Linking the Forest to the End Consumer

PART of the Original Technical Report (March 1999)

Ecological Optimisation of the Paper Chain 98
a joint project of Axel Springer Verlag, Norske Skog Industries, Otto Versand

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1. The Project Idea

The initiative for the project documented in this report was jointly taken by two German companies: Otto Versand Hamburg and Axel Springer Verlag Hamburg in the course of the year 1996. From May 1996 the two companies developed the project ideas and then looked for an innovative partner in the paper industry. After extensive talks to different potential industrial partners, a project agreement between Norske Skog Industries (Norway) and the two German partners was signed. The German companies took the initiative because they felt both the ecological need and the business opportunity for a co-operation project in the paper chain. Major paper users, such as the publishing and printing company Axel Springer and the mail order company Otto Versand were increasingly perceived to be publicly accountable for the ecological quality of the forests from which the pulp wood is harvested. Especially in Germany the perception that paper production necessarily wood lead to de-forestation and deterioration of eco-systems was wide-spread at the time. Axel Springer Verlag was already coping with this situation by asking from its paper suppliers information on their wood supplies and conformity to a set of minimal forestry standards (“Waldnutzungsstandards”). Environmental organisations such as Greenpeace had put the forest issues higher on their political agenda and were increasingly focusing on the issue of clear-cuts and the use of pulp wood from uncontrolled areas of great ecological value such as the virtually untouched Karelian old growth forests. Paper companies such as Enso were publicly accused of having insufficient control over their pulp wood inputs and in fact it was hard for them to give a watertight proof that ecologically unacceptable logging practices had been excluded completely.

As a follow-up of international agreements on forestry and forestry standards, a number of initiatives to develop standards for sustainable forestry were already on their way or in the planning process. The international multi-stakeholder initiative of the FSC, the Forestry Stewardship Council, provided a platform for standard setting on the national level. In Scandinavia, the Finnish, the Swedish and the Norwegian processes followed their own strategy in defining standards and certification systems. One issue in the international and national discussions on forestry standards and certification was - and still is - the so-called ‘chain of custody’: certifying the product produced from certified forests by linking the product to the wood and the wood to the forest. As in the forestry certification debate the focus was mainly on forestry standards and less on the complicated issue of ‘chain of custody’, the project partners saw an important opportunity here. Since the paper producer together with their clients Otto Versand and Axel Springer Verlag and with their local pulp wood suppliers, the forest owner associations, could easily create a close chain of custody and put an example how to deal with the ‘chain of custody’ problem in a practical manner.

From these considerations the idea for a project was borne:

- The project would involve a co-operation between partners in the entire paper chain from the forest owner until the end-user;
- All partners in this co-operation would contribute a relevant ecological improvement in the paper chain within their own span of control. The paper producer (Norske Skog) would realise an ecological improvement to the paper and apply ecological standards to the pulp wood supplies, the printer (Axel Springer Ahrensburg) would realise ecological improvements in the printing process and work closely with the paper producer to guarantee an optimal printing result with changes in the paper recipe. The paper users (Axel Springer and Otto Versand) would use the paper and communicate the project to their readers through the journal printed on the paper and through other communication activities.
- Apart from the above indicated ecological improvements of the paper and the printing a main goal of the project would focus on the creation of a seamless chain of custody system, connecting a roll of paper with the logging used to produce pulp wood for that paper and with the owners of the forests in which the logging has taken place.
- A checking system had to be designed for checking a random selection the logging sites that are connected to certain paper rolls that are used to print a certain item (journal or catalogue in this case).
- The project would be used to communicate a positive message on paper, forestry and ecology to the German readers. Because of the family character of Norwegian forestry, the idea came up to link to Norwegian forest owner family to the German family of readers (see Diagram 1). This idea made more concrete later by choosing the journal ‘Familie & Co” as the Axel Springer printing item.

