

A PLAY IN FOUR ACTS

OR

THE USE OF SYSTEM DYNAMICS AS A CATALYSTIN PUBLIC POLICY DISCUSSIONS

by

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Summary report

As a novice System Dynamicist one learns the textbook rules and advice of modeling. As a practising System Dynamicist one learns the shades of rules and advice. The latter ones are only occasionally spoken about and seldom written down. They exist only as vague mental models of the different roles a formal simulation model can play in a decision making process.

The purpose of this paper is to communicate the Resource Policy Group's experience in the use of system dynamics in public policy discussions. It sums up some of the group's experience through seven years of work with simulation models on the public policy level. The starting point of the article is two of the more important textbook rules.

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These two are:

- model a problem, not a system.
- model the client's problem, not your own.

Two rules which are easy to understand. And equally hard to practise, especially at the public policy level. Here you normally find diffuse difficulties, not clear-cut problems, and you don't find a client, but a number of clients composed of representatives for various interest groups. So what can one do?

With respect to the problem look for the "Common Threat." Our experience indicates that the vague feeling of difficulties often stems from a common threat. It may be a resource constraint, decreasing competitive ability etc. The threat that one looks for is characterized by affecting, or being affected by all the interest groups involved, in one way or another. Thus the problem definition must be broad enough to contain the concern of all interest groups.

With respect to the client, realize that there is no single client, but a number of interest groups with conflicting views on what is a good or bad solution to the problem. Your client, therefore, becomes a reference-group, consisting of representatives of the various interest

groups. A major concern in running a study that requires the collaboration of commonly opposed interest groups, is to avoid being seen as a spokesman for one of the groups. Thus funding by one group is impossible. An "outside" governmental research council is an ideal source.

And finally, with respect to the product, The Model, you must change your perspective on the role of the simulation model. In a public policy setting the model becomes an interactive partner in strategic discussions involving interest group representatives, rather than a result oriented crystal ball. The objective is not to achieve a consensus, but to improve the participants understanding of the likely effects of various policy options. The model becomes a core in the discussion, a challenge to the existing mental models of the problem and a catalyst through which the interest groups can communicate their conflicting views.

The whole article describes how the Resource Policy Group's SOS-Model (Society and Forest Model) was employed in strategic talks about the future of the Scandinavian forest sector. The Common Threat in that study was the limited wood resources in the area. The client was a reference group consisting of representatives of the forest

owners, company directors (owners), the employees, and the parliament. The strategic discussion is presented in a form of a play, reflecting a dialogue that took place when the SOS-Model was presented to panel members in Stockholm, Sweden.

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1. Introduction

As a novice System Dynamicist one learns all the textbook rules and advice of system dynamics modeling. As a practising System Dynamicist one learns the many shades of rules and advice. The latter ones are only occasionally spoken about and seldom written down. The experience gained from applying formal modeling technique to a diffuse ambiguous reality, often exist as vague mental models of the various roles a formal simulation model and a policy analyst can play in the public policy formation process.

The purpose of this paper is to communicate some of the Resource Policy Group's experience through seven years of work with simulation models on the public policy level. The aim is to shed a gleam of light on the problem and client definition in such a setting and to entail a new perspective on the role of the model as well as the policy analyst. It's starting point is two of the textbook rules.

2. The problem and client definition on the public policy stage

As a System Dynamicist you have learned:

- to model a problem, not a system
- to model the client's problem, not your own

Two rules which are easy to understand. And equally hard to practise.

On the public policy level you don't find a clear-cut problem. What you find is vague difficulties. On the public policy level you don't find a client. Instead you find a number of clients composed of representatives for various interest groups, each having a different type of concern about the vague difficulty. Ask them about the problem, and you will get different answers. How can one arrive at a fruitful problem definition? And who is the client?

Through our work we have discovered that the various types of concerns about a specific difficulty often can be traced back to a more long-term, aggregate common concern, or the Common Threat. It may be the exhaustion of a finite resource, the transition from rapid to modest growth, declining competitive strength etc. The answer to the problem definition is to find the aggregate common

threat, for which the different interest groups involved share a common a long-term concern, and from which the more specific concerns can be derived.

With respect to the client, realize that there is no single client, but a number of interest groups with conflicting views on what is a good or bad solution. Your client, therefore, becomes a Reference-Group, consisting of representatives of the various interest groups. The group should cover all the major views on the problem or at least the major competing views to keep the discussion honest. Ideally, the members should be reflective and outspoken and drawn from individuals of stature with long experience from practical life.

