration of a reduced-yield spruce stand, on dry mineral land, into a pine stand is a chain of events starting with a revenue from cutting and not with an expense item. As stated in Chapter 21, the evolved theory can, however, be generalized for all cases in which cash flow changes need to be deliberated. In the following, therefore, forest improvement »investments» and other forest improvements will not be distinguished.

Defining of output

The introduction emphasized two special characteristics of timber growing: the very slow rate at which steps mature into receipts, and the relative freedom of the forest owner to time the cuttings to suit himself. These characteristics also affect the definition of forest improvement output, and they must therefore be discussed in some detail.

The *rotation* of a stand, which here refers to the interval from the establishment of a seedling stand to the final cutting (cf. e.g. NYYSSÖNEN 1958, pp. 7—10) is, under Finnish conditions, at least 70 years. During this interval, the stand undergoes something like 3—7 thinnings and a final cutting yielding sales revenue. The first of them is probably timed for the age of 30—50 years, and the others recur at 5—15 year intervals. In the future the cuttings may become even less frequent (VUOKILA 1969, p. 143).

Let us assume that the forest owner has a cutting programme for the whole, or a part of the rotation in his mind when he starts planning to postpone thinning e.g. by a year. The decision may only imply the postponement of the cutting to another date, by which time increment may have increased the timber volume to be removed. Or, it may mean changes in the timing and volumes of later cuttings as well. In other words, the influence of the cutting decision is apparent in *changes in the cutting programme.*

The determination of these changes in the cutting programme is one of the essential problems of investment calculations for forest improvements. A cutting programme can be compiled and defined in many different ways, and the decisions made in that context substantially affect the contents of the calculation itself. The time dimension of the cutting programme will be discussed further below, while the extent of the object system of forest investments will be discussed here (cf. Chapter 31).

The cutting programme may be understood simply as the intended succession of cuttings in a target stand, or as an economic plan covering the whole forest unit. The former is suggested mainly by operational factors: in calculation techniques, it is easier to make assumptions concerning the treatment of a single stand. The latter is probably closer to reality if the total effects of forest improvement on the cash flows of the forest owner are sought.

The treatment of a stand is usually not independent of that of the other stands, and especially the neighbouring stands, in a forest unit. The selected definition of the object system may therefore considerably affect the extent and timing of the effects (changes in the cutting programme) to be dealt with in the calculation. This may be assumed to happen especially when forest improvement takes place in a stand or stands which represent a relatively large proportion of the whole forest unit (cf. especially SAARI 1942, pp. 28—29; see also LUNDELL 1970).

For a discussion of the extent and timing of cuttings, it may be useful to define the concepts of *bound and unbound growing stock* (V. KELTIKANGAS 1938, pp. 109—128). The bound growing stock of a given date refers to that part of the growing stock in a stand or forest unit which, under valid statutory stipulations (in Finland, especially The Private Forest Act) or market rulings (minimum dimensions and quality standards of timber), must not be cut, or whose cutting serves no useful purpose. Continuity and other requirements set by the forest owner himself may also be interpreted as factors increasing the degree to which the growing stock is bound. *At each cutting, the margin of deliberation is restricted to the part of the stand unbound at that moment; this part might be termed the liquid growing stock.* When drafting his cutting programme, the forest owner must restrict his plans as to whether he will cut or not, only to the growing stock unbound at the moment in the stand or forest unit.

The majority of these restrictions of forest use may be taken to apply to just one stand. The restriction which perhaps most clearly would require a viewpoint of a whole forest unit, viz. the demand for constant or continuing cutting volumes from a forest unit, is not impossed by law on the privately owned forests in Finland, apart from a few so-called land settlement farms. If the forest owner, in his use of forest, observes the principle of sustained yield (or progressive) forestry, he does so voluntarily and probably also according to his own rules. Consequently, the forest owner must take part in the determination of forest improvement output in terms of changes in the cutting programme or allowable cut. The determination is subjective.

Besides changes in the cutting programme, forest improvement may have other effects which need to be considered per forest unit and not only per stand. Among these »indirect benefits» SAARI (1942, p. 9) mentions the improved communications in a forest unit as a result of forest drainage. To what extent and in which form they are included in the calculations also depends on the mutual agreement between forest owner and consultant. There is no point in offering general recommendations in this connection.

This is perhaps sufficient discussion concerning the defining problem. It is of secondary importance for the subject proper of the study, the inclusion of the time factor, and its detailed analysis may be postponed to suitable later studies.

Forest owner's goals

According to the theory presented, the form of an investment calculation — i.e. the method of transforming and processing information — depends decisively on the goals of the forest owner-decision maker at each moment. These, in principle, must be cleared up separately case by case.

When a forest owner undertakes forest improvement, hardly anything more can be said about his goals than about a decision maker's goals in general. Only empirical studies can reveal whether regularities appear in forest

owners' goal settings e.g. by own groups or age groups. Until such analyses are available, we can only assume that all kinds of goals are possible, and the methods must be evolved accordingly.

