Defining Forest Owner's Forest-Management Goals by Means of a Thematic Interview in Interactive Forest Planning

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Numerical optimization may not be the best way to launch an interactive planning process. The forest owner may not be able to identify precise management goals, as required in numerical optimization, for his forest. The owner may also think that it is impossible to express forest-management goals numerically. Due to these reasons, thematic interview was tested as an introductory method in interactive planning in several actual planning cases. It was observed that these interviews helped the owners in outlining their forest-management goals, and they offered an appropriate framework for defining these goals. It was also noticed that the goals defined in the course of the interviews could be included in the planning model in a way understood and accepted by the owners, and the goals defined could be fulfilled.

1 Introduction

The primary goal of tactical forest planning is to find out the combination of treatment schedules for forest compartments (e.g. Pukkala and Kangas 1993). This combination should meet the owner's forest-management goals in the best possible way when evaluated at the level of the whole forest property. Defining the owner's goals, as well as involving them into the planning calculations, are both necessary actions. Furthermore, the owner should feel and understand that his goals form the basis of the plan. *Interactive planning* is one way to strive towards this end.

In general, interactive planning can be understood as a participatory planning approach where the planning consultant(s) and the participant(s)

communicate interactively. However, forest-planning problems are often difficult and complex, and they can not be solved just by discussing the alternative plans. In addition to interpersonal communication, the methods of defining forest-management goals, and the procedure of technical problem solving, as well as the user interface of the planning system, should be interactive (Pykäläinen 1998). This kind of interactive planning offers learning possibilities to the forest owner, and it gives high-quality decision support when selecting a plan fulfilling the owner's forest-management goals (Kangas et al. 1996b, Pykäläinen and Kangas 1996). At its best, interactivity makes planning more interesting, easier to understand, and visually very appealing.

Interactive optimization, in the course of which the forest owner's utility model is formulated and maximised interactively until the forest owner is satisfied with the solution, is an important means of in-depth learning and technical problem solving in interactive planning (e.g. Steuer 1978, Steuer and Schuler 1981, Harrison and Rosenthal 1988, Pukkala 1988, Kilpeläinen 1991, Kangas et al. 1996a, 1996b). The owner has an opportunity to learn about the production possibilities of the planning area and the trade-offs among different forest uses, e.g. income, domestic timber, amenity values, etc. It can be assumed that interactive optimization improves the owner's capability to select a plan fulfilling his forest-management goals. However, optimization can not be attempted unless the forest owner can identify his goals and express them as required by the planning system, or if the forest owner thinks that it is impossible to define these goals numerically.

Thematic interview (Hirsjärvi 1991) is a promising method to help forest owners outline their forest-management goals, and it offers a systematic framework for the process that leads to defining these goals. It is a semi-structured interview method and it can be seen as intermediate between a formal interview, with fixed questions presented in certain order, and an open interview, with no a priori structure or guide. The themes to be discussed serve as a guide to thematic interview (Hirsjärvi 1991).

Thematic interview has several psychological and communicational advantages as a method for defining the forest owner's forest-management goals. These aspects have not necessarily been taken into account in the more analytical methods of preference analysis, e.g. the analytic hierarchy process (e.g. Kangas 1992), or in applications of mathematical programming (e.g. Kangas and Pukkala 1992) in forest planning. Firstly, thematic interviews possess the appropriate psychological background for forest planning. They are at their best when the topics to be studied are emotionally sensitive or fuzzily known, badly remembered, or not handled every day (Hirsjärvi 1991). Hence, defining the forest owner's forest-management goals would appear to be a highly suitable application area for a thematic interview. Secondly, a thematic interview is a familiar way of communication, and easy to adapt by forest owners. Thirdly, a thematic interview offers a framework for discussion between the forest owner and the planning consultant. The framework outlines and promotes discussion of forest-management issues. This increases the productivity of the discussion and helps motivate the forest owner. The framework also ensures that all the important aspects are discussed. And fourthly, the interviewee and the interviewer can learn from each other. This is an important aspect in forest planning because forestry often includes many vague points needing to be agreed upon before continuing the planning process.

The technical means of including various goals into interactive optimization can also be taken into account in thematic interviews. However, it can be difficult to create an "automatic" link between the interview and optimization. In any case, formulation of the utility model requires some thinking on part of the forest owner and the consultant. Defining the utility model certainly becomes much easier if the owner's forest-management goals are defined qualitatively in advance.

