

"Life Cycle Assessment Studies in the Timber Industry"

"Pros and Cons"

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FOREST INDUSTRY LECTURE NO. 35

THE FOREST INDUSTRY LECTURERS

The forest industry in western Canada cooperates with Alberta Environmental Protection to provide funds to enrich the Renewable Resources program at the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta through sponsorship of noteworthy speakers.

The Forest Industry Lecture Series was started during the 1976-77 term as a seminar course. The late Desmond I. Crossley and Maxwell T. MacLaggan presented the first series of lecturers. The contribution of these two noted Canadian foresters is greatly appreciated.

Subsequent speakers in the series have visited for periods of up to a week, with all visits highlighted by a major public address. Visitors have come from throughout North America, Europe, Africa and Asia. Their talks have dealt with a wide range of topics, such as forest ecology, forest science, silviculture, wildlife, forest management, ecosystem management, industry, services and trade, economics and social issues. Speakers have been drawn from among scientists, industry and business leaders, senior government officials, academics and forestry alumni. A full list of these electric topics and speakers is included at the end. Copies of most of their papers are available on request.

This paper contains Arno Fruhwald's major public address given on 2 November 1995.

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Dr. Beck:

I will put on the mike so that I don't have to shout too much, although I don't usually need a mike, since Paul has given me the thumbs up from the back to go Resources Department; that is the Department most Forestry students can consider their home department in there. This series started in 1976 with a series of lectures by two imminent gentlemen and then this continued every year since in there, so that is why it is the 35th. Some years we have had two speakers, sometimes we have had one. And it is continued due to the generosity of many donors and for this year I would like to recognize several of the donors in alphabetical order in here: Ainsworth Lumber Company Limited, the Alberta Forest Products Association, the Alberta Newsprint Company Limited, Alberta Pacific Forest Industries Limited, the Alberta Registered Foresters Association, Beck Consulting, Canadian Forest Products Limited, Canadian Forest Service, the Canadian Institute of Forestry (Rocky Mountain Section), Daishowa-Marubeni International Limited, the Forestry Corporation, Alberta Environmental Protection, the Alberta Professional Alumni Foresters' Association, Pearson Timberline, Silvacom Limited, Simon-Reid Collins Limited, Tall Timber Forestry Services Company Limited, Weldwood of Canada Limited, Weyerhaeuser Canada Limited (Alberta Division), Weyerhaeuser Canada Limited (Saskatchewan Division). I think I would like to ask all of you and help me in thanking those donors.

We don't usually recognize special guests at this particular time, we do that at a later time, but there is one guest in the audience today that I would like to recognize for the first time in 35 Forest Industry Lectures, we have the Chancellor of the University here, Dr. Lou Hyndman, who is our

Chancellor here.

And I want to go back to my theme that I was talking about in here about the donations; these extras that we get for something like this over and above what we can do certainly compliments and enrich the educational experience here of our students and they make the educational offerings just that much better. This continued support is greatly appreciated, especially during the times of fiscal constraints at both the government and university levels in here. I know the students and staff appreciate the support and on their behalf I thank you very much again. And then without any further adhue, because you didn't come here to listen to me today, I would like to ask Marty Luckert to come up here and introduce the speaker for today.

Marty Luckert:

Thanks Jim.

It is my pleasure to introduce Dr. Arno Fruhwald - if my German serves me correctly, I seem to recall that Fruhwald literally means early and forest. And from Dr. Fruhwald's history, we will see that he definitely has quite an early and long standing tradition in the forest. His family comes from the area of southern Germany and Bavaria and has a history of more than 200 years in the timber business. Before attending college or university, Dr. Fruhwald was a cabinet maker, he worked in the timber and sawmilling industry and then he went to university to study a mechanical and timber engineering at a B.Sc. level before going on to receiving a diploma in wood technology and economics. He kept on going in University and received a Ph.D. from Hamburg University at the age of 29 and following graduation with his doctorate he went on to work for the Federal

Research Centre of Forestry and Forest Products where he has worked for four different years. He came back to the University in 1977 as a Professor of Wood Technology and since then his areas of scientific work have included timber processing, energy conservation, and most recently life cycle assessment studies. In addition to his University expertise, he has provided advise to the Federal Ministry of Forestry in Germany and he has worked in many countries throughout the world - some 30 different countries and has helped to set up different academic programs in Latin America, Africa and Southeast Asia. On the more personal side, he has a family and enjoys traveling abroad and riding motorcycles. With that type of diverse background, I am quite certain that he will bring to us quite a breath of knowledge in addressing his topic, so please join me in welcoming Dr. Arno Fruhwald.

Dr. Fruhwald.

Thank you Luke, for the very nice words of introduction. Of course, ladies and gentlemen, we shouldn't be here today because it is so nice day, nice clear weather, and I am sure that you and I would enjoy walking and discover Edmonton. But that is not the job I am here so I of course enjoy to welcome you all to this lecture. You shouldn't have said that I am riding motorcycles, because this is the opposite of the environmental protection and environmental issues of course. And whenever I go to a meeting, for example, in the southern part of Germany and the muni hits about 800 Kilometers, I take a plane of course. But I never should say this, because when you attend a meeting talking about environment you shouldn't take a airplane, you should ride a bicycle or should walk.

Okay you have heard that I am a wood technologist and not a forester. I tried to study forestry in Germany, but we have so many foresters in Germany that we could send thousands

and thousands to Canada, for example. We train 600 professional foresters in Germany, and 15 of them get a job in the forestry sector. So when I learned that about 25 years ago I decided to go into the timber business, or in wood technology and I am really happy. Now I am backed maybe about 50% forestry, because also I am not a forester; I deal quite a lot with forestry because environmental issues on timber and forest industry are very closely connected to the forestry sector. And we are dealing with, - we, when I say we, I mean the wood technologists in Germany, dealing with forestry, because the German foresters are somewhat reluctant to environmental issues. You will see, or some of you may know that forestry has a very long tradition in Germany - hundreds of years, even maybe 600 - 700 years ago we had a sustainable management of forests because of a shortage of timber of course, not because of the deep inside environmental issues at that time. And since then foresters in Germany believe that they are the best guys in the world, because they have invented sustainable management of resources, so they never took part in the discussion about environmental issues and as I am going to explain to you later, the result of such a behavior is that the forest sector in Germany and in the whole of Europe is very much under pressure. Maybe under bigger pressure than the Canadian Forest sector is.