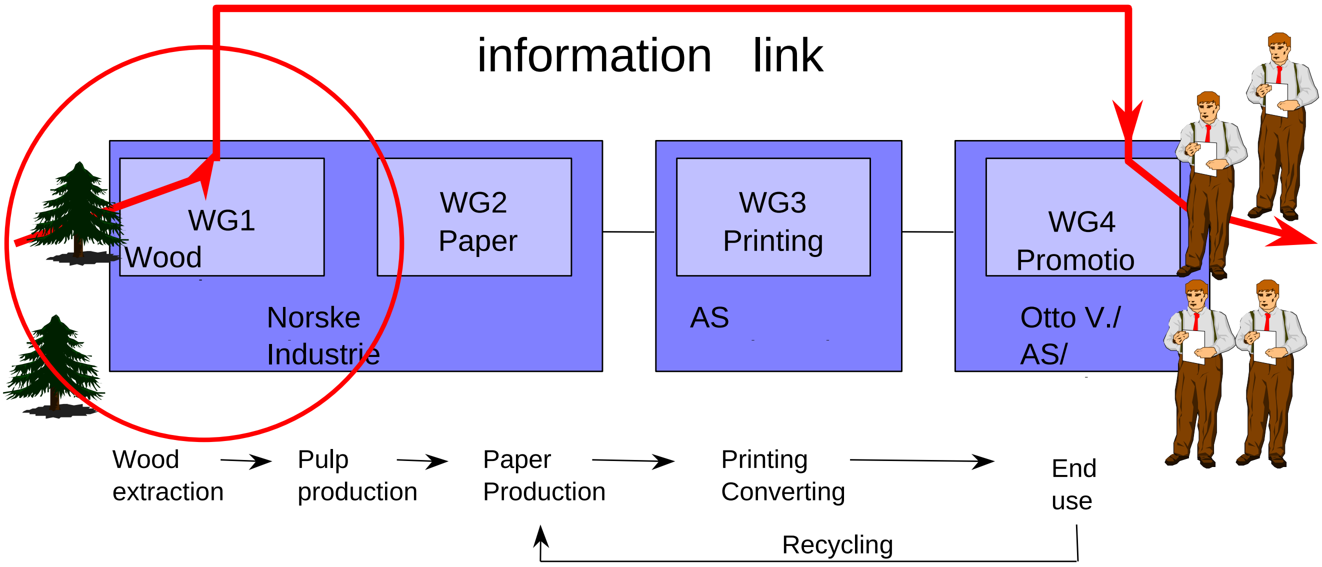


Diagram 1: The Original Project Idea and the Working Group Structure

It took about two years to make these first ideas more concrete: to establish an effective co-operation, to develop the new paper quality, to agree on forestry standards and the checking system to be applied and to involve the forest owner associations as an active partner in this project.

2. Project Summary

2.1 Project Areas and Project Organisation

Project areas

Three areas of improvement were identified:

- the area of forestry standards and traceability,
- the area of ecological improvements in paper production and
- the area of ecological improvement in printing.
- The fourth project area dealt with the issue of communicating the project results ‘from family to family’ and to other relevant target groups.

Below we give a short description of the

- objectives,
- the project tasks and responsibilities and
- the main project results.

Project Organisation

The four project areas were dealt with in four different working groups. The first two working groups (within Norske Skog with participation of the German partners and the forest owner associations) dealt with forestry and paper production issues. The third working group dealt with printing optimisation. A fourth working group, with representatives from Norske Skog, Axel Springer Verlag and Otto Versand was responsible for marketing and communication issues (see also Diagram 1). A Steering Group became responsible for the overall project and a project management (located in Otto Versand) co-ordinated the work of the different groups. A consultant (Dr. Reinier de Man) supported the Steering Group and the Working Groups.

Technical details of the project results can be found in the following chapters. However, this chapter can be read without consulting the chapters with the details.

2.2 Forestry Standards and Traceability

Objectives

In the project agreement, the objective in this field was formulated as follows:

The emphasis is to identify practical and economical systems for the tracing of wood ("Rückverfolgbarkeit"). Goal: To document the wood producer/supplier for a roll of SC paper and to document that the wood comes from environmentally sound harvested forests (e.g.: ASV forest use standards, „FSC" according to development process in Norway in combination with ISO 14001 or EMAS and others) - allowing Otto and ASV to use this product information in the communication with catalogue users/readers.