Our experience is that working with a reference group is quite different from working with a client. The conflicting views and perspectives of the members makes it less meaningful to aim for a solution. There is more of a problem-stating than a problem-solving character. The task is more to discuss possible strategies than to come up with a recommended strategy.

In our view this also changes the role of the model. The Model now becomes an interactive partner in a

strategic discussion involving the interest group representatives. And is viewed more as a tool to facilitate a public policy discussion and to increase understanding than as a final product in its own respect. In such a discussion the model becomes the core, the challenge to the existing mental models of the problem and a catalyst through which the members of the reference-group can communicate their conflicting views. The following pages exemplify this role and use of a formal simulation model.

3. The use of a system dynamics model as a catalyst in public policy discussions

The following illustrates how The Resource Policy Group has used a system dynamics model in strategic talks. The aim was to increase knowledge and enhance understanding of the problems facing the Scandinavian forest sector during its forthcoming transition from rapid to modest growth. The illustration is in the form of a play, (1) and is based on a dialogue that took place when the model was presented to panel members at a symposium in Stockholm, Sweden. The Common Threat in this case was identified as the limited wood resources in Scandinavia. The reason being

(1) The play is drawn from an article by Jan-E. Nilsson and C. Tank-Nielsen: "The transition from ample to scarce wood resources." - A Play in four acts.

that the annual cut in the area is verging on what is sustainable and the forest sector will soon have to make the transition from rapid to slow industrial growth. The client was identified as a Reference-Group composed of representatives for the forest owners, the company directors the employes ombudsman and a member of the parliament.

The transition implies a threat to the forest owners since it will increase the pressure for an excessive overcut. The forest product industry will be threatened because a slower rate of growth will mean that the production costs will be higher than those of its competitors with access to an ample supply of wood. Employment will be threatened since modest growth will accelerate the reduction in job opportunities. Rural communities will be threatened because a slow rate of growth encourages the centralization of production. And the community at large will be threatened, since measures to conserve energy, reduce pollution and improve working conditions are more difficult and more costly during periods of "decline."

The play, which is in four acts, is based on future situations as simulated by the model. Each act or simulation represents a given transition strategy:

- Act one : Development determined by free market forces.
- Act two : Government price control.
- Act three: Regulated industrial expansion.
- Act four : Active industrial collaboration.

The role of the policy analyst is not to intervene in the dialogue but merely to outline the content of the simulated future situations.

The scene being set, let the play begin!

3.1 Act one: Development determined by free market forces

The curtain rises with the panel faced with the transition path that has been generated by the model, subject to the proviso that activities in the forestry sector will be of a consistent nature. The simulated future situation reflects the outcome of development determined by free market forces, with the nature of the transition determined by prices and economic resources.

Policy analyst:

The consequence will be a period of transition during which industrial capacity will expand rapidly until 1990 (as we can see from figure 1). During this time, production capacity will rise above the level of the sustain-

able yield, as a result of which a prolonged period of decline will be inevitable. Excessive growth or overexpansion is a consequence of short-term thinking. Profitability is good, the wood prices reasonable and the market buoyant, indeed, the future is bright. But the expansion leads to rising wood prices, which in turn reduce the profitability since the production capacity is now higher than the sustainable yield from the forests. Industrial decline is therefore an unavoidable reality.

Increasing unemployment is the most readily apparent consequence of the industrial decline. While the industry was expanding, the growth was able, to a certain extent, to counteract the reduction in employment brought about by increased productivity.

The subsequent decrease in production capacity will merely serve to accelerate unemployment.

The sharp decline in the industry manifests itself in that a large number of mills are forced to close down, thereby aggravating regional problems.