A couple of points may, however, be raised. The above theory is built on the idea that the decision making process is created by a gap between the actual and the desired situation (between achievements and the decision maker's aspiration levels). The decision maker's goal in his investment actions is to bridge these gaps (e.g., diminution of money income available for consumption) without creating simultaneous new gaps in some other goal dimensions (e.g., the volume of construction timber used on the farm).

These gaps are not always deficits. Exceeding the aspiration levels may also trigger off a decision making process. The forest owner may start deliberating on a forest improvement measure for the purpose of increasing his future revenues, but the reason may also be because he has made money on cuttings and wishes to invest this money. It is easier for the consultant to work out a calculation in the former case since the decision maker may be expected to have recognized his goal and can express it more clearly. In the latter case, however, the consultant may have to start by defining the goals.

The gaps, and hence the goals, may also be mainly or totally unconnected with the forest owner's cash flows. For example, the forest owner may start draining his swamp because his neighbours have done so. Or he may weed his forest in order to win a local or provincial competition for the best tended forest. If so, the investment calculation plays no visible part in decision making. But the consultant is unlikely to be approached for calculations in a case of this type.

Time horizon

It was pointed out in the introduction that many authors have, with justification, doubted whether the time horizon of a forest owner of the type discussed in the present study can extend as far as to the end of a rotation, at any rate in all cases. It is not known, however, how distant these forest owners' time horizons are in reality.

The only empirical study of time horizons

the present writer has seen (FLORA 1966; cf. Introduction), cannot as such be generalized to apply to Finnish conditions. The material collected by FLORA, it is true, derives from a region where stand rotations do not differ much from those in Finland. Otherwise, however, the conditions and framework of forestry are different. The forest owners interviewed — five from each of the ten New England counties drawn by lot — were the region's greatest private forest owners (mean forest unit size 1505 ha), and no less than 19 of these 50 owned a sawmill as well.

Some indications of the Finnish forest owners' possible time horizons are provided by the following, partly sporadic data. LINDGREN (1968), in his study of the transfer of farms from one generation of a family to another, based on material collected in 1959 and representing the whole of Finland, found that the heir to a farm had an average age of 34—39 years at the time of inheritance and was, on average, 67 years old when he gave up the farm (l.c., p. 45). Such a man, on taking over his inheritance, has about 30 years of ownership ahead of him. If he has no children or other close heirs it is difficult to see why, in planning his activities, he should think beyond those 30 years of his presumable ownership.

The mean age of farm forest owners in Finland is relatively high, about 50 years according to the 1959 Census of Agriculture (Suomen . . . 1962). If such an »average» forest owner in his calculations considers only his own period of ownership, his time horizon is even shorter than 30 years. But if he has children to continue his work they may affect his decisions, and it is possible that the time horizon will be slightly longer. All exact figures, however, must be omitted until empirical studies have been conducted on this point.

These figures provide an overall idea of the limits within which the time horizons may move in average cases. *But the consultant, in each calculation situation, must know the time horizon of the forest owner-decision maker he is assisting.* He can only find this out from the decision maker himself.

The best techniques for determining the time horizon may be overlooked in this connection. But the question of how to take into account a time horizon whose exact length is not known deserves attention. It is just this

situation that arises in studies of the profit-ability sequence of forest improvements. Cal-culations cannot be carried out in advance according to the time horizon of any individual »average» forest owner.

A serviceable solution might be to *carry out calculations using several different horizons*. In other words, results are calculated for each forest improvement alternative using time horizons of, say, 5, 10, 20, 30, . . . years. The user of the results can then first choose the relevant time horizon and then the results cor-responding to this horizon.

If the first positive cash flow change effects to be expected from a forest improvement will be far in the future, say after 30—40 years, it is possible that none of them can be accom-modated within the decision maker's time horizon. All the relevant cash flow changes are then negative. This does not mean that the calculation is unnecessary or that the forest owner directly rejects the forest improvement involved. As pointed out in Chapter 32, forest improvement may have effects other than those expressible in terms of money, and if so, the result of the investment calculation alone is not decisive. Nevertheless, it may be a necessary data for the decision maker.

It should be emphasized that the time hori-zon problem has here been discussed mainly with a view to Finnish conditions, that is to say, in forestry with long rotations. Where a more propitious climate makes essentially shorter rotations, of 5—15 years, the problems discussed above possibly lose a great deal of their importance (cf. SAARI 1967).

Comparison of alternatives

According to the precise definition of the study problem (see Chapter 25), the develop-ment of the theory above was restricted to calculations in which information concerning the effects of *one* investment alternative at a time is transformed and condensed. (In a way, it may be considered that there are two alternatives, for the basis of determining the effects is always the zero alternative, i.e. rejection of the investment. This, however, hardly needs to be emphasized separately.)