To date, forest-planning consultants have used interviews in an unsystematic fashion without any guidelines. Success in taking the forest owner's forest-management goals into account has depended too much on the communication skills of the planning consultant and his ability to include the obtained information into planning calculations. As a consequence of this, the consultant has often made the decision proposals by

himself at the level of forest compartments, relying mainly on wood production instructions. This kind of planning has not served the forest owners in the best possible way.

This study proposes a scheme for thematic interviews for application in forest planning and tests the method in defining the forest owner's forest-management goals. The test includes several actual planning cases in eastern Finland. Interactive planning is started with a thematic interview, and it is continued with an interactive optimization.

The research problem is to find out whether the thematic interview is an appropriate way to define the forest owner's forest-management goals. The specific questions are: (1) Can the forest owner's forest-management goals be identified? (2) Do the goals become clearer? (3) Does the owner understand the connections between his qualitatively defined goals and the utility model used in interactive optimization? (4) Can the forest-management goals defined in the interview be fulfilled? It is assumed that if the answers to questions 1 and 2 are in the affirmative, the psychological background and the communication through the thematic interview helps define the forest owner's forest-management goals.

2 Planning Method

2.1 Functional Idea in Forest Planning Interviews

The forests of the planning area are divided into homogenous stand compartments for planning and management purposes. A compartment has one or more alternative treatments in the planning period. These treatment alternatives are simulated and their outcomes are predicted prior to optimization. The task of optimization is to find out such a combination of treatment schedules, which meets the forest owner's management goals in the best possible way. Hence, defining the forest-management goals is an essential step in the planning process.

The functional idea of the thematic interview method in forest planning is to define the forest owner's forest-management goals by asking and answering questions according to an interview guide (Fig. 1). Both the consultant and the owner can ask and answer questions about the topic under discussion despite the consultant's guiding role. This kind of role exchange is one of the basic characteristics of an interview (Donaghy 1984).

There are three main issues to be discussed when holding a forest planning interview:
(1) What are the forest owner's forest-management goals?
(2) Does the forest owner have time preferences or spatial specifications for the goals?
(3) What is the relative importance of each goal?

The forest owner's forest-management goals are defined qualitatively, and they are typically presented as verbal statements. The owner does not need to present quantitative information about his goals. However, he is allowed to set desired values for specific goal variables or describe their mutual importance. These kinds of goals can be directly included into interactive optimization.

Themes are the framework of the thematic interview and they are the topics to be covered. Well-defined themes set the direction of the interview, allow control to be maintained, permit an easy flow of conversation and help avoid confusion (Donaghy 1984). In tactical forest planning, the themes include potential forest-management goals.

Each theme is first discussed separately. As a result, the forest owner and the planning consultant know the forest owner's forest-management goals related to each theme. Furthermore, the owner may have spatial specifications for the goals. Certain forest compartments may be identified as being important for amenity values or for the conservation of fauna and flora. The owner may also have time preferences related to the goals. For example, the owner may prefer early, late or even income.

At the end of the interview, the planning consultant summarises the goals related to the different themes, and asks the forest owner to specify the goals when necessary. After that, the consultant asks the forest owner to describe the mutual importance of the goals. If the interviewee

PROBLEMS	CATEGORIES	THEMES	GOAL VARIABLES	OTHER MEANS
FOREST MANAGEMENT GOALS	Economy	Timber sales income	Net income	
		Economic value of forest	Value and volume of timber Value growth of timber	
		Domestic timber	Saw log harvest	
TIME PREFERENCES AND SPATIAL SPECIFICATIONS	Scenic values	Far view landscapes	Area of clearcuttings	Landscape visualizations Treatment limitations
		Close view landscapes	Close view score Volumes of different tree species Area of clearcuttings	Landscape visualizations Treatment limitations
	Game habitats	Capercaillie	Area of old forest	Treatment limitations
		Black grouse	Volume of birch	Treatment limitations
MUTUAL IMPORTANCE OF GOALS	Berries and mushrooms	Cowberry	Estimated yield	
		Blueberry	Estimated yield	
		Mushrooms	Estimated yield	
	Nature protection	Certain species		Treatment limitations
		Overall biodiversity	Biodiversity index Area of old forest Volumes of dead wood and hard wood	

GUIDE OF INTERVIEW   **OPERATIONALIZATION OF THE GOALS**

Fig. 1. The outline of the interview as applied to the planning cases of this study, and the means of including the various forest-management goals in the planning.

is unable or unwilling to describe the importance, the goals will be assumed to be equally important.