Tasks

On the basis of this objective, the main tasks were:

- to define ecological standards to apply to the pulp wood deliveries for the paper that would be produced for Axel Springer Verlag and Otto Versand and to integrate them into the contract system;
- to choose wood suppliers for the pulp wood that would be used for the mentioned paper;
- to define the system to be used to trace back the wood from the Norske Skog Saugbrugs wood yard ('Kasa') to the logging site and the forest owner.
- to define the system to be used to trace back the fibre in the paper to the particular pulp wood delivery at the wood yard, including the lay-out of separating certified wood deliveries from non-certified wood deliveries;
- to calculate the quantity of wood needed for producing enough paper with a high content of certified fibre;
- to define the system to be used for checking the logging site against the agreed standards;

Responsibilities

The work was carried out by 'Working Group 1" . Members were representatives of Norske Skog Supply (responsible for pulp wood supply), Norske Skog Saugbrugs (responsible for mill-related issues) the forest owner associations and a representative of the German partners. Fibre flow calculations were made by the Finnish engineering bureau CTS and by Dr Reinier de Man.

Results

- The ecological standards chosen were derived from the standards being developed in the framework of the Norwegian forestry standard process “levende skog”. Only those standards were applied that relate to the logging site since they can be checked after logging. Levende Skog standards that are related to forest management etc. have not yet been included;
- Only supplies coming by truck to the paper mill in Saugbrugs are traceable. For practical reasons, the project exclusively uses wood from Haldenvassdraget and Nedre Glommen Skogeierforening; For coming productions it will be possible to have wood from an additional forest owner association, Nidarå, that will be transported per ship from the other side of the Oslo Fjord to the Saugbrugs mill in Halden. Swedish wood is excluded, since it would be difficult to have Norwegian checks on Swedish territory, for understandable reasons.
- Tracing back the wood delivered to Saugbrugs to the logging site is done on the basis of the existing measurement system that is operated jointly by the paper industry and the forest owner associations. Every pulp wood delivery has a unique number. On the basis of this number the delivery can be traced back until the location at the roadside where the forest owner has put the wood. From this location it is easy to see where the wood has been cut.
- As could be expected, the traceability of the fibre through the paper mill proved to be a substantial problem. As paper production involves a great deal of mixing processes, there is no realistic possibility to link any particular paper roll to any specific pulp wood delivery. Any paper output can only be linked to some 15 hours of pulp wood input.
- Because of the use of non-traceable saw-mill chips and non-traceable chemical pulp, the maximum level of traceable and certified fibre in the SC paper used is below 80%. After switching from non-traceable to traceable pulp wood the level of traceable and certified fibre in the paper is only coming up slowly because of the mixing processes in the paper mill. A simplified fibre flow model was built as an instrument for analysis and decision making. The model shows that, from the moment the first traceable fibre arrives at the paper machine, it generally lasts more than 20 hours before the level of traceable fibre is more than the minimum level that was defined in this project: 70%. This long switch-over time can be made some hours shorter by switching off one re-circulation pump in the system, but it remains long. This is an argument to produce as much paper as possible at one production run. The goal for the coming month is to *r*un some 6 to 7 production runs with a yield of a

minimum of 500 tons of paper for Axel Springer Verlag and Otto Versand. For that purpose there is a need of about 3250 solid cubic meters of traceable pulp wood at the wood yard, that is being stored separately for the special production batches. In winter, this quantity is not a problem. In summer, it might need some additional planning to have such a quantity at the wood yard without having to store it too long;

- It has been agreed to apply third party checking to a random selection of the logging sites that relate to a particular paper production batch. The independent check is done by Det Norske Veritas. External verification was preferred above internal checks by the German partners because of greater credibility.

Technical details can be found in Chapters 3, 4 and 5.

2.3 Ecological Improvements in the Paper Production

Objectives

The objective of this part of the project was to find an attractive area of improvement in the area of paper production. As the normal environmental management measures in the Saugbrugs mill had already been implemented, the focus was not on emissions to the environment but on the use of resources. The idea was brought forward to produce an SC paper with a lower content of chemical pulp. From an ecological perspective, this is interesting since chemical pulp is less efficient in the use of wood and implies higher environmental impacts than the production of thermo-mechanical pulp (TMP). In the project agreement it was formulated as follows:

Development and implement environmentally attractive and economically feasible improvements in the paper manufacturing process
Focus:
1) Reduction of ink absorption
2) Development of SC paper with a lower content of chemical pulp
3) Assess environmental advantages of 1) + 2)

In the course of the project it was decided not to go into the first item.