Depending on the situation, the alternative considered may be, for example, regeneration of a single stand, or a forest improvement programme covering the whole forest unit and consisting of a number of different steps. However, it is essential that *the investment calculation — as understood in the present study — does not contain the comparison and elimination of several alternatives*. Nor does it state the acceptability or rejectability of the alternative proposed. These two steps, ac-cording to the interpretation adopted in the frame of reference and definition of the study problem, are parts of the decision making process following after the investment calcu-lation. They are to be carried out by the decision maker himself rather than by the consultant.

Restriction to one alternative in many cases apparently corresponds to the decision making situation. This is usually true when the forest owner must decide whether or not he will take part in a joint drainage project. The individual participants in the project seldom have much choice concerning the extent, timing or method. Usually there is only one alternative and the consultant must explain its effects to the forest owner, in the form required for decision making.

Also, when there are several possible forest improvement alternatives to be considered simultaneously, for example when the forest owner chooses a method of regenerating a stand, it is customary and obviously also appropriate to prepare separate investment calculations for each alternative. When the forest owner is presented, for each alternative, with information on its effects in comparable form he can carry out the comparison himself and choose the one he finds best.

Not until there are so many alternatives that the consultant, in order to master the situation, must somehow reduce the number before he presents the decision maker with in-formation, or when, instead of choosing one alternative, an *investment programme* com-posed of several alternatives must be com-piled, it may be advisable to combine in the same calculation, at least partly, the trans-formation and condensation of information as well as the comparison and elimination of alternatives. In timber growing this situation usually arises only in the composition of a management plan for a forest unit.

The scope of the present study, however, did not include the methods and calculations to be used in this type of planning. They are no longer real investment calculations but rather

their applications. It seems, however, that the rules drafted above for the treatment of the time factor in investment calculations must also be followed in the applications. Hence the theory formulated in the present study can serve as a frame of reference and starting point for future studies of the significance of the time factor in forestry planning.

What has been said above concerning the comparison of investment alternatives in timber growing holds good, mutatis mutandis, also for comparisons of e.g. forestry and agricultural investments, or agricultural and, say, digging machine investments. The consultant treats each alternative separately, and comparison is carried out on the basis of transformed and condensed information.

It is not necessary to assume that the same consultant would be at work all the time. It might even be difficult to find a consultant equally versed in the ways and means of earning an income from forestry, agriculture, and possibly other additional income. Information can be expected to be comparable even when provided by different consultants as long as they have understood the decision maker's goals and time horizon identically,

transformed the information according to the same principles, and lost no relevant information in the condensation. The necessary calculations for timber growing may be ordered from a forestry consultant and those for the clearing and drainage of arable land from an agricultural consultant.

In addition to those discussed here, there are still many more aspects and component problems associated with the application of this theory — the more numerous the details included the more their number grows. Questions such as how to handle, in the calculations, state subventions and taxes paid or how to analyse the forest owner's financing and investment possibilities, are probably more naturally discussed in connection with application studies.

The theory evolved would also provide a basis for deliberating many interesting forest policy problems, such as financing the forest improvements, forest taxation, and the possible development of the forms of forest ownership. There is every reason to revert to these subjects in future, separate studies.

5. CONCLUSIONS

It may be recalled that the study problem as defined in Chapter 25, was how the time factor, i.e. the time differences in the changes of the series of receipts and outlays, should be taken into account in the calculations by which the consultant assisting the forest owner transforms and condenses the information he has obtained or formed on the expected effects of investments in timber growing on the forest unit, when his target is to put this information into a form which the forest owner can directly compare with his goals.

After all that has been said above, the author gives the following answer:

1. For the forest owner, his time horizon sets limits to the cash flows relevant to him. The consultant, therefore, must *adjust the horizon of the investment calculation according to the true time horizon of the forest owner he is working for.* Extending the time horizon to infinity or to the end of a rotation, because the consultant does not know the true range of the forest owner's time horizon, may be a very misleading solution. When the forest owner's time horizon is at a relatively close range — say, at 5—30 years which, according to opinions advanced and information available, would seem possible at least in some cases — the principal revenue effects of investment in timber growing may be totally irrelevant. More empirical studies of the distances of time horizon are, however, required.

2. *When expected cash flow changes within a relevant time horizon are transformed and condensed into fewer parameters, it is necessary to take into account the forest owner's true goals and his realistic possibilities of financing the cash flow changes and making the investment.* The forest owner's time preferences are manifested in his goals for consumption changes, which therefore must not be included in the calculation in any other form. Since an economic unit must always be able to settle its expenses when they fall due and receipts are not available until the moment they are obtained, discounting and prolongation of outlays and receipts is realistic only if a corresponding realistic financing or investment procedure can be indicated.

3. If the consultant is ignorant of the forest owner's goals or his possibilities of financing and investment, *it may be advisable not to transform and condense the expectations (information).* When the purpose of an investment calculation was specified, half the purpose was said to be the condensation of information into elements fewer than their original number. Since cuttings are few, the relevant time horizon often accommodates no more cash flow changes than are permitted by the forest owner's ability to deal with information (cf. Chapter 241 above). This tolerance limit, therefore, does not always make condensation necessary. On the contrary, the price paid for condensation in the form of lost information may be »high» compared with the benefit obtained.