The production possibilities of the planning area are not explicitly included in the forest planning interview. Therefore, the first proposal and the final plan may differ considerably. However, this does not mean that the interview has been unnecessary because the first utility model must be formulated.

2.2 Questions

Many divisions of questions in interviews have been presented in the field of social research (e.g. Eskola 1975, Hirsjärvi 1991). The most common way to classify questions is to divide them into open and closed ones. Closed questions limit or restrict possible answers while open questions are used when the question does not limit or specify the response (Donaghy 1984).

Open and closed questions may be used in forest planning interviews. Open questions can be used, for example, when "warming up" for the interview. Closed questions may be needed if the forest owner is unable to identify his goals through open questions. However, the planning consultant's influence on answers must be minimised by using questions that are as open as possible.

For some forest owners, promoting the discussion with open questions may be an appropriate way to support them in defining their forest-management goals. Closed questions may not be needed at all. In other cases, defining the goals may call for strictly closed questions. Therefore, the factors affecting the forest owner's communication skills, or ability to discuss the goals (e.g. age, gender, educational background, social position, profession), should be taken into account when formulating the questions. The questions are typically sequenced according to a "funnel sequence". This means that general questions give

way to more restricted ones as the interviewer moves through a topic (Donaghy 1984).

The questions can also be divided into (1) factual questions, (2) knowledge questions, and (3) opinion questions. Factual questions comprise a preliminary phase for the interview. The facts to be asked may include the forest owner's profession and place of residence, etc. These questions give the planning consultant personnel information about the forest owner and helps the planning consultant to formulate the knowledge and the opinion questions. The facts about the forest area under planning can be calculated on the basis of field inventory data. Thus fact questions about the planning area are not necessary.

Knowledge questions promote an understanding between the interviewer and the interviewee (Donaghy 1984). Their role, as well as that of the opinion questions, is extremely important in the interview. The knowledge questions are presented and discussed as an introduction to each theme. Both the planning consultant and the forest owner may ask and answer questions related to the theme under discussion. They can learn from each other, and they have an opportunity to adopt similar views about the meanings and the contents of the themes before going on with the opinion questions.

Opinion questions are asked to identify the forest owner's opinions concerning various themes. The opinions are superficial expressions of the forest owner's values and attitudes (Jyrinki 1977). The main tasks of the opinion questions are to define the forest owner's forest-management goals and his time preferences and spatial specifications for them, as well as to obtain information about the mutual importance of the goals.

2.3 Including the Forest Owner's Forest-Management Goals in Interactive Optimization

The owner's utility model is formulated for interactive optimization following the thematic interview. Co-operation between the consultant and the forest owner is the best way of doing it. Otherwise, there is the danger that the forest owner may not understand the connections between the interview and the optimization, and

thereby optimization will not attain its purpose.

Mathematical programming and heuristics can be used in interactive optimization. In mathematical programming, the forest owner's utility model is approximated through the objective function and the constraint equations, whereas explicit utility functions (value functions) may be used in heuristic optimization (Pukkala and Kangas 1993). The latter approach is used in this study where the standard version of what is called the HERO-method (Pukkala and Kangas 1993) is modified to facilitate interactive planning. Some other HERO modifications have been also presented, e.g. for participatory planning (Kangas et al. 1996a), for including multiplicative parts into the utility function (Kangas and Kangas 1998), and for integrating risk and the decision maker's attitude toward risk into planning (Pukkala and Kangas 1996). The present HERO modification for interactive planning is briefly introduced below.

Methodologically, the utility that the forest owner expects from the plan is computed from an additive utility function:

$$u = \sum_{i=1}^{m} a_i u_i \qquad (1)$$

where m is the number of goal variables, a_i is the importance of goal variable i, and u_i is the sub-utility obtained through the goal variable i. The sub-utility is defined through a sub-utility function (Fig. 2).

The planning consultant and the forest owner select the goal variables, give an approximate relative importance to them (a_i in Equation 1), and form a sub-utility function for every goal variable (Fig. 2). The sub-utility function is determined through the smallest possible, target level and largest possible values of the goal variable. Defining the target levels usually decreases the number of iterations needed to find the best solution. The sub-utility function will be linear if the forest owner does not have any target level or he cannot define it.