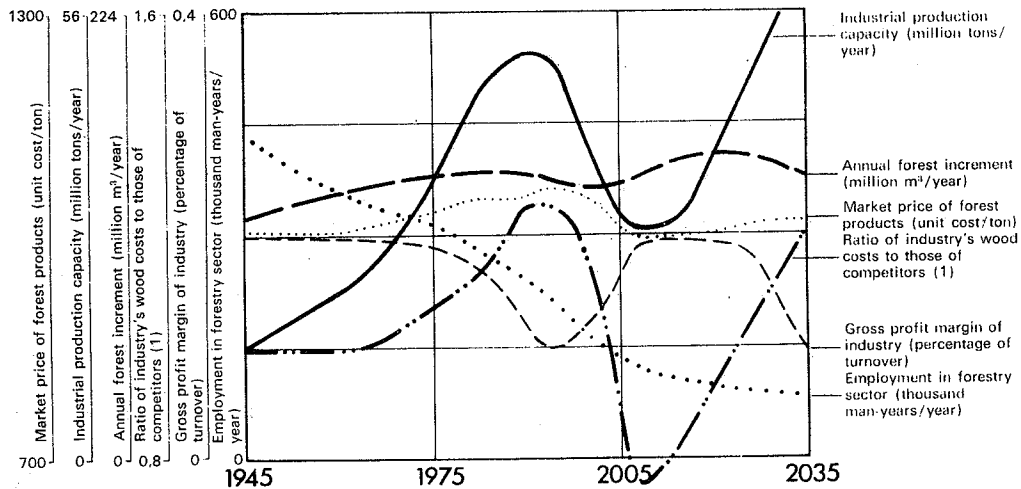


Figure 1 Development determined by free market forces

Member of parliament:

In the interest of the community we have three main objectives in the forestry sector, namely, we want to maintain:

- a) an international competitive forest products industry,
- b) sustained-yield forestry, and
- c) employment and regional balance.

During the period when the supply of raw materials made the continued expansion of industrial capacity possible, there was really no conflict between the three objectives. But, as we can see from the scenario before us,

these conflicts are now accentuated. Consequently, those of us who are concerned about all of the aspects of the problem are confronted with a further constraint on measures that we can take.

Company director:

The scenario presents us with a picture of the future that, from our point of view, is as undesirable as it is unexpected. A sharp decline in industrial capacity creates considerable problems for our competitiveness as well as for employment. This decline is therefore totally unacceptable.

If we compare the conditions in the Scandinavian forest products industry with those of our competitors abroad, the problem becomes as clear as daylight. We find that the production technology is identical, as are the products and, with one important exception, the nature of costs as well. It is in this exception that the problem lies - the cost of raw materials. For the Scandinavian industry to be able to defend its position on the world market, the raw material costs must be kept under control and on the same level as those of our competitors. Clearly then, we must regulate the raw material costs as a matter

of necessity. If this were followed by a decrease in logging costs, it shouldn't create any serious difficulties for forest owners.

Forest owner:

You know, there is a complex relationship between the price of wood and the supply. To adjust the price of wood is therefore to over-simplify the problem. What we should be concentrating on is the creation of a properly functioning market. The invisible hand of the market in itself is an assurance of an efficient allocation of the resources.

Ombudsman:

But this invisible hand is not only an instrument for allocating resources. It is also a means of redistributing wealth. We can never accept as reasonable a situation in which the forest owners just grow richer on the profits of their monopoly, while, at the same time, the forest products industry is being forced to close down more and more mills, and often in places where the mill provides all the jobs in the area. If it's a choice between increasing unemployment among the workers in the industry or the

rapid accumulation of additional wealth on the part of the forest owners, it is obvious where our priorities lie. The present pricing mechanism must be abolished and wood prices controlled. After all, this is the cause of the problems facing the industry.

Forest owner:

To claim that the forest owners are growing rich at the cost of the workers suggests to me that there is a misunderstanding in respect of the way in which the pricing mechanism actually works. The question of the distribution of wealth must be dealt with separately, for example through taxation. In this context it is of little interest into whose pockets the money actually falls.

The price merely provides an indicator on which the various parties can base their respective courses of action. A rise in the price of wood reflects that the volume of the annual cut is broaching on the volume increment of the forests. In this way a curb is put on a trend which conflicts with the policy of sustained-yield forestry. If we allow the price to be fixed by bureaucratic decree at a low level, we throw the road open to an unrestrained and ruthless exploitation of our forest resources. And neither

case does anything for employment since rise in unemployment is the result of advancements in technology and has nothing to do with the price of wood.

Ombudsman:

It must be a very strange sort of technology if it only makes the forest owners richer.