4. Condensation of a series of cash flow changes to its discount or present value corresponds to the decision maker's goals only in certain cases which can be precisely delineated. Should the consultant not know the forest owner's goals, he is well-advised to present both the *series of cash flow changes as it is, and its present value.* If he shows only the present value, the consultant may conceal information essential for the decision making.

Applied to the needs of the contractual research mentioned in the introduction, these conclusions give rise to the following proposal of how to carry out the calculations.

The results of the contractual research should also be helpful to individual forest owners in their decisions concerning forest improvements. Since their goals, time horizons and financial and investment facilities apparently vary, all the factors mentioned must be considered as variables when the effects of forest improvement alternatives are calculated.

In other words, it is *advisable to carry out the calculations of the contractual research separately, using several time horizons and several interest rates.* In addition, in view of the pos-

sible goals for consumption change that the forest owner utilizing the results may have in mind, the *series of cash flow changes to be expected* should also be presented *as they are*, unprocessed.

Empirical knowledge so far available hardly justifies any more conclusions, either as

regards the form of the investment calculation or its most suitable application to general investigations such as the contractual research. Experience and the new empirical material accruing from this contractual research, will however help to test and improve the theory here developed.

6. SUMMARY OF THE RESULTS

The purpose outlined for the study was to establish how the time factor, i.e. the temporal differences in the effects of alternative actions, should be taken into account in investment calculations concerned with timber growing in the forest of an economic unit owned and controlled by one physical person.

Since forestry, almost without exception, is carried out parallel with other economic activities and not on its own, the premise that investment calculations associated with timber growing, as well as those associated with other economic activities, be derived from the same model was considered justified. The first thing, therefore, was to expand the time factor theory of investment calculations for this kind of economic unit so as to cover all investments, including those in forestry. The investment calculations of timber growing were to be studied as a special application of this more general theory.

Investment was defined as an integrated series of outlays and receipts, with an outlay as the chronologically first member. From the point of view of the total cash flows in a forest owner's economy, investment always means the replacement of an expected total cash flow by another.

A review of the theory of decision making led to the construction of a model of decision making, and this again to a detailed definition of the purpose of an investment calculation. The investment calculation was interpreted as a calculation transforming and condensing the information on the immediate effects of the investment. It was decided to study it as a calculation made by a consultant assisting the forest owner. It was also found useful to define the study problem more precisely and to confine it within more narrow limits than was originally intended.

The study problem in its ultimate form was to investigate how the time factor should be taken into account in the calculation with which the consultant assisting the decision maker transforms and condenses the information, composed of the expected effects of the investment, in order to put it into a form in which the decision maker can directly compare it with his goals. There were also some cardinal problems to be discussed concerning the application of the theory so evolved to cases in which the investment objects consist of various steps in timber growing in a forest unit of the type described.

The concepts of system theory were utilized to carry out the task outlined. The direct effects of investment, i.e. the information to be transformed and condensed, was defined as changes in the relationships between the object system of investment and the decision maker's relevant environment. Accordingly, the individual's goals were interpreted as changes he seeks to carry out in his own state and/or that of his environment, their elements, systems and relationships. The precise content of both these concepts — the effects and goals — ultimately depends on the observing party. In other words, it depends on how this party perceives and defines the decision maker's relevant environment, its components and its boundaries.

The investment calculation must be operational. Hence it cannot possibly include all information relevant to decision making. The investment calculation, therefore, is a partial calculation with a structure governed both by the situation to which calculation is applied and by the goal setting in each individual case.

It was agreed that the series of changes to be included in the investment calculation should consist of the changes in the decision maker's cash receipts and cash outlays, i.e. cash flow changes. The effects of investment manifested as forest owner's own labour and other inputs, and the output he uses himself may be measured in money if certain conditions are met, i.e. they may be replaced with imaginary cash flow components, but in the present study this aspect was only mentioned in passing. Other types of investment effects were completely excluded from the transforming and condensing calculation. They

must be considered separately by the forest owner when he makes his investment decision.

An analysis of the individual's possible goals revealed that they may, in different cases, be changes at least in consumption, assets and liquidity, and changes in the certainty of expectations, individually, or differently grouped. A more detailed analysis gave the following further results.

If the individual has consumption goals, the investment calculation must contain a plan of how to finance and use the cash flow changes. The acceptability of the calculation depends on whether the measures (borrowing, lending, investment) proposed in the plan are realistic. Before he can produce a relevant calculation the consultant, therefore, must know the decision maker's realistic possibilities of financing and using the cash flow changes. If the consultant does not know them it may be advisable not to transform and condense the series of cash flow changes.