The utility value for the worst value (not necessarily the minimum value) of each goal variable is selected to be 1 and the utility value of the best value (not necessarily the maximum value) of each goal variable is selected to be 100. The
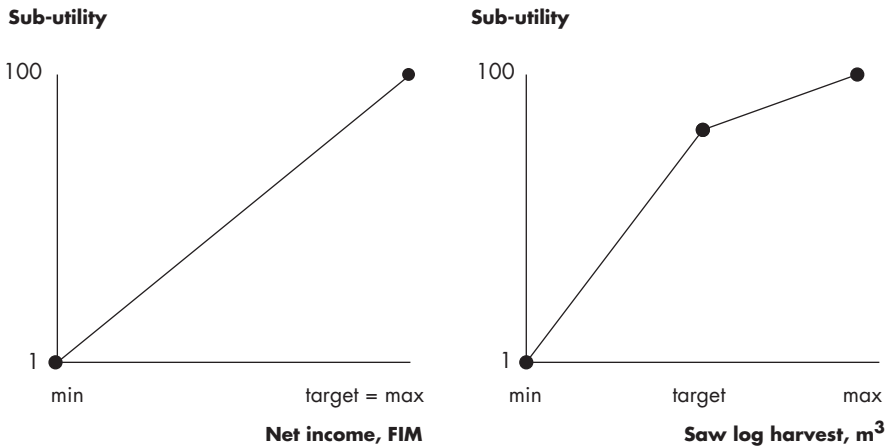
Fig. 2. Examples of sub-utility functions.

utility value of the target level is more than or equal to 1 and less than or equal to 100.

In this study, formulating the utility function is made more straightforward than in the standard version of HERO. Instead of using pairwise comparisons as in standard HERO, direct numerical evaluation is used to determine the importance of the goals and to form the sub-utility functions. Scaling of the sub-utilities also differs from the standard version. The method is easier to understand and quicker to use by means of these simplifications. The simplifications are also justified with the a priori information about the forest owner's forest-management goals obtained in the thematic interview, and with the possibility of correcting errors in the utility function in interactive optimization. Furthermore, the role of the utility function is to work as a tool for producing different plans for evaluation by the forest owner in interactive planning. The purpose is not to define the forest owner's forest-management goals perfectly.

The forest owner's time preferences for the goals (defined in the thematic interview) are taken into account through utility function formulation, and through interactive optimization. For example, net incomes during the first and the second sub-periods of the entire planning period are weighted according to the owner's goals in the a priori utility function. However, the time preferences may not be fulfilled in the first plan due to other goals in the utility function, and the final plan must be developed interactively.

Spatial goal specifications are taken into account by limiting the treatment alternatives in certain parts of the planning area (Fig. 1, "Other means"). This may be done for amenity values, game habitats or nature conservation. Landscape visualization is one possible method for checking the effects of intended forest-management actions on the landscape. Unsatisfactory impacts on landscape can be eliminated by changing the utility model, or by limiting the range of permitted treatment alternatives.

The initial solution is produced by using a heuristic optimization algorithm (Pukkala and Kangas 1993). The owner can change the current values of a_i. The problem is re-solved after every change, and the new solution is immediately displayed. The owner has easy and full control of the process, and can immediately see the effects of adjusting a_i.

3 Case Study

3.1 Forest Inventory and Treatment Schedules

The forests of the holdings involved in the case study were inventoried according to the normal

practice of Finnish private forest planning, using visual standwise inventory. After that, the inventory data were input to the MONSU planning system (Pukkala 1998), and the present status of the forest was calculated.

The planning consultant simulated one or more treatment alternatives for each forest compartment. The treatment alternatives defined possible development scenarios for the stands. Growth models were used for estimating the future yields.

Silvicultural aspects were taken into account in simulating the treatment alternatives for young stands. E.g. only cleaning or thinning was simulated in all very dense sapling stands. This was done because the benefits of silvicultural actions are not necessarily realized within the planning period (10 years). In general, all the alternative treatment schedules were legally and technically feasible. They could be implemented if the forest owner's forest-management goals called for it.

3.2 Planning Sessions

The thematic interview method was tested in two planning projects and localities (Polvijärvi and Pyhäselkä) in North Karelia, eastern Finland. The forest owners involved were mainly people of middle age or older, they had typically some tens of hectares of forest, and they mainly lived near their forest holdings. Agriculture and forestry were important sources of income for them. The owners of two of the holdings also received incomes from tourism. Only a couple of women took part in the planning sessions. The planning sessions were arranged in the forest owners' homes.