Okay, you know of course, that the title of the lecture and I give today and I have to excuse about my English. As you heard I started my career as a furniture maker and I left school at the age of 13 1 /2 and I never learned English in school and I took my English from the road and so excuse me when it is not really good Canadian English.

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What I am going to explain to you this afternoon.

First, I would like to demonstrate or to tell you what the problem is with slash/cycle assessment studies; why are we talking about those things and why does environmental concern of the public affect the forestry sector; of course, most of you know, because you are living with the forestry sector which is under pressure, but why should it affect the forest industry sector. And of course then, I will try to show you a way out of the problem - a way out of the pressure. And this way I am going to explain today is the approach of life cycle assessment studies which is a very common approach at the moment. I am going to attend an LCA-ISO meeting next week in Vancouver and international is in its very factual and very high level, so we have had six meetings during the last 18 months all over the world spending a lot of money matchmg a lot of miles with the airplanes talking about the environment and and then I will try to conclude with some statements that we should bring the environmental advantages of timber utilization to the marketplace. What are the people's concern or the environmental concern in the past 30 years. I have put here some of the really big events during the 1970's; you all know that we had the oil crisis the first in the 1973 and the second in 1977 which affects especially the European countries quite a lot. I remember when I stopped with my car in the middle of Germany I

couldn't move on to Hamburg from my home town and I had to wait for three days to get fuel at that time in 1977. At that time the concern about non-renewable resources started in Europe. In the 1980's we had some really big incidence - the Severus incident you will remember the first big thing with dioxins then later we had opal - we had a very tough formally high discussion in Europe which has affected - at that time - the timber industry quite heavily, especially the board industry, so we brought in laws as early as 1981. And we had the intercloth and oil discussion in Germany and some other countries in Europe and later on the Lindawn discussion. So people became aware that some materials, especially for example, formaldehyde, PCP, all in dawn could be toxic to human and toxic to the environment. And starting maybe in the middle of 1980's, but today during the 1990's it is a very high level discussion. The global warming discussion – I remember it in the Summit in Rio. And I am going to explain to you a little bit about the European perspective of this environmental concern. In Germany and in some European countries later on we had a very big event it was that forest decline due to environmental pollution. And this has affected the forest sector quite tremendously. Maybe you have never heard of this "Forest Health Problem" so we discovered around 1975/76 that some trees, especially fir trees got defoliated and had a loss of needles. And foresters for quite a couple of years said that is normal drought according to weather, according to drought, according to cold winters and so historically, fir is declining since about one thousand years and later on the German government and Minister of Forestry took over the problem and so some kind of inventory was made according to the defoliation stages and when a tree was defoliated by 10% it was still called healthy, or the defoliation class zero and defoliation between 10-25% was slightly affected, 25-50% was moderately affected and more than 50% was heavily affected, and of course if there are no needles or leaves left then the trees are dead. And just round figures

for the German forest, but very similar figures you could find in Sweden and the Netherlands, in Poland and even more than that in Czechoslovakia. So you will see that only 50% of the softwoods and only 40% of the hardwoods are considered as still healthy trees. And 10% of the softwoods and 15% of the hardwoods are considered heavily affected. I didn't give any number for the dead trees because the foresters always cleared the dead trees so there are no figures for the Class IV of course. But in some years, they only cut only the dead trees and fulfilled the annual cut. So you can imagine that both artists, the public and the forest sectors were very heavily concerned. The public, of course, they wanted to have healthy forests to enjoy the forests on a Sunday afternoon and the foresters wanted to have healthy forests too because it is their income to sell and to produce timber and along with defoliation and along with declining health, the foresters discovered a lower yearly increment by 10%, by 20% and some stands even by 50%. And what the foresters did they asked for financial compensation, so they made a big case out of it. And they asked the government, they asked the industry for financial compensation of the reduced annual growth. By the way today, we know that the annual growth is even increased because of the fertilization especially with nitrogen from the traffic. So at that time, it was 10-15 years ago, the forest sector in Germany it really was a very, very big discussion, and so everybody was aware of the problem of declining forests. Of course, there was no financial compensation at all until now, but now the public was aware of a forestry problem and of course, you know that especially the Germans are very accurate in what they do, they do it very accurate and so they discussed about the forests but not only about the German forest, so they discovered

also a health problem in all the forests all over the world, especially in the tropics. And so this was the time really that discussion about tropical timber, clearcutting or utilization of tropical forests started on a very high level. So the consequences of this development - one side from the German forest problem, on the other side, the concern on global warming, on renewable resources has led to really a couple of big problems to the German forestry sector, but also to the German forestry industry sector concerning tropical timber. Quite a number of communities and state governments banned the use of tropical timber in public building. This had led, for example, to reduced share of tropical timber in the window industry from close to 40% of all of the windows have been made from tropical timber down to much less than 20% today and many of the do-it-yourself markets in Germany which sell more than 50% of the semi-finished timber products in Germany or in Europe, they banned tropical timbers. Whenever Robinwood or GreenPeace demonstrated in front of the do-it-yourself market the management decided "no more tropical timber products in our market" and you will find in more than 2/3 of all the do-it-yourself markets in Germany, you will hardly find any trace of tropical timber. And of course later on, the discussions or the especially the NGO's blamed as you all know, the cutting practices not only in Canada, especially in B.C., not so much in Alberta, I guess most of the members or activists from the NGO's spent most of their holidays mainly in B.C. and not in Alberta, but I learned this year that Alberta is even nicer than B.C. - I spent a couple of weeks traveling together with my wife in B.C. and in Alberta only a couple of days. So therefore, I came back yesterday and will back in the early spring.

So we still have the discussion about cutting practices in Canada, and in Sweden which is a European country, the biggest fibre supply in Europe and some others. The consequence, for example is in the paper industry, paper consumers require what they call environmental declaration. I will come back to that later.