Interpretation of the goal for change in assets may vary. It is also difficult to show a completely acceptable method of transforming and condensing a series of cash flow changes so that the parameter obtained would indicate the change in the value of assets. If this change refers to an exchange value it is, in principle, impossible to determine it on the basis of the series of cash changes alone. Other ways and means must be found. If the subjective utilization value and its changes are considered, the discount rates used in the evaluation of separate cash flow changes must be selected according to the calculation situation. They may be based on the decision maker's possibilities of financing and investment or, in addition to these, on his time preferences for consumption.

Liquidity is understood to mean either that receipts and outlays must be correctly timed, or that assets must be convertible into cash without delay. The former will be automatically realized if the investment calculation is made in the form of a plan of financing and using the cash flow changes. In the same connection, restrictions on borrowing which liquidity may make necessary must be taken into account. Convertibility of property into cash, on the other hand, cannot be inferred from the series of cash flow changes as such. Where required, it must be shown by some other method.

The uncertainty of cash flow changes alone may be a detail relevant to the decision maker. In investment calculations, however, the effect of uncertainty is manifested in the position of the time horizon. The time horizon is the limit beyond which the expected cash flow changes are of no relevance for the consumption of the decision maker. Nor can the utilization value (present value) of the assets be determined on the basis of cash flow changes beyond the horizon. Conceptually, the value coinciding with the horizon is necessarily the exchange value.

These conclusions compose the sought-for theory of investment calculations in timber growing. It was considered new, especially from the point of view of the approach used. A uniform theory was created by interpreting the investment calculation, made by a consultant, as a transformation and condensation of information, to be continued only as far as available information permits. The conclusions contained in this theory are largely compatible with the more or less sporadic ideas advanced earlier. The traditional methods of calculation in timber growing can be considered to cover special cases in the sphere of the theory developed.

Certain central problems encountered when the theory is applied to calculation situations in practice were then discussed. Special attention was paid to investments in forest improvement.

Essential effects of forest improvement are changes in the cutting programme of a stand or forest unit. In principle, the consultant should always find out the effects on the cutting programme of the whole forest unit. For operational reasons, however, it may be necessary to limit the study only to the object stand and its cutting programme.

The cutting programme is composed of separate cuttings (cutting decisions). The freedom of choice, whether to cut or not, is restricted to the part of the growing stock unbound at the moment. Growing stock may be bound by the stipulations of the Private Forests Act and marketing possibilities, but also by the goals the forest owner usually sets himself for the continuity of forestry on his forest unit. Since these goals are subjective, close participation by the forest owner is necessary in determining and modifying the cutting programme for the forest unit.

Little empirical knowledge is available concerning the goals of forest owners, and their detailed analysis therefore presupposes future studies. A problematic situation, however, was found to arise not only when achievements lag behind expectations, but also when they exceed the level of aspirations. If the forest owner's goals, all or a number of them, were associated with factors other than cash flows, it is improbable that he would ask anybody to make an investment calculation.

While no empirical data are as yet available, indirect indications of the Finnish forest owner's time horizon can be obtained from the results of studies concerning change of farm ownership. Since the average period of ownership is around 30 years, it is quite probable that the owners, at least if they have no children, do not apply a longer time horizon.

For an investment calculation, however, the consultant must know the relevant forest owner's time horizon. If he does not, he can nevertheless carry out the calculations on the basis of several time horizons. Then it is up to the decision maker to choose the calculation which he finds in best agreement with his own time horizon.

If the forest owner's time horizon is very short, it is possible that no positive cash flow change occurs within it. The role of effects other than those manifested or measurable in terms of money will then become decisive.

It was considered necessary to emphasize particularly that what is said here is primarily applicable to the Finnish forestry, with long rotations. In more favourable climatic conditions where the rotations are only 5—15 years, the time factor may play a less important role.

While an investment calculation applies to only one investment alternative at a time, the comparison of several alternatives takes place on the basis of information about each of them, individually transformed and condensed. Only if the number of alternatives is very high and if compilation of an investment programme is intended, the transformation and condensation of information, and comparison of alternatives, may be combined in one calculation. In timber growing this is usually the case only when management plan for a forest unit is drafted.

The results of the study were finally assembled to constitute an answer to the study problem. The consultant must strive to carry out the investment calculation using the true time horizon of the forest owner he is assisting. In the transformation and condensation of the expected cash flow changes he must take into account the forest owner's goals and realistic financing and investment possibilities. If the consultant does not know them, it may be preferable not to transform and condense the information at all. When the forest owner's goals alone are unknown, it may be advisable for the consultant to present the series of cash flow changes as it is, unprocessed, and its present value.

In conclusion, a recommendation was developed for the calculation procedure to be used in the so-called contractual research into the profitability sequence of forest improvements. It would seem advisable to carry out the calculations using both varying interest rates and varying time horizons. In addition, it is justifiable also to present the expected series of cash flow changes, such as they are, among the results.

Future empirical studies will be needed for a more advanced development of the theory, and also to test the above conclusions. The theory now drafted on the basis of the present studies will form the necessary frame of reference.