Member of parliament:

I think the whole thing is a question of balance. On one side we have the forestry interests and, on the other, we have to consider the question of employment in the industry and the areas in which the effects are being felt. In view of the current situation, a ceiling on the price of wood is a conceivable solution to the problem. However, it must be sufficiently high for the forest owners yet, at the same time, must serve to increase the competitiveness of the Scandinavian forest products industry. But it must be said that a government price control would not necessarily be a definitive solution, we must therefore reserve the right to adopt any additional measures that may be required to supplement this policy in the future.

3.2 Act two: Government price control

Following on from the dialogue of Act one, this simulation concerns government price controls. Basically, the policy ensures that the net operating surplus of forest owners is not permitted to exceed 50% of the wood price. The model is changed and a few minutes later the new transition path appears, with an appearance that is illustrated in figure 2.

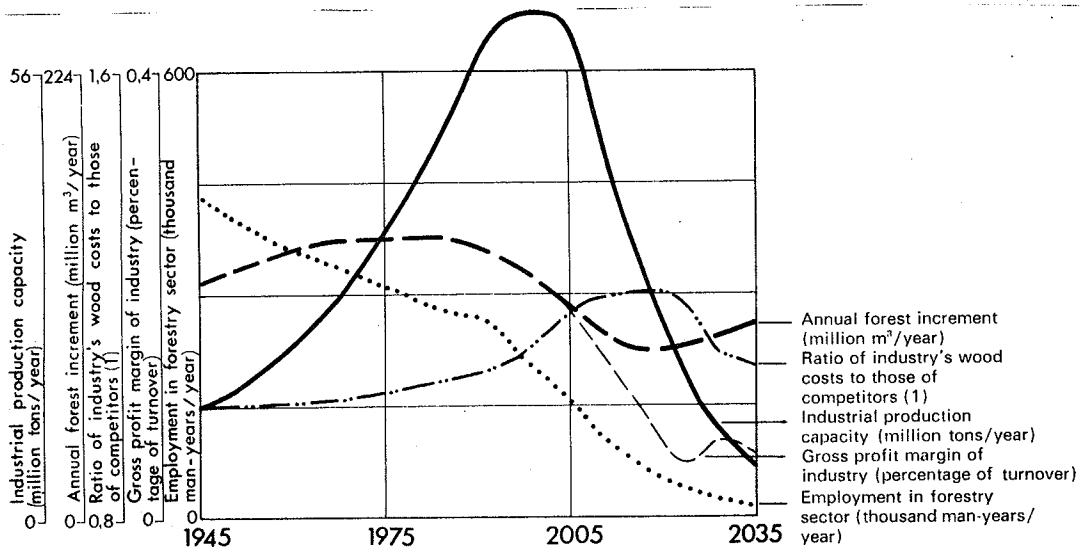


Figure 2 Government price control

Policy analyst:

The simulation shows that the decline in the industry is still a reality. Admittedly, it now occurs at a later date, but the decline is generally stronger and persists for a longer period.

With the lower cost of wood afforded by the pricing policy, the forest products industry is able to maintain profitability for a longer period than would otherwise have been the case. Thus, the situation allows the industry to continue to grow above the previous level. The inevitable result of this is an excessive overcut. Forest increment is drastically reduced and there is a conspicuous physical shortage of wood. In spite of the favourable economic situation, several mills must therefore be closed down.

Notwithstanding the limit imposed on the net operating surplus, the price of wood rises somewhat. This is explained by the fact that the intensive exploitation of the forests has made it more expensive to extract the wood, the standing crop is less dense in the stand, transport distances have increased, etc. The cost of wood, which in the control or reference development shown in figure 1 fell rapidly in conjunction with the decline in the industry, now falls at a much slower rate, as is apparent in figure 2. This contributes to prolonging the crises facing the industry. The reason that the response to fluctuation in demand is slow in coming is that in this case the shortage is due to physical reasons. Thus, the change in the price of wood at this stage is determined by the

regeneration of the forest, which can only occur after considerable time. Only when the forest has become reestablished will the cost of wood have reached its original level.

Forest owner:

Clearly the scene shows that the imposition of government restraints on forestry may be compared to crossing the stream to fetch water. The problem does not lie in forestry itself but stems from the expansion in industrial capacity. The natural thing to do would therefore be to control this expansion. A policy restricting the creation of additional capacity might be one way of achieving this.

Ombudsman:

Even the unions wouldn't wish to see a future like the one described in this scene. We want to prevent powerful fluctuations. It seems obvious, then, that steps must also be taken to control the increase in production capacity.