So to show you the effect this development has had on the German forest products market, which is not very typical for you - they are other countries like France, Netherlands, the U.K. that do not worry about these problems. So for example, during the 1960's and the 1990's today; so to give you a rough idea - the forest area has been 7M hectares in Germany and in the 1990's, now we have 7.1M - it is only the old provinces or the old states, not the former GDR. The annual cut has been for a long, long time around 30M cubic metres per year -- you will see that this is about 4.5 cubic meters per year in hectare and hectare line you will see to 22M cubic hectares. Now this is constant since a couple of years and the management plans for the forestry departments they even consider less than 22. The imports in their own good equivalence, of course, have been increased from between 30-40, to today 50-60 mainly in the form of paper products and semi-finished and finished products. And you will see from the 30-40 about 10% has been tropical timber, before it fell to degrees less than 1M cubic metre. And the paper recycling rate also due to environmental concern has grown from around 25% today to 57%, and the target for the year 2000 is 65% waste paper recycling. And, of course, this has affected especially the small size diameter timber market from Simons, for example. The estimate is that during the 1960's and the years before we didn't cut between 8 and 10M cubic meters a year which has been grown but we didn't use it. And the stocking volume in the forest has grown up during the last 40 years since WWII - we now have more than 300M cubic meters per hectare logs in a diameter of bigger than 7 centimetre including bark. And due to the reduced annual cut we do not use about 50M cubic meters of the especially the small sized timber at the moment. Of course this will have the effect that the stocking volume will grow and grow, but of course it is quite clear that you can't have a high stocking volume under German or European conditions of more than 350 or 400 cubic meters per year. So this would mean that we will get some time

maybe in 10-15-20 years time some kind of - not a primary forest, but an unmanaged secondary forest. Of course, this is very important for the economic situation of the forest sector. So all of the forest sector in Germany and many parts of Europe has no profit anymore, and so the government has to cover the losses. Just recently there was and is still going on a discussion in Germany regarding a National Park founded 25 years ago in the southeastern part of Bavaria, and it is due to the fact that the forest department is making losses higher than the cost for the national park, management per hectare, the Minister for the Forest of Bavaria is considering to transfer a substantial part of the forest into a National Park because of lower costs.

Okay when people thought we should use that amount of wood anymore to reduce clearcutting, to reduce heavy harvesting, or to grow up the stocking volume in the forest people will require, of course products. And so change in the materials could be observed, for example a substitution of tropical timber and for railway ties or railway sleepers, you could produce railway sleepers, of course, of native species, for example, of beechwood which is not very durable and then you have to impregnate it with creosote, for example. Or as it has happened in Germany, the tropical timber sleepers and the beech sleepers were replaced by reinforced concrete by 100%; there is no single wooden railway tie in production in Germany anymore. Or, as I said before, you can replace tropical timbers for windows, for example, by pine - we have a quite lot of pine in Europe but due to the low durability you have to treat it with preservatives, like PCP or lindane. Or you replace the wood window frames by PVC and in Germany now the share of PVC is close to 60% or it is aluminum. So what. The customers were buying PVC windows instead of buying tropical timber window frames they think, of course, that they are doing something positive for the tropical forest so they rescue some kind rescue for the tropical forest. So this shows clearly one of the key problems for the forest industry sector in the environmental

discussion. So there is a view only on areas which are likely to have a negative environmental impact. As I said formally high problem and people stop buying polyboards because of the formally high polyboards, they stop buying treated window frames from pine because of the treatment and they are buying PVC, or they stopped buying wooden railway ties and they replaced it by reinforced concrete. So there was only one aspect, in most cases, and because of that aspect there was a change of materials or a move out of timber by 100% and nobody, not the government not the single final customer consider other aspects whether they are negative but not as big as the one or whether they are positive, of course they are also positive aspects if you look at the whole life cycle of the product starting from, what we say, the cradle and growing, up to the grave. So one of the solution out of this dilemma is considered to repair life cycle assessment studies, to look into the whole life cycle of a product, whether it is a very simple product, like a building element, or it is a more sophisticated product like a piece of high priced furniture where you not only do you have wood or timber, but you have also plastics, glues, metals and other things. And in such a life cycle assessment study all effects on the environment, whether they are positive or negative should be considered and then weighted, the positive ones and the negative ones.

And, some people say, a new scientific area was born. And still when I discuss with especially the industry I am very often asked, who is the one who discovered this method of life cycle assessment. Some people, especially in Germany think, that the government we have a very active and very strong environmental office in Germany, of course you have in Canada, the same authorities and they handled really life cycle assessment during the last six -seven years. They have prepared some studies or they have asked consultants to do the studies, for example, on "soft drink packaging" comparing aluminum tins, paper bags or glass bottles; or on milk packaging, paper products, plastics, polyethylene and glass. Of course, in some cases, also especially the

competitors of the wood sector played this game during the last years. I will give some examples later. Of course, the industry thinks always the scientific community has created or has discovered this area because they are asking for a lot of money today to develop the methodology, as I said we have had six meetings all over the world during the last 18 months. It may happen also that also the final customers interested to get more information about positive or negative effects. So my guess is that the industry and the final customers they played the most important and strong role. Customers asked, for example, the German printers main offices in Hamburg, some of you may know, the company they are buying 20% of the paper which is printed in Germany and so they had some really big cases with Greenpeace and other NGO and they decided to buy only paper which has some kind of a certificate and of course the paper manufacturer, he has to work with the certificate, he will ask the pulp manufacturer, and the pulp manufacturer will ask the forester to provide him with the necessary information.

So, what is a life cycle assessment study. A systematic tool of assessing the environmental impacts associated with the products or service system. A service system means also transport, for example, or bringing one litre of milk from the cow to the man or women who drinks the milk, that is the service systems, or a product is, of course, a railway tie, or a window, or a door, or something else. To build an inventory of inputs and outputs to make it qualitative and quantitative assessment or evaluation of those inputs and outputs and to identify the most significant aspects of the system relative to the objective of the study. That reads a little bit complicated and there are other definitions - this is the definition from the ISO (International Standardization Organization - CD Committee Draft 14 - 040 Second Version) and there will/may be a third version by the end of next week after the Vancouver meeting. The Chairman of the Federal Environmental Office - I am

not going to read this definition because I am always confused when I read it, and I have read it a thousand times or even more and I still don't know what is in it. So I will give you thirty seconds to go through it just to confuse you.

.... Are you through?