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SELOSTE:

AIKATEKIJÄ JA INVESTOINTILASKELMAT PUUNKASVATUKSESSA

TEOREETTISIA PERUSTEITA

Tämä tutkimus aloittaa laajemman metsänparannustöitä ja niiden edullisuusjärjestystä selvittelevän tutkimussarjan. Pyrkimyksenä tässä ensimmäisessä osatyössä on hahmottaa tarvittavaa teoreettista perustaa mainitun tutkimussarjan yksityistaloudellisille laskelmille.

Tutkimuksen tavoitteeksi asetetaan aluksi selvittää, miten aikatekijä eli vaihtoehtoisista toimenpiteistä koituvien seurausten eriaikaisuus tulisi ottaa huomioon puunkasvatusta koskevissa investointilaskelmissa, kun kysymyksessä on yhden fyysisen henkilön omistamaan ja hallitsemaan talousyksikköön kuuluva metsälö.

Koska metsätaloutta lähes poikkeuksetta harjoitetaan muiden taloudellisten toimintojen ohella eikä yksinomaisena, katsotaan välttämättömäksi, että niin hyvin puunkasvatukseen kuin muihin taloudellisiin toimintoihin liittyvät investointilaskelmat johdetaan samasta ajatusmallista.

Investointi määritellään yhteenkuuluvaksi meno- ja tulosarjaksi, jonka ajallisesti ensimmäinen jäsen on meno. Metsänomistajan talouden kokonaismaksuvirtojen kannalta investointi aina merkitsee yhden odotettavan kokonaismaksuvirran vaihtamista toiseen.

Päätöksenteon teoriaan luotava katsaus (luku 21) johtaa päätöksenteon mallin rakentamiseen ja tämä puolestaan investointilaskelman tehtävän yksityiskohtaisempaan määrittelyyn. Investointilaskelma tulkitaan investoinnin välittömiä seurauksia koskevaa informaatiota muokkaavaksi laskelmaksi. Sitä päätetään tutkia metsänomistajaa avustavan neuvonantajan laatimana laskelmana. Vastaavasti katsotaan aiheelliseksi täsmentää ja rajata tutkimusongelma alkuperäistä ahtaammin.

Tutkimustehtäväksi muodostuu nyt (luvussa 25) selvittää, miten aikatekijä olisi otettava huomioon laskelmassa, jolla päätöksentekijää avustava konsultti muokkaa investoinnin odotetuista seurauksista koostuvaa informaatiota tavoitteenaan tuoninformaation saattaminen sellaiseen muotoon, että päätöksentekijä voisi välittömästi verrata sitä tavoitteisiinsa.

Tehtävän suorituksessa käytetään hyväksi systeemiteorian käsitteistöä (luku 31). Investoinnin välittömät seuraukset eli muokattava informaatio määritellään muutoksiksi investoinnin kohdesysteemin ja päätöksentekijän relevantin ympäristön välisissä relaatioissa. Vastaavasti yksilön tavoitteet tulkitaan muutoksiksi, joita tämä pyrkii saamaan aikaan omassa ja/tai ympäristönsä tilassa, niiden alkioissa, systeemeissä ja relaatioissa. Kummankin käsitteen — seurausten ja tavoitteiden — tarkka sisältö riippuu tällöin viime kädessä tarkastelijasta. Toisin sanoen siitä, kuinka tämä mieltää ja rajoittaa päätöksentekijän relevantin ympäristön ja sen osaset.

Investointilaskelman todetaan olevan sidottu operationaalisuuden vaatimuksiin, joten se ei voi sisältää läheskään kaikkea päätöksenteossa mahdollisesti relevanttia informaatiota. Investointilaskelma on siten osittaislaskelma, jonka rakenteen voidaan sanoa määräytyvän sekä laskentatilanteen että kulloisenkin tavoitteenasettelun mukaan.

Investointilaskelmaan sisällytettävien meno- ja tulosarjamuutosten katsotaan olevan päätöksentekijän kassaan- ja kassastamaksujen eli maksuvirran muutoksia. Luontoissuoritteina ilmenevät investoinnin seuraukset (panosten ja tuotosten muutokset) saatetaan tietyin edellytyksin mitata rahassa eli korvata kuvitelluilla maksutapahtumilla, mutta tässä tutkimuksessa ne sivuutetaan maininnalla. Muunlaiset investoinnin seuraukset sen sijaan suljetaan täysin muokkauslaskelman ulkopuolelle. Ne päätöksentekijän on otettava erikseen huomioon investointiratkaisussaan.

Yksilön mahdollisiin tavoitteisiin kohdistettu tarkastelu (luvussa 34) johtaa päätelmään, että eri tapauksissa tavoitteina saattavat olla ainakin kulutuksen, omaisuuden ja likviditeetin muutokset samoin kuin muutokset odotusten varmuudessa, kukin erikseen tai useammat yhdessä. Yksityiskohtaisempi erittely tuottaa edelleen seuraavat tulokset.