Results of this part of the project have been reported elsewhere.

2.4 Optimisation of the Printing Process

Objectives

The general objective of this part of the project was described in the project agreement:

Development and implementation of environmentally attractive and economically feasible improvements in the printing process

It was also considered useful to make an inventory of optimisations that had already taken place that could be communicated positively in this project, such as the implementation of environmental management systems (EMAS/ISO) and the use of toluene reducing inks.

Tasks

The tasks were to

- identify potential areas of optimisation
- to implement changes
- to identify interesting improvements that had been implemented already.

Results of this part of the project have been reported elsewhere.

2.5 Communication from Family to Family

Objectives

The general objective at the project start was defined as the development of a

Joint communication strategy of project and project results to market and public

Evidently, the German market and the German public was meant here. During the project this objective was made more concrete and linked to the specific possibilities of Axel Springer Verlag and Otto Versand.

Tasks

The following tasks had to be completed:

- The definition of the target groups to be addressed;
- The definition of the messages to be conveyed;
- The definition of the media to be used to bring the messages across;

- Concrete planning of activities.

Results of this part of the project have been reported elsewhere.

3. The Production of Paper from Certified Wood

3.1 Overview

In this chapter the issue of tracing back the fibre in the paper to the logging site in the forest and to the forest owner is being addressed.

The basic structure of the fibre flows is given in Diagram 1. The idea is to be able to link a paper roll for Axel Springer / Otto Versand to information about the forestry applied to produce the corresponding pulpwood. As an additional service to Otto Versand and Springer, the paper roll should contain information about the quantity of fibres from certified wood and the certification standards applied. In addition it should be possible to perform checks on the logging sites from which the pulpwood has been harvested. Therefore some form of back-tracing from paper roll to (groups of) forest owners and their logging sites is needed.

The fibre flow, as symbolised in Diagram 1 starts with both certified and non-certified forests. The pulp wood from these forests is transported to the Saugbrugs paper mill, with some intermediate storage at railway yards and/or the Kasa wood yard at Saugbrugs. From there the pulp wood is fed into the different pulping processes (both thermo-mechanical (TMP) and stone groundwood). The pulp is being used in three different paper machines: the TMP is used in PM4 and PM6; the stone groundwood pulp is being used in PM4, PM5 and PM6. The SC paper for Axel Springer and Otto Versand will be produced in PM6. Of course PM6 produces paper for many other clients as well. In some cases on part of the full production width is produced for AS/Otto whereas, due to trimming of the reels, another part of the same paper is being produced for a different client.