If not, it doesn't matter.

..... laugh, laugh, laugh

What is more important is, and this is agreed more or less worldwide the four steps or phases of the LCA of the life cycle assessment study. And we will see that each of the phases is even more difficult to process. The first is called definition and scope - it reads quite easy; the second is the life cycle inventory analysis; the third is the life cycle impact assessment and the fourth, which is very much under discussion, is the conclusion and improvement assessment. And this reads different after each meeting that this group has.

You will see on the right the ISO proposed standards there is a committee draft (14-040) which has been rejected by the members of ISO this year. There is ISO 14-041, the Life Cycle Inventory, it should reach, it was announced the status of a Committee Draft by the end of next week and I am sure that it will be rejected next spring and Life Cycle Impact Assessment Group has nothing on paper yet and a group for the fourth step - the improvement assessment or not, there is nothing being said about that. So very many experts believe there will be no 14-043 at all.

What does this mean -- "life cycle". I jump over the first step. I will come back later. What does this mean -- life cycle inventory? We have the life cycle of the product starting, for example, timber product starting with forestry activities, the timber production, the wood

production in the forest then it goes to primary processing after harvesting, then from the lumber for example, the secondary processing produces windows or furniture then we use these products, the window for 40 years and the furniture for 5 years maybe, and then we have the choice to dispose it on the garbage side or to burn for energy generation, or to burn it just to get rid of it. Or recycle it and make a new product whether the same kind of product as we see it in the paper production and we call the close loop recycling, or we go to another product like the plastics, the recycle plastics become park benches, noise protection walls along roads and so this is open loop recycling. So we divide the whole life cycle in parts maybe the five which I have presented here, or ten or fifteen, at the moment we have eight different parts for the forestry sector under Germany under study. We have about 6 or 7 different primary processing activities, like sawmilling, like the pouring port manufacturing, like the transmission pool manufacturing of veneer manufacturing, and we have much, even more than that second processing. And of course, product utilization is somewhat unclear and disposal energy generation or recycling is somewhat difficult. So the idea is to have this whole life change for the different types of products broken down into smaller units and have some kind of a mosaic to produce life cycle inventories for the various types of products.

This sounds very easy and I will demonstrate you that this is theory and nothing really to be done in the industry. We have the inputs and outputs. The inputs mean that everything what you need to produce this product, or to use the product, or to get rid of the product is an input and everything what is going out of that system, whether it goes into the air, into the water, on the land, or whether it is eaten up by someone is an output. And, of course, you have to consider how are you going to break down the life cycle and what kind of inputs and outputs are you going to study. Of course, you should use all the inputs and outputs, or you should study all of the inputs

and outputs which are relevant to the environment. Tell me the other way around. What is not relevant for the environment. Everything is relevant. Even my lecture today is very much relevant - as I said I came by plane. Of course, if I would have taken a canoe last year coming over to Canada - of course - I have to produce the canoe, I have to buy the canoe, so the production of the canoe is also important And only sitting one guy in the canoe paddling to Canada and in the plane yesterday they have been 385 people and I have discussed this with a staff they told me that the plane needs 3.6 litres of kerosene 400 Kilometers to bring me over to Canada. So what kinds of inputs and outputs can you imagine the number of different things, so the ISO draft says several types of factors to be considered: primary flow of materials and energy, distribution and transportation, production on use of different types of fuels, generation of energy - electricity and heat, primary fuel acquisition and processing of fuel in a usable form. Also, the pipeline coming down from Northern Canada to Edmonton - I don't whether there is one, but the pipeline you have to consider. The disposal of processed wastes and cleaning of processed water, the manufacture of interior materials. So, the machine which has produced the canoe has to be considered.

Land Use.

When you have a disposable side - the size of the land. Of course, in forestry the size of the forest land you need to produce a cubic metre of wood has to be considered and I remember when I explained to my students five years ago, even the food of the dog of the forester and the tin which contains the food and the machinery you need to produce to tin you have to consider. Maintenance operation such as lighting and heating as a consideration relating to impact assessment (if any). So you have to consider everything. So this becomes, even if you

look to a single window, this become a world model -- includes everything if you try keep it correct on a scientific basis. So, what should we do with that paper here. It is almost hopeless.

The third step, you remember, was the impact assessment means that you assess the impacts of inputs and outputs to the environment. What does it mean for the environment if you need one hectare of forest land to produce wood. What does it mean for the environment if you release one grain of dioxin when you burn 10 tonnes of wood, for example. What does it mean? The problem is even more severe. Of course, you have 6,000 outputs and 4,000 inputs discovered, and maybe you have data for it if you have worked for twenty years, and then you have dioxin emissions, and on the other hand you have land use. Both is relevant for the environment. How can you compare them both? What is more relevant? One hectare? You have produced the wood and you have burned and released dioxins. How can you compare the land use and the dioxin emissions? Or the 10,000 other things. So, the experts, the scientists today, but also the practitioners in the industry say, okay, we should create impact cardigerous, and then we put the single inputs and outputs into these cardigerous and, of course, there is a big, big fight nationally and internationally how many of these cardigerous and what type of the cardigerous we should create. So this not by far, not a complete list. I have just cracked the very big list, a greenhouse effect. So every input and output which has some relevance for the greenhouse effect, for example, SO₂ emission and CO₂ emission, or OX emission, I assume is put into this category. Or, for example, human toxicity, dioxins, CO₂ emissions, for example. So you can imagine, for example, soil destruction and harvesting activities, or not only harvesting, agricultural activities. So, you can imagine that, even if you have all of the information from the inventory, it seems unlikely to get a clear picture on the impact on the environment on the next 50 years. This is the most severe problem - to come to a clear result, but there is some more problems