The planning consultant interviewed the forest owner and used the planning software. Apart from pen and paper, no technical means were needed in the thematic interview. A visual interactive forest planning software product called MONSU (Pukkala 1998) was used in the interactive optimization. This software produces instant landscape visualizations.

The thematic interview typically took about a half an hour, and the entire planning session took about two hours. However, this time also included the introduction to the computer supported planning, where all the forest compart-

ments were visualised on the computer screen, and the data of the growing stock and the site were studied. The planning consultant and the forest owner computed and studied also the present status of the forest holdings.

Data on fourteen planning sessions were collected in Polvijärvi. The forest-management goals defined in the thematic interviews are discussed below.

At the end of the thematic interviews the owners were satisfied with the goal definitions. The owners' forest-management goals were well identified in the interviews, and they could also be summarised by the consultant in a way accepted by the owners.

The forest owners' goals were most often related to the "timber sales income" and the "economic value of forest" themes. Nine owners wanted to have high income and to control the stumpage value of the growing stock at the end of the planning period. Among these nine owners, seven owners (owners 1, 2, 5, 6, 7, 8 and 9, Table 1) preferred an even flow of forestry income during the planning period (10 years), while two owners (owners 3 and 11, Table 1) wanted more income at the beginning of the planning period than in later years.

One owner had goals related only to the theme timber sales income (owner 10, Table 1). He wanted more income at the beginning of the planning period than in later years.

Two owners (owners 4 and 12, Table 1) had goals related to the themes timber sales income, the economic value of forest and household timber. In addition to even-flow of forestry income and good development of the economic value of the forest, these owners also wanted an even-flow of saw timber harvest during the planning period.

Two owners (owners 13 and 14, Table 1) had goals related to their timber sales income, the economic value of the forest and the scenic values (far- and close-view landscapes). These owners obtained income from tourism, and they thus wanted to include scenic values into planning. They had no time preferences for their income during the planning period. None of the fourteen owners had goals belonging to the categories game habitats, berries and mushrooms, or nature conservation.

Table 1. The goal variables and the solutions in interactive optimization.

Holding	Goal variables	Initial state importance	1st solution	2nd solution	3rd solution	Total change [1]	Change ratio [2]
1	Net income 1998–2002, [FIM]	6	4 672				
	Net income 2003–2007, [FIM]	6	32 690				
	Felling value 2008 [FIM]	5	279 870				
2	Net income 1998–2002, [FIM]	5	439 379	331 210		–108 169	0,8
	Net income 2003–2007, [FIM]	5	151 900	322 779		170 879	2,1
	Felling value 2008, [FIM]	5	1 731 570	1 674 086		–57 484	1,0
3	Net income 1998–2002, [FIM]	7	133 104				
	Net income 2003–2007, [FIM]	5	18 690				
	Felling value 2008, [FIM]	4	353 654				
4	Net income 1998–2002, [FIM]	5	13 276	50 108	39 777	26 501	3,0
	Net income2003–2007, [FIM]	5	45 388	37 476	37 476	–7 912	0,8
	Felling value 2008, [FIM]	8	505 034	469 097	481 131	–23 903	1,0
	Saw timber harvest 1998–2002, [m^3]	5	103	230	200	97	1,9
	Saw timber harvest 2003–2007, [m^3]	5	152	119	119	–33	0,8
5	Net income 1998–2002, [FIM]	5	26 794	27 590		796	1,0
	Net income 2003–2007, [FIM]	5	31 568	31 568		0	1,0
	Felling value 2008, [FIM]	5	396 942	391 090		–5 852	1,0
6	Net income 1998–2002, [FIM]	5	25 613	20 297		–5 316	0,8
	Net income 2003–2007, [FIM]	5	0	29 127		29 127	
	Felling value 2008, [FIM]	5	309 965	277 656		–32 309	0,9
7	Net income 1998–2002, [FIM]	5	180 861	174 377		–6 484	1,0
	Net income 2003–2007, [FIM]	5	99 070	134 119		35 049	1,4
	Felling value 2008, [FIM]	5	1 240 006	1 206 621		–33 385	1,0
8	Net income 1998–2002, [FIM]	5	526 721	264 489	303 214	–223 507	0,6
	Net income 2003–2007, [FIM]	5	115 647	90 469	209 932	94 285	1,8
	Felling value 2008, [FIM]	5	1 448 119	1 791 528	1 616 885	168 766	1,1
9	Net income 1998–2002, [FIM]	5	196 816	177 233		–19 583	0,9
	Net income 2003–2007, [FIM]	5	0	124 151		124 151	
	Felling value 2008, [FIM]	7	1 133 583	1 024 761		–108 822	0,9
10	Net income 1998–2002, [FIM]	7	98 974	101 557		2 583	1,0
	Net income 2003–2007, [FIM]	5	99 816	94 925		–4 891	1,0
11	Net income 1998–2002, [FIM]	7	56 337				
	Net income 2003–2007, [FIM]	5	7 389				
	Felling value 2008, [FIM]	5	336 320				
12	Net income 1998–2002, [FIM]	7	–1409	2117	1st solution was accepted		
	Net income 2003–2007, [FIM]	7	22 945	15 709			
	Saw timber harvest 1998–2002, [m^3]	5	16,3	19,7			
	Saw timber harvest 2003–2007 [m^3]	5	53,4	39,9			
	Value growth 2003–2007, [FIM/a]	6	35 769	35 891			
13	Net income 1998–2007, [FIM]	5	192378	213315		20 937	1,1
	Close scene score 2003	5	3,8	3,8		0	1,0
	Close scene score 2008	5	3,9	3,9		0	1,0
	Total volume 2008, [m^3]	5	5305	5144		–161	1,0
14	Net income 1998–2007, [FIM]	5	499956	501533		1 577	1,0
	Close scene score 2003	5	4,1	4,1		0	1,0
	Close scene score 2008	5	4,2	4,1		0	1,0
	Total volume 2008, [m^3]	5	17523	17756		233	1,0