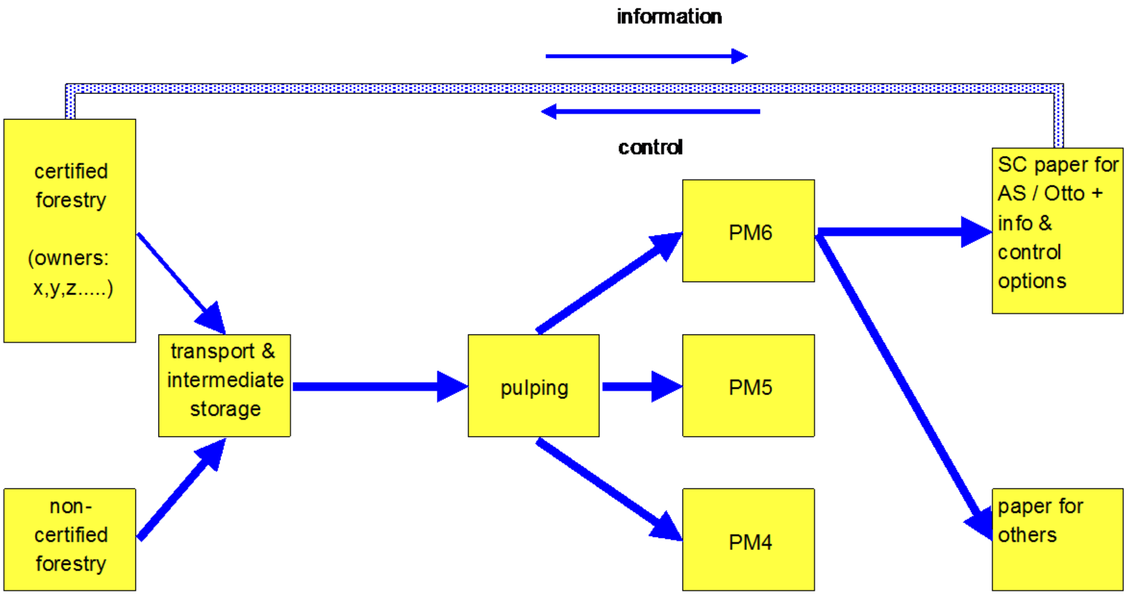


Diagram 2: Fibre Flows

3.2 Tracing the fibre through Saugbrugs: a calculation model

3.2.1 Coupled Production Processes

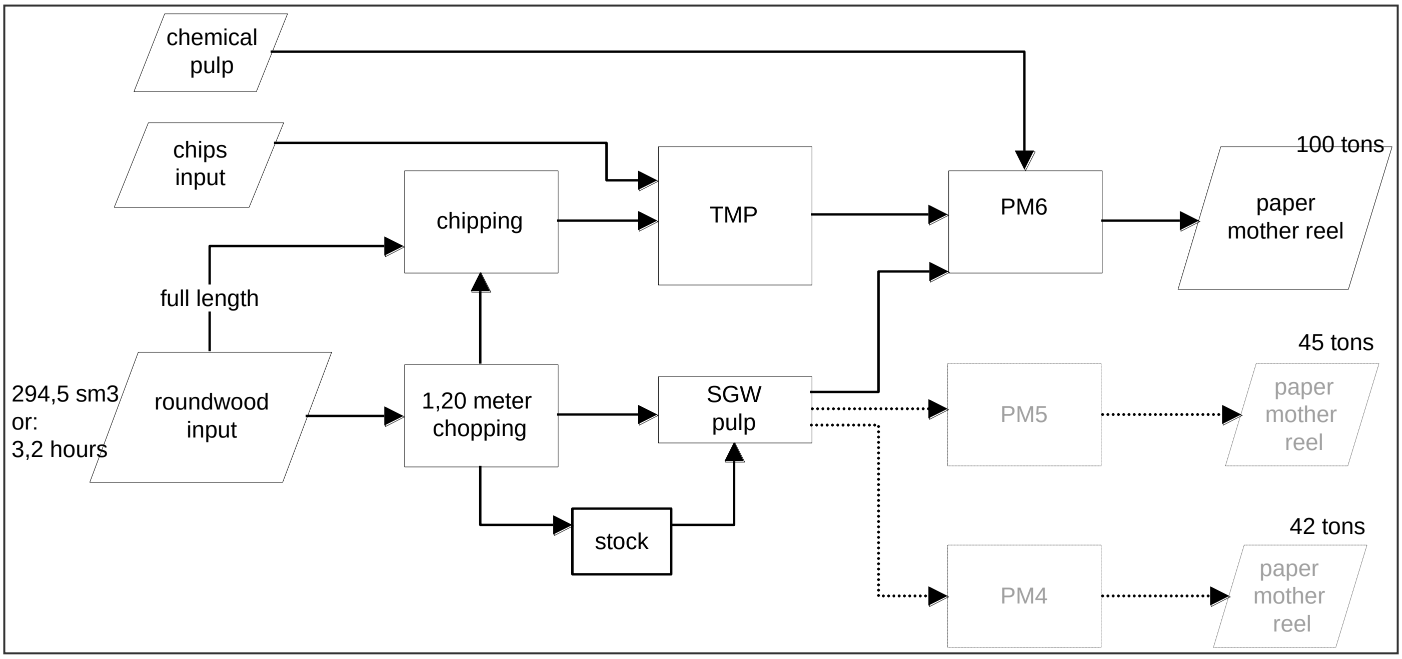
The Saugbrugs plant consists of three coupled paper machines that use the same fibre inputs. Therefore much more special wood is needed during a special production than for PM6 alone!