from the methodology - setting system boundaries, selection of input and output factors (I have already discussed that), data acquisitions, you can imagine that from very many input and output factors there are no data available. If I would ask the sawmillists among you - "what is the power consumption for cubic meter". Do you know that? It is quite easy because you have to pay for the power that you consume and you know how many cubic metres of lumber you have produced so you have just to divide soil compaction in the forest per cubic meter of lumber you have produced. So that is the real big problem and this cost a lot of money. And then we have the allocation problem and the handling of material recycling. Just a few examples: setting system boundaries because this system; of course, we could be interested in not to look at the world model as I said before. Maybe we could say let's concentrate on recessing cause to come to a specific product I could have two different ways of processing, let's say we could mold as a planner the lumber or we could sand it with a sander and we have the ready made lumber -- two different processes. And of course, for this comparison of the two processes you shouldn't look to the forestry sector, we shouldn't look to see what we are going to do with the board after twenty years. So we could create a smaller system and this of course, could lead us to thinking that we could exclude everything what is difficult. Let me give you this example: life cycle inventory/assessment studies could be used for two purposes. One purpose is a so called internal use to determine the biggest negative effects in a life cycle or in a processing/production step or it could be used externally to compare two different products or to compare the product with the same function produced from different materials -- Wooden window frames against PVC window frames. Or for example here, structural building elements -- say a beam -- could be made of timber, could be made of steel, could be made of reinforced concrete and you have the life cycle steps for the life cycle forestry processing product used and the timber, the beam could be burned afterwards

to produce energy or it may be recycled -- I don't know really, or it could be disposed in a disposable site. A steel element mining for iron and coal, the processing and the product used and the recycled - steel is recycled by a very high percentage and the reinforced concrete - you have to mining for the three parts and the processing the product used and reinforced concrete normally is disposed in the same time steel is recycled.

Okay, let's say a customer - a government agency is going to build a big building is using the life cycle assessment approach to decide on the material because they would consult an expert, and the expert, of course, is not a forester, normally not, so the expert has some problems with forestry to do the inventory on the forestry part. And then he may say okay that this is too difficult - let's exclude the forestry sector and then we exclude the material requisition here and also here, so let's start from here. So, by that approach we have excluded very many positive effects of forestry. Of course, forestry is not only providing wood and wood products, it is also providing non-wood products. I have learned that at the moment you are at the moose season and there may be some hunters; this is also an important output of forestry and then of course, you have the climate acclimating surface and ground water soil protection landscape recreation and all these things what we call sometimes the social effects of forestry. We would have excluded all the positive, and the negative effects, but in forestry we have quite a lot of positive effects to the environment. And of course the steel if I would be the consultant and I would get my salary from the steel company or from the steel producer's association, and I would say that steel is recycled, so we should include the final end of the life cycle because if you burn the wood here then you will have of course air pollution which is a negative effect of the environment and if you recycle the steel you have no air pollution, of course during the recycling process, a little bit - I will discuss this later. So there is a lot of room to make life cycle inventory

and assessment studies uncomparable just by setting the boundaries here. Because you have to set system boundaries otherwise you have your world model. And so the question who is paying for - there have been to date 5 studies in Europe about window frames, comparing one window frame, PVC window frames and aluminum wood window frames. We will show you one result from one study and according to the sector who has ordered the study you can imagine the result. The same of course is with packaging material - the plastic industry has partly financed the study which was executed by the German Environmental Office and therefore, the big soft drink suppliers have plastic bottles on the market.

The second problem from the methodology point of view which influences the result of a study quite tremendously is the so called allocation problem. Of course, we have a system -- let's say we could produce lumber; we have the raw material input, the energy input, some other inputs of course, we have emissions, and we have two products, which is, for example, the lumber and the chips. So we have to allocate the inputs and outputs to the product unit, per cubic meter of lumber for example. But we have two products which are different. So we could say we are lumber producers and not chip producers, or we allocate 100% of the inputs and outputs on the lumber. In that case the chips would have no environmental burden so it is burden free. You could say. So all we can allocate some of the inputs and outputs to the various products. You can allocate by weight or by mass, one ton of lumber, one ton of chips, but then you should have the same moisture content of course or by volume which makes for not real sense in this example, or by value, and this is very many people propose because a cubic meter of lumber cost \$300 and a solid cubic meter of chips costs \$100, so allocate three parts to the lumber and one part to the chips. Or some people even say okay we

should allocate according to what this product could carry for the forest utilization. But this is the most crazy. There is no solution at the moment, so in the nationally it is more the mass which should be used.

And now it is the most interesting point and we are coming close the end --15 minutes to end. And this example, I can really demonstrate how you can use every one of you who is interested in that tool can use it to his advantage. So, recycling. Let us assume that we are going to produce paper. We have the raw material, mainly wood, of course, some other things and we produce the paper. We have other inputs as energy, water and what else and we have the outputs, and then disposable site. We need the land for disposing and we have water and air pollution. Because of the degradation of the paper during maybe 50 years we have water pollution and air pollution. But this life cycle is very simple so we have environmental burdens from the Step A, from the Step B, and from the Step C. And of course now, we are going to recycle paper. So no more disposing or burning, of course, if we would have burned the paper we would have had air pollution and soil pollution with the ash, for example. So we have recycled by 100% . Of course, then we have some inputs and outputs during the recycling process, the de-inking process for example and then we have the secondary fibre brought in here and produce paper from secondary fibre. So our environmental burden is only partly here, we need some fresh fibres, even for recycled paper, so we have only a part from A still in our environmental burden, we still have B during use which may be the same, but we don't have C anymore because we have no disposable or no thermal utilization, so we are minus C, but we have the D recycling process. So the difference between paper from fresh fibre, we call it new paper and recycled

paper - the difference is AB, is it more or less than a part of A plus D minus C. That is the question. Nobody can answer it at the moment. So there are very many countries there are studies under the way to deal exactly with that problem to find out what is the difference here. What side is bigger or smaller. So the German government I have said before since 6 or 7 years thinks that recycling is more environmentally friendly, therefore supports and pushes recycling, quite a lot, up to 50% - 65%, or even more than that. The result is that the German foresters can't sell fibres anymore and what this means for the forest sector, I have explained to you. So by this recycling processes, of course you get less environmental burden here on that end. But the question is how big is that environmental burden here. For example, if you do de-inking of course, that is the normal process of waste paper, what are you going to do with the de-inking sludge. Either you burn it or you dispose of it. If you would have burned paper, approximately 90% of the pollution comes from the non-wood fibre material in the paper, you have the 90% also here. So that is really a question whether this recycling pays in terms of environment positive effects of not. So this is very simple, because this is a closed loop recycling. You used the recycled fibres for new paper but if you would imagine collecting more than 1M tonnes of plastic in Germany, it was so-called Green Point, some of you may have burned afterward because there is no outlet for a raw material, and if there was an outlet, this would never become such a product anymore. As I said before, we have a lot of PVC most of the PVC - the recycled PVC you can buy it as a park bench or a garden chair. A nicely white colored garden chair costs you than \$395 Finish in Germany. It weighs 5 or 6 Kilograms, of course - that is a big business because the company who recycles PVC get one thousand marks per ton. So they are producing 200 garden chairs - sell it for 4 marks each, makes 800 marks. Sales revenues plus the thousand marks they get when they take the PVC makes \$1800 marks and the production costs for the chairs are \$600