But at the same time we have to remember that

unilateral restraints on growth involve the risk of accelerating structural changes. So we must be certain that such changes will not manifest themselves in unemployment. To this end the forest products industry must start thinking along different lines. Further conversion is a precondition for employment levels being maintained.

Company director:

I must admit that government price controls do not seem such a good idea as I had reason to believe earlier. This is especially true in the light of the long-term consequences. Nonetheless, this does not mean that the regulation of industrial expansion is a better solution.

The consequences of regulating expansion in this way will be that the forest are preserved at the cost of the industry becoming outdated. Obviously we are aware of the advantages in terms of production technology that are inherent in the construction of new mills. But by imposing constraints on the capacity of the industry, we prolong the life of the present production lines. Thus, in time the mills will become steadily outmoded and the Scandinavian industry will gradually lose its competitiveness.

Member of parliament:

The scene underlines the necessity of finding over-all solutions that take into account both the present situation and that of the future. A policy of government price controls obviously only serves the short-term interest. In the longer term, such measures lead to a worsening of the situation for all concerned. The solution is also unacceptable for the community at large, since we will lose a considerable amount of our forest land, which not only serves as an economically important source of raw materials but also provides opportunities for recreation. At best this policy could only be used as a temporary solution and only on the condition that it were possible between now and the time when the industrial decline sets in to drastically improve the forest increment. One possibility would be to make use of fast-growing tree species and to intensify silvicultural activities. But I remain doubtful about the potential effectiveness of these measures. If industrial capacity should grow faster than the forests, this alternative would be almost utopian.

Our point of departure must be to curb excessive increase in industrial expansion. We have to accept the fact that the forestry sector is faced with a biological

limit in addition to the economic and marketing limits. Future growth must therefore be at a lower level than that to which the industry has been accustomed in the past. A realistic alternative would therefore be to regulate expansion in production capacity by imposing limits on the establishment of new plant-starting now. The industry itself should welcome such a measure since this will avert a sharp decline at around the turn of the century.

3.3 Act three: Regulated industrial expansion

Regulated industrial expansion is imposed through limits on the establishment of new plant, and a new transition path is generated (figure 3).

Policy analyst:

The process of decline changes drastically. Instead of considerable over-expansion, followed by an equally marked decline, the industry goes through a much steadier phase of development. What happens is that growth in the industry is arrested at the end of the 1970's in conjunction with the demand for wood attaining the same level as the potential supply. A consequence of this is that the price of wood does not go up. Thus, profitability in the industry can be maintained, which implies that there is

still a powerful stimulus to expand. Since the regulatory mechanism is not perfect, a certain amount of excessive growth does take place. This over-expansion then causes a sharpening of the controls, whereupon the industry's expansion plans are cut back to such an extent that the establishment of new capacity is not as great as the capacity lost through closures. In this way, the industry is steered into a situation of moderate decline.

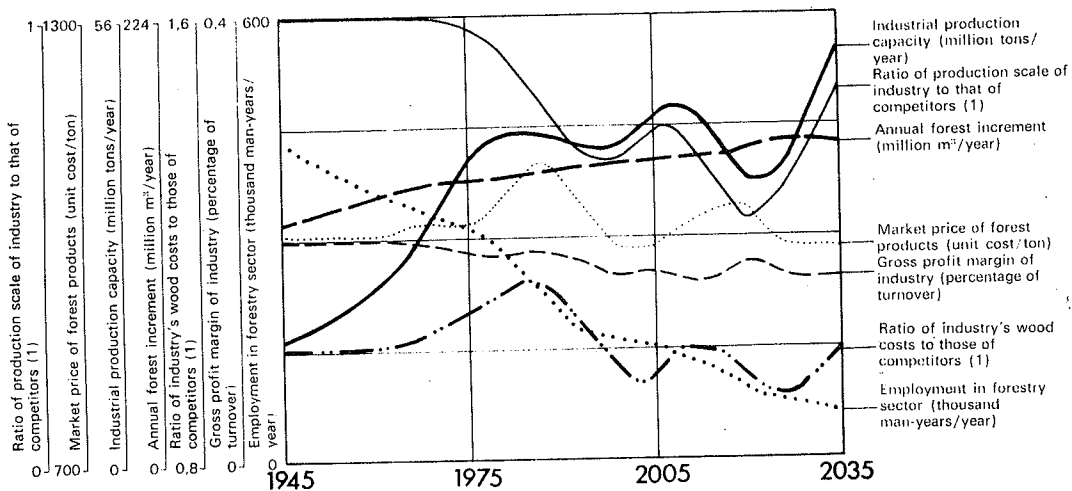


Figure 3 Regulated industrial expansion

Once industrial capacity has fallen to a level that is acceptably below the prescribed ceiling, the demands for regulation are relaxed and the industry enters a new period of growth. However, this is only of short duration and the industry once again enters a period of stagnation. The