The SC paper for AS/OV is made on PM 6. The basis for the further calculation, which is shown in Diagram 3, is the production of 100 tons of SC paper on PM6. During this production, that lasts 3,2 hours, 42 and 45 tons of paper are being produced on PM4 and PM5, respectively. PM4 and PM5 are using SGW (stone groundwood) pulp and chemical pulp as well. SGW and TMP (thermo-mechanical pulp) are both using roundwood as an input.

During the 3,2 hours production 3,2 * 92 = 297 sm^3 roundwood input is fed into the combined PM4, PM5 and PM6 production in order to produce 100 tons of paper at PM6.

Diagram 2 is the basis for our calculations on traceability. Of course, there may be variations in different inputs. These should be accounted for, when making calculations for a particular batch production.

Diagram 3: Basic Flows at Saugbrugs



3.2.2 Two Questions

With the following calculation model we will be able to answer the following two questions:

- what is the precise content of certified fibre in the paper and how does it change over time during a particular production?
- to what extent will the fibre in a particular paper roll be traceable to the logging sites?

These questions will be answered on the basis of a model that describes the mixing processes from the roundwood and chips inputs until the paper production. Appendix I contains a detailed flow chart for the entire Saugbrugs process. To model all the details in that chart would be rather complicated. Therefore we focus on those process that involve considerable mixing, i.e. that spread the output of a particular input over a considerable period of time. All other processes are considered to be linear. They can be described by a single time delay parameter, in some cases with some statistical time variation (see below).

3.2.3 The Simplified Process

In Diagram 4 we have simplified the complex Saugbrugs process into its essential elements.

After the roundwood input, the process splits up into the SGW and the TMP process. The two processes join and then go to the paper making process:

- the SGW process is a rather simple flow process in which no major mixing occurs. The process time is some 16 hours. In order to have the certified wood from both processes at the same time into the bleached pulp process, an additional delay after debarking of 10 hours is necessary (intermediate storage). We model the entire SGW process as a simple linear process with some statistical variation.