marks so they earn \$1200 marks. And the PVC is still there in the form of a garden chair. But the difference is that you recycle this type of product which has "Green Point" on it but the garden chair when it has broken down after 5 years because of the short wave radiation you just put it in the normal garbage and it is burned in the incineration plant. Why shouldn't we burn this in the same plant. So you can play around with this methodology quite a lot and those people - there are some in Canada from the aluminum industry and some in the United States -- they really know the game. So I explain more of the negative aspects of the life cycle assessment, and the counts of methodology is not developed as yet and the comparisons of the different studies is very difficult. It needs a lot of time and costs a hell of money. Just to repair the mill life cycle study for window manufacturer here is the stuff of forty and producing - I remember right - 50,000 windows a year, so I have send one of our colleagues for nine months to look through the whole process to prepare a very, very rough study . Of course, he got it free but normally it would have cost approximately 100,000 Canadian dollars.

Okay, I should tell you some positive aspects. Of course, if you do such an exercise you know about the negative effects, but if you publish your study all your customers/competitors also know about it. This is a fear for many of the practitioners in the industry. But on the other hand, you have also discovered or disclosed the positive effects. So you can say okay that is positive. I have the negative effect here. I have some air emission. But listen, this is positive compared to the other products. You can use this tool for an improvement in your enterprise, and you can change processes for example, so the closed loop, the close water paper process or something like that, or you can use it as a marketing instrument. And Industry at the moment, not the timber industry, but the plastic and the steel industry and brick industry in Europe is using that instrument quite a lot.

So, I give some examples of showing results of life cycle assessment studies. So one of the main environmental concerns at the moment is the global warming. And the key role in global warming place CO₂ and on Rio Summit there was not an world wide agreement on CO₂ reduction but some countries convinced that they will reduce CO₂ emission like for example Germany, 25% by the year 2000 on the basis of 1990, so one aspect which is an outcome of life cycle inventory assessment studies is the following: in one cubic meter of timber which has the weight of 600 K without water we have 300 K of carbon in it, and this is equivalent to 1 tonne of CO₂. So that is very easy. One cubic meter of timber is a CO₂ equivalent of one ton. So whenever you grow you produce a cubic meter of timber, you have reduced the CO₂ in the atmosphere by one ton.

So we can do some calculations. Germany for example, I don't know what is the biomass in the Canadian forest, so I choose the Germany forest - we have 4,000 M cubic meters of biomass above ground in Germany's forests. So this is a CO₂ equivalent of 4,000 M tonnes. The world wide emission is 22,000 M tonnes a year so this gives some kind of a relation. In Germany we have 1,250 M tonnes of wood products in use, of course, not only in the wood that is in the forest, not only that wood contains carbon, the same wood here in the chairs and desks contains carbon. And so, in Germany we found out more than one million of cubic meter of wooden products including newspapers and all the books in your house, and in your floors in your house - this is 1,250 M tonnes of CO₂ equivalent. The unit emission is 900 M tonnes in Germany for example. Canada has much less. Not so much. Canada has more than Germany. So this is more than 12 tonnes per capita here in Germany. So every German is responsible for 12

tonnes of CO₂ per year. And so now you have this information. You can do some marketing strategy You can say, you are a wooden window manufacturer, of course, you can say if you are a customer if you buy a wooden window frame the weight would be 60 K, this would be an equivalent of 100 K of CO₂. So if you buy this wooden window frame you reduce the atmosphere content of 100 K - of course, this is nothing. But if you buy one billion windows, but what are you going to do with one billion windows. So better, you buy a wooden house. For a wooden house you will need an 50 cubic meter of timber, and this is the equivalent of 50 tonnes of CO₂. This is four times as much you are responsible for the yearly emission, but if you buy a wooden house instead of a brick type house, then you have no CO₂ problem for four years time. No, you should say, if you would buy a wooden house, then you and your two kids have no problem. Then that is even more important. And so you can continue. You have burned down your house after four years - you put it down and process the energy . And then you save oil or coal and this also reduces the CO₂, but I am not going to buy a house which I have to burn down a house after four years.

This is one aspect. Carbon storage in products. I have had a meeting with the Hanover Fair Company in the City of Hanover and this is the largest industrial fair in the world and I had a discussion with the management because they intended to introduce the fair which they have semi-finished food products on display which they have on display and discussed about the organization of the fair and after two hours discussion of the fair I said, okay you should stop thinking of having a wood fair and timber fair on their fair grounds. And they asked why. And I said that they have no wooden building here and if the timber people come here and they see only aluminum, concrete and steel and they are very unhappy to see all of the other materials. And then I just explained for a couple of minutes the advantage of carbon storage and low

energy for processing of all these things, and I will consider this. And talk to the top manager. Two weeks later an architecture from Munich called , you crazy guy, you have told Hanover guys that they should build a wooden building, a huge building more than 30 thousand square metres instead of a concrete one because of environmental reasons and they have decided to have it build in wood by March 1996, and this happened last summer. So within 5-7-8 months, it wasn't built so they have to change the whole plans from concrete to a wooden building.

Wood products are low energy products, so that is the second advantage and it can demonstrated by life cycle inventory or assessment studies.

The energy demand for producing one window of 2.7 square cubic meters. For wood aluminum and for PVC window. Manufacturer including the heat content of the material - that is an important thing, because wood can be burned afterwards and you can also burn the PVC can be burned afterwards for energy generation, but you cannot burn aluminum for energy generation. So wood is the lowest.

The second column is the manufacturer including the heat content minus the energy you can produce from the processing residues (the chips or the shavings) you can burn and you can see there is a substantial amount of energy can be provided from the residues. So we should stop here and make the comparison.