reason for this is that the capacity increases that foreign competitors decided were necessary during the earlier period of decline in Scandinavia's production capacity are now coming on line. As a result, world market prices are kept down. Profitability in the Scandinavian forest products industry falls and the economic base that was decisive for new growth disappears. Instead, the industry faces a further period of decline, although on this occasion it can be attributed to economic factors.

Forest owner:

Now we are getting close to a form of development that is acceptable. Admittedly many may hold the view that wood prices are rising too sharply but what we must remember is that this makes it possible for high prices to be charged on the European wood products market.

Company director:

I wish it were true that a high cost of wood enabled us to charge higher prices on the market - if so our troubles would be over. The limited supply of raw materials would then influence neither profitability in the industry nor employment. Only the forest owners would make

greater profits.

Member of parliament:

If we compare our experience of government price controls and of a policy of restricted expansion, then the latter policy is clearly the most advantageous. Whereas the policy of price control has considerable drawbacks for all concerned, a policy of regulated industrial expansion spreads the disadvantages relatively evenly.

Company director:

What we are dealing with is a high export-oriented industry operating in an atmosphere of stiff international competition. The unfavourable development in the price of wood is therefore a central issue. The forest products industry will end up in an impossible situation. The forest owners must make a concerted effort to reduce their costs instead of extracting the maximum benefit from their monopoly of the market.

Forest owner:

I think it would be much nearer to the truth if we

were to talk about a seller's market rather than a monopoly.

Company director:

Another serious effect of imposing constraints on industrial expansion - which the simulation only gives an indirect hint of - is that the structure of the industry will become obsolete and the other variable costs (apart from the cost of wood) will also increase in consequence.

Member of parliament:

Unfortunately it is true that this policy will exacerbate the problems associated with the structure of the industry. But the problem is not confined to the fact that old mills are being closed down. The lower level of profitability also limits the prospects of the industry investing in further conversion.

Ombudsman:

We have already established that a policy that restricts industrial expansion inevitably gives rise to serious problems in respect of the structure of the industry. And experience just lends weight to our view.

There will be a rapid rise in unemployment.

Company director:

It might be possible to offset the negative effects on costs if the companies were to collaborate in new investments. In that way, we could create modern production facilities and a development that would not be far from the optimum.

Ombudsman:

Optimum, maybe, but not for us. I guarantee that a merger between some of the major industrial companies would cause the unemployment curve to shoot off the top of the chart.

3.4 Act four: Active industrial collaboration

By means of simple modification of the model parameters, the pattern of investment in the industry is changed. Through collaboration with each other the companies construct a limited number of optimum production units instead of a large number of smaller ones. Thus, in spite of the shortage of wood, the industry is much better equipped to maintain its international competitiveness.