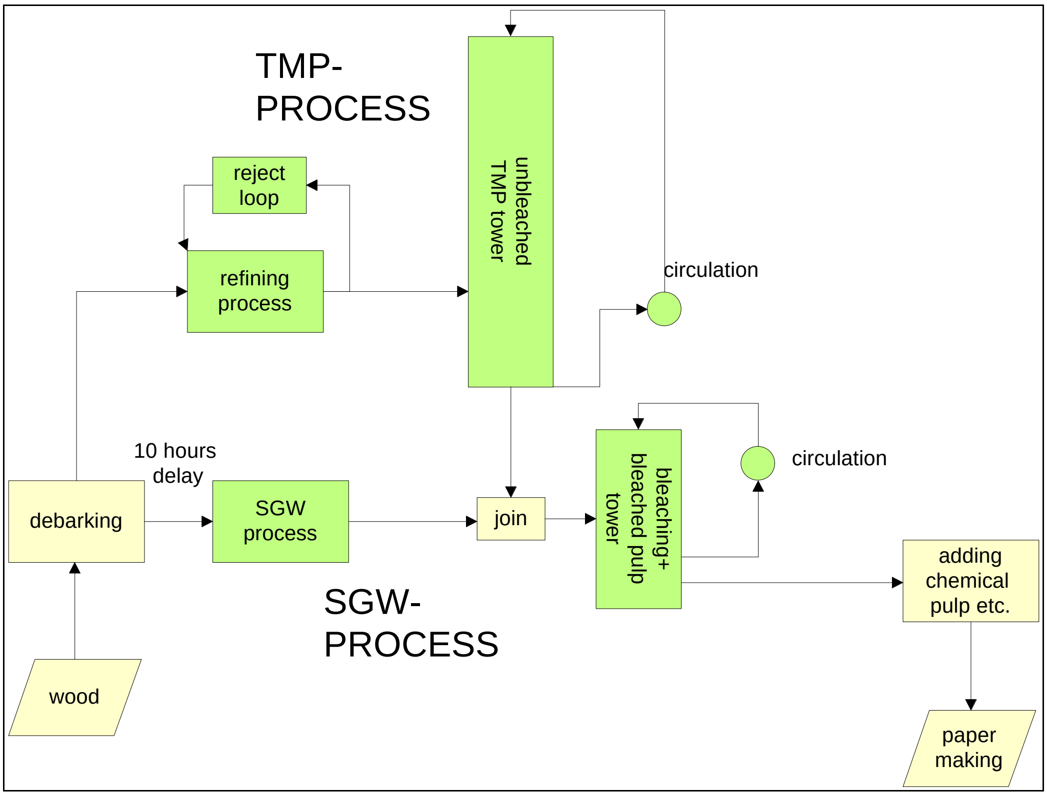


Diagram 4: Simplified Flow Diagram

- the TMP-process contains two important mixing events:
  a) in the refining process there is a reject loop that feeds in a part of the TMP back into the process;
  b) the unbleached TMP tower has a re-circulation pump that pumps the unbleached TMP from the bottom to the top of the tank.
  Both processes are modelled explicitly below.
- After the TMP and SGW processes have joined, there is a bleached pulp tower with re-circulation that is modelled explicitly, see below.
- The process after the bleached pulp tower is a simple linear process with a duration of some 54 minutes.

Reducing Re-circulation Speed

The mixing process in the 4000 m^3 unbleached TMP tower has the effect that after switching from uncertified to certified wood inputs there is a long time before pulp with a high certified content comes out. Therefore, we have considered the possibilities to reduce the speed of re-circulation in this tank explicitly or even to switch it off.

Also the mixing time in the 2000 m^3 bleached pulp tower has a considerable influence on the yield of certified paper from a given amount of certified wood. We have calculated the possibility of switching the re-circulation pump of the bleached pulp tower off.

3.2.4 The description of a mixing process

We have used a simple mixing model for modelling (a) the reject loop, (b) the unbleached TMP tower and the (c) bleached pulp tower. The model is basically the same for all mixing processes with a little change for the reject loop. Here we apply the calculation model to the unbleached storage tank.

A mathematical model of the re-circulation process

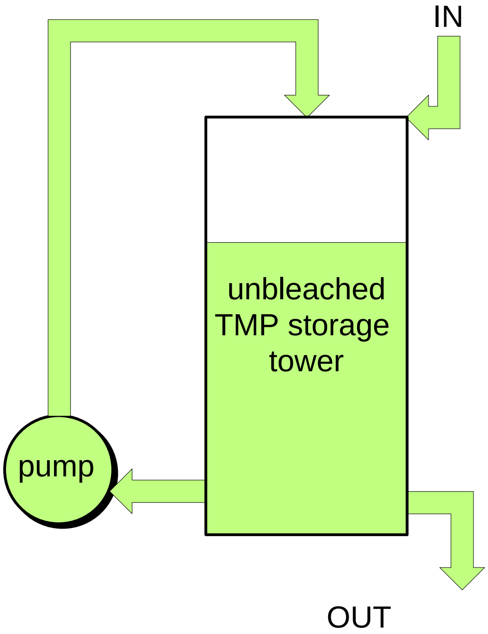


Diagram 5: Unbleached TMP tower with circulation

The mixing process in the tank basically depends on the ratio of the pulp throughput through the storage tank and the circulation speed. If the circulation is high, certified inputs will be 'contaminated' by non-certified pulp pumped from the bottom of the tower. The throughput of pulp through the tank is some 105 l/sec. If we assume that circulation is some 200 l/sec and we assume some mixing processes in the tank, we roughly calculate the output percentage of certified pulp over time. See the calculation below.

Mathematical description of the mixing process

The throughput velocity is $v_{through}$. The circulation velocity is v_{circ}. We define the ratio a as

$$a = \frac{v_{circ}}{(v_{through} + v_{circ})}$$

An input at the top of the tower at a certain point of time comes out in different fraction after n = 1,2,3, …. times going through the tank.

q_{in} is the fraction at the top of the tank, q_{out} is the fraction coming out at the bottom.

$$q_{in} = a^{n-1}$$

$$q_{out} = (1-a) * a^{n-1}$$

In our example of the unbleached TMP tower, *a* is about 2/3: two third is being re-circulated from what reaches the bottom. After every re-circulation a new, smaller fraction comes out. After 8 cycles, see Diagram 6, more than 95% of the fibre has left the storage tower.