The third column is plus maintenance, so for 40 years period of maintenance of the utilization of the windows of course, you have to repaint the wooden window every five years, not the PVC, and not the aluminum and this of course requires energy so you have to increase in

energy, the wood aluminum, you have to paint the wooden part, and the PVC it is very little, and then you can burn it afterwards, or you have to dispose of it and therefore you will get some energy when you burn the wooden window frame, and let's assume that you burn 50% of the wooden window frame and 50% of its disposable side. and You can burn part of that and you can also burn the old window frame from PVC. But in all the cases, wood has the low energy content.

Another example. You all know what gluelam is. You glue boards together to make a beam and you build big houses or big buildings. There is one cubic meter of gluelam. You need about 2.1 cubic meter of round wood for the gluelam, for one cubic meter of gluelam, you need 18,500 megagules of solar energy to grow the wood. You need some energy for the forester to go with his four wheel drive to go to the forest and with his truck to take out the wood. You need for lumber manufacturer a certain substantial amount and for the gluelam manufacturing - so that is the energy input. You get some energy output from the residues of lumber production and you get some output from the residues of the gluelam production . Maybe you save some energy because the heat transfer of wood is much lower compared to steel than compared to concrete and when the gluelam is out of use after hopefully in 200 years because then you have stored the carbon and reduced the CO₂ in 200 years you get an amount of energy so to make a balance sheet out of it - the input of energy, the solar energy and the other energy and the energy output, so we will say okay, environmentally, we have seen that the solar energy is free because it is there, so we have a input of non-solar energy of 5.8 thousand and **an output of renewable energy, that is the important thing to note** of 18 thousand. So a ratio of 1 to 3. So we have a higher energy output than the input is, three times as much. And we have the possibility to use the gluelam for a long period. So if

you would do a comparison with steel or with reinforced concrete it would be in the contrary. So this is a clearly outcome, that wood is a very low energy product. So to come to the conclusion.

We have a lot of positive environmental effects not only the negative, especially when we consider the forestry part within the life cycle of the wooden product and we should bring it to the market place. We should tell the people, our customer, about the advantages, and of course we should sell these advantages, because these advantages are some kind of property. We talk about technical property, and we talk about costs, and we should talk about environmental properties and people, if we could convince them that there is an advantage then they would be willing to pay. I don't know how much they would be willing to pay more for a wooden window frame, instead of a PVC window frame. In some cases they pay more.

Actually, we have three approaches when we talk about environmental certification and environmental aspects in the industry. One is the life cycle assessment of products I have talked all the time. But we also have the possibility and necessity to make some kind of an inventory of an enterprise. Some scholars in Europe and North America - some enterprises have some kind of a eco report where they sum all of the materials that they have brought in and sum up all of the

emissions that they have measured. Very few they have measured. There are other they have not measured - they are not in the report. This is mainly the basis for auditing afterwards. You may know that the European community has released two years ago a proposal for an environmental auditing scheme for the industry which is voluntarily, but I am very sure that a part of the industry, especially the bigger industry will take up and will come up with equal auditing of the enterprises.

Environmental management which comprises life cycle assessment studies for products or these equal reports of enterprises of the equal auditing can be seen very similar with what we have today and what we know of today as quality management. Most of you know what is meant by ISO 9000 standards- the introduction and the implementation of quality's management system and a quality auditing and you can have the same safety management system and so today, there is some overlapping between the different systems so today it is most likely that the environmental management systems and environmental auditing would follow more or less the same procedure as the quality management systems and the quality auditing. So overall of course this costs a lot of money for the industry, consumes a lot of manpower, but at the final end we have no other choice than going along with the thinking. Thank you very much for today and for the time that you have spent with me.

Dr. Blenis

At the onset, Dr. Fruhwald mentioned that it was a really nice day and we should all be outside. Well, I am not sure that I agree. I think that the last few minutes have been really well spent. As I was listening to him speak I was thinking of a number of things. I was thinking of why

the cups were styro and not paper. And I was also thinking about some words, I don't know whether it was Makin or someone else who said it, and I think he said something to the effect that for every complicated problem there is a solution that is simple and straightforward and wrong. I think what Dr. Fruhwald has been doing this afternoon is taking us on a journey from a very simplistic way about thinking about environmental effects to a far more sophisticated way of thinking about environment affects and how we can use life cycle analysis to come to grips to what really these affects are. Now someone who gets paid on a monthly basis to tell people about things, I think something that is very important is to express complexity with clarify, and not with confusion - although I knows that it is easy to be confusing. And that is exactly what Dr. Fruhwald has done. He has also done it in a way that is proven to be very interesting. Interesting to the great diversity of individuals within this audience -students, staff, representatives from industry and from government. So would you please join me once again in thanking Dr. Fruhwald for an excellent presentation.

Dr. Beck

Question Period.

Before anybody leaves, I am sure that he would be willing to answer a few questions, if anybody's got any questions

Dr. Fruhwald.

I am staying until Sunday morning, so we have enough time.

Dr. Kare Helium

It was mentioned that you have worked in other parts of the world. And sitting and listening to your talk reminds me of a seminar I went to some years ago where I listened to a buddhist monk talk about mind things - talk about trimming hairs. And he talked about compassion. And I see very little difference except for the technical content between your talk and the talk of the Buddhist monk. But, my question to you is when you deal with people with different persuasions from living in different parts of the world do you also get the different perceptions and an expressions of opinion and understanding about what those matters that you presented to us today.