1) Total change indicates the absolute difference between the last and the first solution. It is measured in the unit of the goal variable.
2) Change ratio is the ratio between the last and the first solution.

Strict spatial specifications for the goals were not very common. In other words, the owners were willing to change their spatial specifications when striving for the goals defined at the level of the whole forest holding. Only a couple of owners did not allow regeneration cuttings next to their house.

The results of the thematic interview were utilized when defining the forest owner's utility model for the first time. For example, the most common profile of goals, to have a high and even flow of income without endangering the development of economic value of the forest was included in the utility function by using the net income on the first 5-year sub-period as the first, the net income on the second five years sub-period as the second, and the felling value of the growing stock at the end of the whole planning period as the third goal variable.

Defining the target levels for the goal variables in the sub-utility functions was either quite difficult or then the owners simply did not have any. "The more the better" principle usually held true. The target levels were typically set to the maximum, i.e. the sub-utility functions were linear.

The various plans were also illustrated to the owners by means of landscape visualizations. The effects of the current plan on far- and close-view landscapes could be seen instantly. However, the forest owners did not set any new spatial specifications because of the landscape effects of the current plan. Neither were the utility functions changed due to the landscape effects.

The change ratios, indicating the relationship of the objective variable values (e.g. net income, timber volume at the end of planning period) between the last and the first solution in the optimization varied between 0.6 and 3.0. (Table 1). The plan was determined on the first trial (only one iteration or all the change ratios were 1.0) in seven cases (50 %), on the second trial in five cases (36 %), and on the third trial in two cases (14 %).

3.3 Formal Inquiry

A formal inquiry (Appendix 1) was used to collect information about the forest owner's initial knowledge in forestry, about learning in planning, and about the owner's opinions regarding interactive planning. It also offered information applicable when evaluating the thematic interview. The inquiry was done in Polvijärvi and in Pyhäselkä.

The inquiry was short and simple, because the forest owners were responding to their first experience of interactive planning. The forms were left with the forest owners after the planning sessions, and they were asked to be returned anonymously through the mail. The social pressure to answer in the affirmative was thus minimized. Nineteen owners responded to the inquiry (three forms were not returned).

In accordance with the results of the inquiry, the forest owners knew their forest-management goals quite accurately already before planning (very accurately 0 %, quite accurately 68 %, neither accurately nor inaccurately 26 %, fairly inaccurately 5 %, very inaccurately 0 %). However, 79 % of the owners thought that the discussion held before computer-supported planning (the thematic interview) made their forest-management goals clearer.

The connections between the goals defined in the thematic interview and interactive optimization were well understood. Computer-supported planning was very easy for 16 %, quite easy for 63 %, and neither easy nor difficult for 21 % of the owners to understand. Nobody thought that computer-supported planning was quite or very difficult to understand.