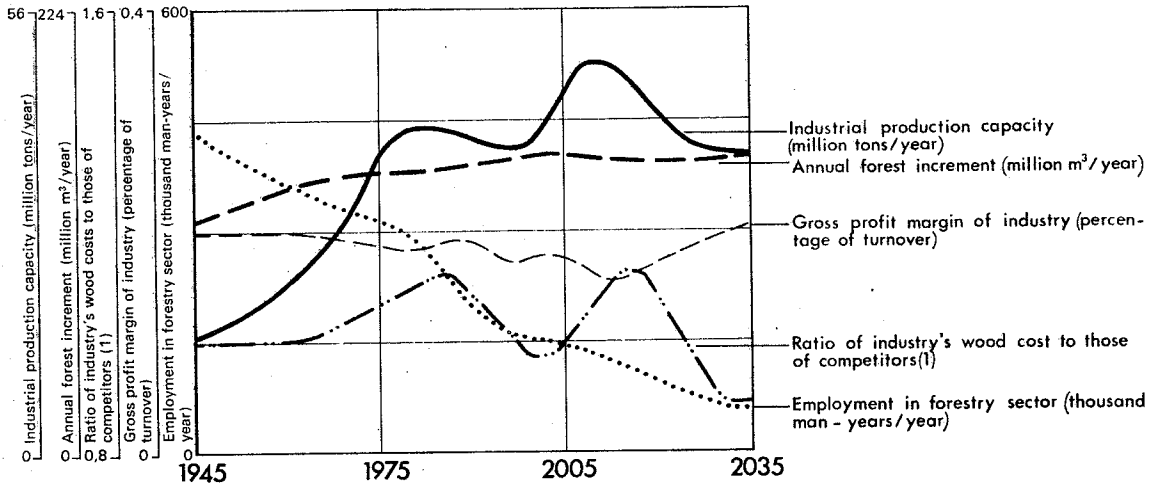


Figure 4 Active industrial collaboration
(and regulated expansion)

Policy analyst:

If we focus our interest on the gross profit margin of the industry, we find in figure 4 that this improves. Thanks to the collaboration between the companies the industry is able to construct optimum production units as expected, in spite of the policy of regulating industrial expansion. Productivity rises faster and, in consequence of the controlled expansion,, this tends to sharpen the increase in unemployment. The improvement in profitability enhances the ability of the industry to grow, which tends to increase the volume of the overcut in the forest. However, this is not of such magnitude that it constitutes a

threat to the policy of sustained-yield forestry during the period in question.

Company director:

I am surprised by the fact that the effect of active collaboration in the industry is to widen the gap between production capacity and forest increment. Nonetheless, the gap never becomes so wide that it poses a threat to sustained-yield forestry. From the profitability curve it is apparent that the forest products industry manages to tolerably to maintain its international competitiveness.

So the indications are that this is the gospel to be preached. Of course, there are practical difficulties but these should not prove insurmountable.

Forest owner:

The simulation also demonstrates quite clearly that the question of employment cannot be solved by the forest sector: the solution is to be found in other branches of industry.

Member of parliament:

You know, to claim that we must look outside the forest sector in order to solve the employment problem is analogous to throwing out the baby with the bath water. I am convinced that the solution to the problem is essentially a matter of increasing the degree of conversion. We must find more sophisticated ways to convert the valuable raw materials provided by the forest.

Ombudsman:

Of the three objectives mentioned by the member of parliament by way of introduction, it is certainly difficult, given that there is a limited supply of raw materials, to realize all of these aims. Apparently, the task of maintaining employment levels is going to be difficult to achieve. But if the companies feel any responsibility towards the community, the forest products industry must endeavour, to a much greater extent than before, to diversify away from the traditional forestry sector. It is obvious that if employment levels are to be maintained, there must be continued growth in production.

Yet I fear that we cannot rely on the social responsibility of the companies. The government and parliament must seriously attack the problem and take measures to safeguard the jobs of the workers.

3.5 Epilogue:

Now, as the curtain falls and the play is over, it is time for you, as a qualified spectator, to write the review. Let me close with some comments on the role of the model. The role has, in my mind, been changed from a tool that produces solutions to a tool to improve discussion and understanding. The model seeks to create an educational process for those involved rather than to reach strong, unambiguous conclusions. Increased understanding is achieved by a structured and repetitious confrontation between the mental models of the participants and the formal simulation model.

It is important to note that the simulation model need not be "good" in order to generate this type of discussion. The model may at the outset be very rough and imperfect. It helps to attract attention to the problem not because it is perfect, but because it exists. It helps initiate a discussion not because it is statistically sound, but because its accompanying and well founded explanation

of the different transition paths becomes a challenge to existing models. In short, the traditional requirements of a formal model, becomes less important.

Three conditions, however, must be satisfied if a model is to serve the purpose outlined above. First, the model must be made up of concepts that have a base in reality. These concepts must then be intergrated in a structure that is straight-forward enough to enable users, on the basis of the simulation results, to understand the mechanisms in the model system that create the results. Understanding is not gained from the results but through light thrown on the underlying mechanisms. Secondly, the model must be constructed so that it can be modified easily and quickly to enable new results to be obtained. Thirdly, the use of the model should not involve any great costs.

The model employed here requires only five minutes work and three dollars of computer time to modify a given strategy and generate the results of the new strategy. A system dynamics model easily meets these conditions. Few other types of models do.

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