Mikäli yksilöllä on kulutustavoitteita, investointilaskelman tulee sisältää maksunmuutosten rahoitus- ja käyttösuunnitelma. Laskelman hyväksyttä-

vyyden ratkaisee suunnitelmaan sisällytettyjen toi-
menpide-ehdotusten (lainanotot, lainanannot, sijoi-
tukset) realistisuus. Relevantin laskelman laatimi-
seksi on konsultin niinmuodoin tunnettava päätök-
sentekijän reaaliset mahdollisuudet maksunmuu-
tosten rahoittamiseen ja käyttöön. Ellei päätöksen-
tekijä tunne näitä, saattaa maksunmuutossarjan
jättäminen muokkaamatta olla tarkoituksenmukai-
nen ratkaisu.

Omaisuuden muutostavoitteen tulkinta saattaa
vaihdella. On myös vaikea osoittaa täysin objektii-
vista, so. henkilöstä riippumatonta menetelmää tu-
lonmuutossarjan muokkaamiseksi niin, että saatu
tunnusluku ilmaisisi omaisuuden arvonmuutoksen.
Jos viimeksi mainitulla tarkoitetaan vaihtoarvon
muutosta, on sen määrittäminen pelkän maksun-
muutossarjan perusteella jo periaatteessa mahdo-
tonta. On turvauduttava muihin keinoihin. Mikäli
taas kysymyksen katsotaan olevan subjektiivisesta
käyttöarvosta ja sen muutoksesta, on erillisten mak-
sunmuutosten arvostuksessa käytettävät diskont-
tausprosentit valittava laskentatilanteen mukaan.
Ne voivat perustua päätöksentekijän rahoitus- ja
sijoitusmahdollisuuksiin tai näiden lisäksi myös
hänen ajallisiin kulutuspreferensseihinsä.

Likviditeettivaatimus voidaan käsittää joko
siten, että tulojen ja kulutuksen on oltava oikein
tahdistettuja, tai siten, että omaisuuden on oltava
nopeasti rahaksi muutettavaa. Edelline toteutuu
itsestään, mikäli investointilaskelma laaditaan mak-
sunmuutosten rahoitus- ja käyttösuunnitelmana.
Samassa yhteydessä voidaan ottaa huomioon myös
lainanotolle likviditeetin vuoksi mahdollisesti ase-
tettavat rajoitukset. Omaisuuden rahaksimuutetta-
vuutta ei sen sijaan voida johtaa maksunmuutos-
sarjasta sellaisenaan. Se on tarvittaessa osoitettava
muilla keinoilla.

Maksunmuutosten epävarmuus saattaa jo sinänsä
olla päätöksentekijälle relevantti tieto. Investointi-
laskelmassa epävarmuuden vaikutus näyttäytyy
kuitenkin ensisijaisesti aikahorisontin muodostumi-
sena. Tämä merkitsee rajaa, jonka takaisilla mak-
sunmuutosodotuksilla ei yleensä ole päätöksenteki-
jälle kulutuksen kannalta merkitystä. Myöskään ei
horisontin takaisten maksunmuutosten perusteella
voida määrittää omaisuuden käyttöarvoa (nykyar-
voa). Käsitteellisesti horisontin kohdalle sijoitettava
arvo on pakostakin vaihtoarvo.

Näistä päätelmistä koostuva teoria on esitetty
puunkasvatuksen investointilaskelmien teoria. Sen
voitaneen katsoa olevan uusi nimenomaan käytetyn
tarkastelutavan osalta. Tulkitsemalla konsultilla
teetettävä investointilaskelma informaation muok-
kaukseksi, jossa konsultin tulee edetä vain niin pit-

källe kuin kulloinkin käytettävissä olevien tietojen
perusteella on mahdollista, on aikaansaatu yhtenäi-
nen teoria. Tämän teorian sisältämät päätelmät ovat
paljolti yhdenmukaisia jo aiemminkin esitettyjen
mutta enemmän tai vähemmän irrallisten käsitysten
kanssa. Traditionaalisia nykyarvomenetelmiä voi-
daan tietyssä mielessä pitää kehitetyn teorian eri-
tyistapauksina.

Tämän jälkeen (luvussa 4) otetaan käsiteltäväksi
eräitä teoriaa käytännön laskentatilanteisiin sovel-
lettaessa esiintyviä keskeisiä ongelmia. Etualalla
ovat tällöin investoinnit metsänparannuksiin.

Metsänparannuksen keskeisiä seurauksia ovat
metsikön tai metsälön hakkuuohjelman muutokset.
Periaatteessa konsultin tulisi aina määrittää vaiku-
tukset koko metsälön hakkuuohjelmaan. Operatio-
naalisista syistä joudutaan kuitenkin turvautumaan
myös metsikkökohtaiseen tarkasteluun.