The goals defined in the thematic interview could also be included in planning. The plan produced using the computer fulfilled the forest owner's needs very well in 26 %, quite well in 53 %, and neither well nor badly in 21 % of the cases. Nobody thought that the plan fulfilled their needs quite or very poorly.

Planning made 89 % of the forest owners more interested in forestry, and 63 % of the owners learned something new about forestry. They were not asked as to which steps of planning were important in these senses.

Eighty-four per cent of the forest owners thought that no important aspects had been forgotten in planning. On the other hand, 16 % of the owners thought that something had been forgotten. However, these owners could not say what exactly was missing. One of these owners

thought that he would be able to better partici-pate in planning in the form of a field trip.

89 % of the forest owners would like to take part in planning in the same way also the next time. The majority of the forest owners preferred the method applied in the study over the present way of Finnish forest planning (this topic was studied only in Polvijärvi). 25 % of the owners strongly agreed, and 33 % slightly agreed with the very strong statement " Finnish forest-plan-ning organizations should use the approach test-ed instead of the present method. Otherwise, the resultant plan may not fulfill the forest owner's goals." 42 % of the forest owners did not tell their opinion.

After the planning sessions, 16 % of the own-ers knew their forest-management goals very ac-curately, 79 % quite accurately, and 5 % neither accurately nor inaccurately. Nobody knew his goals quite or very inaccurately.

4 Discussion

This study proposed a scheme for thematic inter-views for application in forest planning and test-ed the method in defining the forest owner's forest-management goals. The purpose was not to develop all aspects and steps of interactive planning. The economical value of growing stock was simply defined by the felling value of the growing stock, instead of the more justifiable soil expectation value. The forest owner's time preferences were included in planning by treat-ing the net incomes of different sub-periods as separate goal variables, the importance of which was decided by the owner.

In spite of some simplifications, the planning approach offered better decision support than planning with no interactive optimization at all. As a whole, the planning models worked well enough so that the thematic interview applica-tion could be tested as a part of the overall plan-ning process.

The forest owners' forest-management goals were identified as a result of the thematic inter-views. The owners and the planning consultant had similar views about the owners' goals at the end of the interviews. Furthermore, the owners

and the consultant understood each other well also during the interviews. The knowledge ques-tions did not have as important a role in the interviews as was expected. In this sense, the potentials of the thematic interview in defining extremely fuzzy goals could not be tested in the planning cases.

The forest owners had quite clear forest-man-agement goals already before the planning ses-sions. In spite of this, 79 % of the owners thought that their forest-management goals had become clearer in the course of the interviews. They were not asked as to whether they were left confused by the interviews. Be as it may, it seems that forest owners' forest-management goals are seldom so clear that a thematic interview at the beginning of planning would not be of some benefit. Furthermore, it is very difficult to say in advance who does not need the interview. Due to these reasons, it would be a wise practice to start planning systematically with thematic in-terviews of all forest owners.

The forest owners understood quite well the connections between their qualitatively defined forest-management goals and the utility model in the interactive optimization. The thematic inter-views may have helped them to understand opti-mization because it worked as an introductory method to multi-criteria planning. Furthermore, it should be taken into account that this was the first time that these forest owners took part in interac-tive planning and numerical optimization. Using interactive optimization in planning certainly be-comes easier after some practice.

The forest-management goals defined in the course of the interviews were fulfilled in interac-tive optimization quite well according to the own-ers' responses. Furthermore, only a few solu-tions were needed in optimization. More than one iteration step was needed in only 50 % of the cases. The maximum number of iterations was three. The values of the goal variables in the first and the last solutions in the interactive optimiza-tion were quite near each other. The goal varia-bles did not have to be changed at all. Also, the rapid convergence of optimization implies that qualitative goal definitions could be successfully translated into utility functions by the planning consultant and the forest owner.

On the other hand, the need for more than one

iteration in 50 % of the holdings means that a plan fulfilling the owner's goals can not always be found out at the end of the first trial. The same result was observed by Kangas et al. (1996b). One reason for the need for several iterations in interactive optimization is that the production possibilities of the planning area and the connections between different forest uses are not known in advance. Another reason is that the forest owner has fuzzy forest-management goals. Furthermore, the forest owner's values and the attitudes can change when he becomes better informed of the connections between the various forest uses in the course of interactive optimization. In these cases, the initial goal definition must be changed, and the utility model reformulated. Technical difficulty of formulating an appropriate a priori utility function is the third reason for several trials. Especially defining the weights of the objective variables is quite a difficult task.