Dr. Fruhwald:

Yes, and I think that the answer is very difficult. And what I need to talk to about different aspects. So we have maybe - I can answer it in the following way. We have had ISO Expert Panel in about 28 different countries, also from different parts of the world even and less developed countries, and of course, there is a big concern from lesser developed countries. As we think that small companies in our industrialized countries, as the same as with our lesser developed countries they cannot afford the high standards and the high expectations and this is really a problem that this kind of an approach could be some kind of a trade barrier or can change competition on markets and of course, this is only seen from a technical point, so if you look/remember to what I said on impact assessment, everybody of us is of a different thinking of impacts on the environment, everybody of us has a different opinion on what the environment is. Very many people for example, very many so called experts think that

human beings are not part of the environment and we should not consider them of the environment, not to be affected, only sources for effects. So this is not really an area where you can go and use only technical aspects of thinking. It looks, as I presented it today, it looks very technical, but you may the impression that it is very technical. But that is the only way the people who are dealing with that matter think that they can go, because all of the different opinions could not be included in such a methodology, or such a system. So only when everybody agrees and that is the procedure in ISO, everybody has to agree, not everybody, but two-thirds of the member countries have to agree and if more than one-third is objecting that will not be a standard. And I have been involved with these discussions for quite a long time I am very doubtful that we should continue. And this is what I recommended to all of the crew. I had a feeling at the end of the last meeting we have even behind the discussion of the meeting we had a year ago, so that is maybe a very rough answer.

Dr. Murphy.

You made a very strong case for the energy and the manufacturers - what we are finding typically is with the goods in the European centres redistributing their facts - is the forest house cleaning operations. And they were having difficulty and I was wondering if you could give us any insights how we might approach that as to sustainable system of management perspectives. It could well take us into Sunday evening.

Dr. Fruhwald.

You are totally right there.

Most of the studies so far put the energy aspects in the centre of the study. This is because of two reasons: one reason is that energy in and outputs are clearly to discover in a company or in an enterprise, because as I said you have to pay for the energy and you have to pay for the energy you consume and you can easily handle this kind of in and output. And the second reason is that energy plays a very important role in the environmental discussion in many countries starting with the oil crisis, and coming to the moment to the global warming discussion. These are the two main reasons why energy places such an important role in most of the so called life cycle assessment studies are purely energy studies and not more. Of course, the forestry sector to me at the moment, is the most difficult part. Because we have no so-called experts again - have no clear idea what kind of input, what kind of outputs, we could look on and what is the effect on the environment. And the logical way would be the other way around starting with the determination of effects on environment and then looking at what are the input and output factors in such a system play what role on the effects. Then again, linking this my answer to the previous answer, for example, you could say, okay when you look on the forest soil, on the damage on the forest soil and on the damage of the clearcut harvesting system and of course, you could say, and I look mainly to what has happened in the forest soil to the remaining stand. If I go in the clearcut system once in 50 years time and then I replant it and then I go in anymore, I don't build heavy roots -- to be able to go in a selective logging system every two years and so it is really difficult, what impacts you are looking on. If you look on landscape architecture, for example, how do you measure it. Of course, to be frank when I fly over Canada, as yesterday, was a clear day, as well, and you see every clearcut area, because it was white colored and the rest of the forest was green or brown, or you could see everything, so I could feel. I would prefer selective logging in Canada, but that is not a scientifically based, not a

realistic judgment, so this is why these discussions are so difficult. And of course, sometimes the discussions is not very irrational. What you are doing in Canada at the moment we have done it 100 years ago. Why do we have all of the spruce and pine forests - there haven't been spruce and pine forests before - there have been clearcut areas as for timber use or for agricultural purposes, and then they have been replanted with spruce and with pine because we didn't need the land for any other purposes anymore. So, one thing that I didn't mention was the time frame in such a study, especially when it comes to forestry. So, a life cycle assessment study is a one spot one time assessment, but of course, when you come to forestry then you have to consider 50 years period, 100 years period and then there is no instrument, no tool at the moment to handle such things in a more or less scientifically based and scientifically accurate study. And maybe this is one reason why German foresters are very reluctant to go into this area. They clearly refuse. We have set up two expert panels consisting of about 60 experts and there is only one forester in the administration of the private forest organization, he is in the expert panel, but no state foresters, no professional foresters, because they do not know what to do, or what to say.

Dr. Beck.

I would like to cut off for questions there and to ask all of you to join me in thanking our speaker again.

And, then I am going to have to ask you to indulge me for just a few minutes more before we break. The forestry program began in 1971, our first graduating class went out in 1974, and as will happen with any institution that has been turning out graduates for that number of years, a certain number of our graduates have passed away. And this last couple of years, the Forestry Alumni Association has looked at how to look at remembering some of these people, and they

have come up with the idea that the University has accepted and we have put in place a Forestry Memorial Grove which has just started – the grove now is very short trees but I would like to ask Barry Lewis, who is the President of the Alumni Association to come up here and say a few words about it. And for those who are interested, I think he is going to invite you out in the cold to look at and honor our first official opening of our grove. Barry

Barry Lewis....

Thank you.

All I wanted to say was a little bit about the Alumni Association first of all. Our goals are to promote fellowship among students and staff, to promote a liaison between the forest program and the business communities at large, to provide additional avenues for identification contact, representation of a forest alumni, and to provide a student support network. These are just a few of our goals and we are moving in those directions in a number of ways - for example, for the first year we have been a sponsor of the FILS Series, tonight we will be making a presentation to a first year student award, and we have established, as Jim Beck says, a Forestry Memorial Grove. Now, the Memorial Grove Concept was conceived, I guess, my understanding by the 20th Anniversary Forestry Reunion Committee which was a subcommittee struck from the Alberta Alumni Forester's Association and since that time the project has been carried through by the collective efforts of many people. I will just name a very few of them. I am sure I am not going to hit everybody. Morley Christie, Byron Grundberg, Bruce Dancik, are just a few. However, I would like to extend special thanks to Jim Shaw, who has really shouldered the burden of this project. Thanks a lot, Jim Shaw.

In terms of funding, our association is largely funded by dues approximately 10% of graduates of the forestry program are paying members. We are also funded by donations from industry as well we receive donations from the Chairs' Discretionary Fund. My plug I want to make is that we have 10% of the forestry graduates are currently members. If any of you are not members right now, could you please consider membership.

Anyways, what we are going to do now, and you are welcome to join us, we are going to take a walk down to the grove. It is located by the University LRT Station and Rutherford Library, south on 89th Avenue. And we have, I think, 8 trees planted out there now, we are going to plant 4 more in the spring, some deciduous trees, and we have a sizable rock with a bronze plaque bolted onto this rock, and we are going to go down and take a look at it and have a little bit of a dedication ceremony. And remember the 15 deceased graduates. So if you want to join us, you are welcome to join us and walk down there and join in the ceremony.

Thanks very much.

Dr. Beck concludes the presentation.

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