Hakkuuohjelma koostuu erillisistä hakkuista
(hakkuupäätöksistä). Niitä tehtäessä harkinnanvara
rajoittuu puuston kulloinkin sitomattomaan osaan.
Sidonnaisuutta saavat aikaan paitsi yksityismetsä-
lain määräykset ja markkinointimahdollisuudet
myös metsänomistajan yleensä itse asettamat met-
sälön metsätalouden kestävyystavoitteet. Viimeksi-
mainittujen ollessa subjektiivisia on metsälön hak-
kuuohjelmaa ja sen muutosta määritettäessä met-
sänomistajien kiinteä osallistuminen tarpeen.

Metsänomistajien tavoitteista on varsin vähän
empiiristä tietoa, joten niiden yksityiskohtaisempi
analyysi edellyttää jatkotutkimuksia. Ongelmati-
lanteen todetaan kuitenkin voivan syntyä paitsi
saavutusten jäädessä jälkeen odotuksista myös nii-
den ylittäessä tavoitetason. Mikäli taas metsän-
omistajan tavoitteet ovat joko kokonaan tai pää-
osiltaan muita kuin rahavirtoihin liittyviä, on epä-
todennäköistä, että hän pyytäisi laatimaan inves-
tointilaskelmaa.

Suomalaisen metsänomistajan aikahorisontista
voidaan nimenomaisten selvitysten vielä puuttuessa
saada välillisiä viitteitä maatilojen omistajavaih-
doksia koskevista tutkimustuloksista. Kun keski-
määräinen omistuskausi on noin 30 vuotta, on melko
todennäköistä, että ainakaan lapsettomat omistajat
eivät juuri käytä tätä pitempää aikahorisonttia, jos
sitäkään.

Investointilaskelmaa varten konsultin on kuiten-
kin tunnettava juuri kulloinkin kyseessä olevan
metsänomistajan aikahorisontti. Mikäli hänellä ei
ole sitä tiedossaan, hän voi silti laatia laskelmat
käyttäen useita eri aikahorisontteja. Päätöksente-
kijän tehtäväksi jää tällöin valita laskelmista se,
jonka katsoo vastaavan omaa aikahorisonttiaan.

Mikäli metsänomistajan aikahorisontti on hyvin

lyhyt, on mahdollista, ettei sen sisään mahdu yhtään positiivista maksunmuutosta. Muiden kuin rahassa ilmenevien tai mitattavien seurausten merkitys muodostuu tällöin ratkaisevaksi.

Erikseen on syytä korostaa, että tässä esitetty liittyy ensisijaisesti Suomen pitkien kiertoaikojen metsätalouteen. Suotuisammissa ilmasto-oloissa, missä kiertoajat jäävät 4 – 15 vuoteen, aikatekijän merkitys saattaa olla vähäisempi.

Investointilaskelman koskiessa vain yhtä investointivaihtoehtoa kerrallaan tapahtuu useampien vaihtoehtojen vertailu niistä kustakin muokatun informaation perusteella. Vasta kun vaihtoehtojen määrä on hyvin suuri tai kun tavoitteena on investointiohjelman koostaminen, tulee kysymykseen informaation muokkauksen ja vaihtoehtojen vertailun kytkeminen samaan laskelmaan. Puunkasvatuksessa tämä liittyy yleensä vain metsälön taloussuunnitelman laatimiseen.

Tutkimuksen tulokset kootaan lopuksi (luvussa 5) tutkimusongelmaan annettavaksi vastaukseksi.

Konsultin tulee pyrkiä laatimaan investointilaskelma käyttäen kulloisenkin avustettavan metsänomistajan tosiasiallista aikahorisonttia. Maksunmuutosodotusten muuntamisessa ja tiivistämisessä harvempiin tunnuksiin hänen on otettava huomioon metsänomistajan tavoitteet ja reaaliset rahoitus- ja sijoitusmahdollisuudet. Ellei konsultti tunne näitä, voi olla tarkoituksenmukaista jättää informaation muokkaaminen kokonaan suorittamatta. Metsänomistajan tavoitteiden pelkästään ollessa tuntemattomia konsultin saattaa olla tarkoituksenmukaisinta esittää sekä maksunmuutossarja sellaisenaan että sen nykyarvo.

Lopuksi kehitellään suositus metsänparannustöiden edullisuusjärjestystä selvittelevässä ns. sopimustutkimuksessa käytettäväksi laskentamenettelyksi. Laskelmat näyttäisi olevan syytä laatia käyttäen paitsi vaihtelevia korkoprosentteja myös vaihtelevia aikahorisontteja. Tämän lisäksi on perusteltua esittää tuloksina myös odotettavat maksunmuutossarjat sellaisinaan.

The role of the time factor is discussed from the viewpoint that investment calculations are expected to be used to transform and condense information and not necessarily to show the optimum. Some general conclusions are drawn concerning the recommendable form of such a calculation when used by a consultant advising a forest owner. A few of the practical problems arising in the connection of applications to timber growing are also dealt with. Further studies will follow.

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