The applied HERO optimization does not tell the forest owner when to stop interactive optimization. Some interactive mathematical programming methods use mathematical stopping rules for this purpose (e.g. Steuer 1986). However, decision makers have not necessarily been sure about optimality of the suggested solutions in these methods either (Halme 1992). This problem is typically caused by shortcomings in goal analysis. The method presented in this paper integrates careful goal analysis with interactive optimization, and by doing this, tries to promote forest owner's learning process so that he can select the best plan by himself. The feedback from the forest owners indicates that there is no need for technical assistance in the stopping of interactive optimization.

The utility functions were derived directly from the qualitative goal definitions in the case study. This approach worked well. Many iterations were not needed, and the owners were satisfied with the plans.

Applying a preference analysis method such as paired comparisons could make it easier for the owner to tell his real preferences especially in the cases of many goals. This is why a method in which the defining of the goals starts with thematic interviews and continues with paired comparisons would be worth testing.

Interactive planning made the forest owners more interested in forestry, and the owners learned something new about their forests. A distinct step toward clearer forest-management goals was also noticed. When explaining these results, it is difficult to separate the roles of thematic interview and interactive optimization. However, it is obvious that neither thematic interview nor interactive optimization would have been equally good alone.

It may be that thematic interviews, like interactive planning in general, are of even better service to owners, who have more goals, or are not familiar with their forest and their forest-management goals (i.e. owners who are not economically dependent on forestry, urban owners, and members of estates of the deceased, etc.) than to those forest owners, who participated in the present study. Of course, "absolute" success with these owners could be worse than with the owners participating in this study. But this would be an incorrect way to evaluate thematic interviews and interactive planning. The correct way would be to compare their results with those of other planning approaches. This kind of a test would be an interesting topic for future work.

Thematic interviews could also be used in group planning. The stakeholders could participate separately in the interviews, and interactive optimization could then be applied as a negotiation-support tool when searching for the best solution acceptable to all the stakeholders.

Acknowledgements

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Appendix 1. The questions and the response frequencies in the formal inquiry.

	Polvijärvi	Pyhäselkä	Total
1. How accurate were your forest-management goals before planning?			
Very accurate	0	0	0
Quite accurate	7	6	13 (68 %)
Neither accurate nor inaccurate	4	1	5 (26 %)
Quite inaccurate	1	0	1 (5 %)
Very inaccurate	0	0	0
2. Did the discussion with the planning consultant (before computer-supported planning) make your goals clearer?			
Yes, it did.	10	5	15 (79 %)
No, it didn't.	2	2	4 (21 %)
3. Computer-supported planning was			
very easy	2	1	3 (16 %)
quite easy	8	4	12 (63 %)
neither easy nor difficult	2	2	4 (21 %)
quite difficult	0	0	0
very difficult	0	0	0
to understand.			
4. How did the plan produced with the computer fulfill your needs?			
Very well	3	2	5 (26 %)
Quite well	7	3	10 (53 %)
Neither well nor badly	2	2	4 (21 %)
Quite badly	0	0	0
Very badly	0	0	0
5. Did the planning stage make you more interested in forestry?			
Yes, it did.	11	6	17 (89 %)
No, it didn't.	1	1	2 (11 %)
6. Did you learn something new about forestry during the planning?			
Yes, I did.	6	6	12 (63 %)
No, I didn't.	5	1	6 (32 %)
One forest owner could not answer this question.			
7. Were there any important aspects, which you would have been willing to take into account, forgotten in the planning?			
Yes, there were.	3	0	3 (16 %)
No, there weren't.	9	7	16 (84 %)
8. Would you like to take part in planning in the same way also next time?			
Yes, I would.	10	7	17 (89 %)
No, I wouldn't.	2	0	2 (11 %)
9. How accurately do you know your forest-management goals now (after the planning stage)?			
Very accurately	2	1	3 (16 %)
Quite accurately	9	6	15 (79 %)
Neither accurately nor inaccurately	1	0	1 (5 %)
Quite inaccurately	0	0	0
Very inaccurately	0	0	0
10. Finnish forest-planning organizations should use the planning approach tested instead of the present method. Otherwise, the plans produced might not fulfill the forest owner's goals.			
I strongly agree.	3 (25 %)	This question was not asked	
I slightly agree.	4 (33 %)	in Pyhäselkä.	
I can not say.	5 (42 %)		
I slightly disagree.	0		
I strongly disagree.	0		