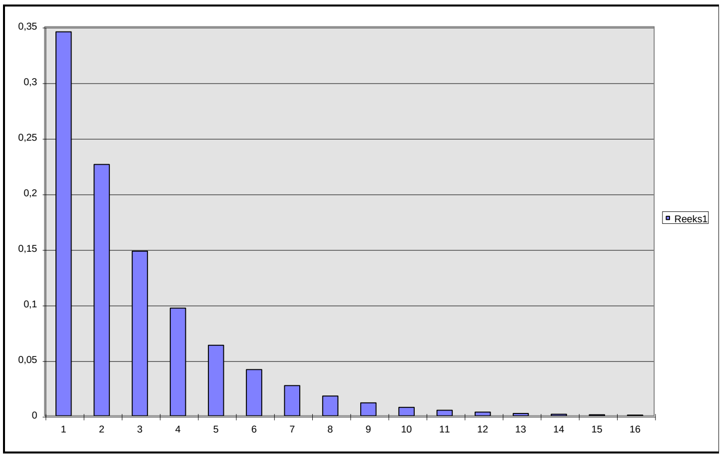


Diagram 6: Output fractions for each re-circulation loop

Conversely, if we look at the output of the storage tower at a certain time *t*, the fibre is the addition of different inputs that have gone 1,2,3, …., *n* times through the storage tower. A certain output at a certain time derives from the following inputs:

$$q_{in} = (1-a)*a^{n-1}$$

Evidently, the sum of all inputs equals 1 (100%):

$$\sum_{1}^{\infty}(1-a)*a^{n-1} = 1$$

Each re-circulation cycle has the duration of

$$\Delta t_{cycle} = \frac{V}{v_{circ} + v_{through}}$$ in which V is the tower's effective volume.

In the unbleached TMP tower example (level 70%)

$$\Delta t_{cycle} = \frac{70\% * 4000\,m^3}{(244+720)m^3/h} = 2{,}9\text{ hours}$$

With n re-circulation cycles, a time $n*\Delta t_{cycle}$ is associated.

The inputs consists of certified fibres from t_{start} with a duration of Δt.
For the rest of the time, the inputs are not certified. For the output the content of certified fibre can now be calculated :
The certified output at a time t is

$$\sum_{n}(1-a)*a^{n-1}$$

where the values of n are defined by

$$\frac{t-(t_{start}+\Delta t)}{\Delta t_{cycle}} < n < \frac{t-t_{start}}{\Delta t_{cycle}}$$

The result is that the percentage of certified pulp builds up in steps. The time length of the steps is equal to Δt_{cycle}. After *n* cycles the level has built up to

$$\sum_{1}^{n}(1-a)*a^{n-1}$$

Matrix expression for the re-circulation process

We can describe the input-output process by a simple transformation matrix.

The output is calculated by

$$\vec{o} = M.\vec{i}$$

in which $\vec{i}$ contains the input values i_t, i.e. the content of certified fibre in the input at time *t and* $\vec{o}$ contains the output values o_t, i.e. the content of certified fibre in the output at time *t.*

A column j of matrix M represents the contributions of inputs at *t=j* to the outputs at time *t=i*. The values in the first column of M are calculated from the above mathematical model. If, for example, Δt_{cycle} = 2,9 then we will have a matrix such as

0,25															
	0,25														
		0,25													
0,19			0,25												
	0,19			0,25											
		0,19			0,25										
0,14			0,19			0,25									
	0,14			0,19			0,25								
		0,14			0,19			0,25							
0,11			0,14			0,19			0,25						
	0,11			0,14			0,19			0,25					
		0,11			0,14			0,19			0,25				
0,08			0,11			0,14			0,19			0,25			
	0,08			0,11			0,14			0,19			0,25		
0,06		0,08			0,11			0,14			0,19			0,25	
	0,06		0,08			0,11			0,14			0,19			0,25
		0,06		0,08			0,11			0,14			0,19		

Zeros in the matrix have been left blank. We only calculate the first column as there is no change in the process parameters over time. The next columns are the same but each next columm shifted one position further down. Note that we have to round the output times 2,9 / 5,8 / 8,7 etc. to entire numbers 3, 6, 9 etc. This creates a little inaccuracy in the calculation outcomes.

The same matrix calculation method was used for the bleached pulp storage tank.

Modelling the TMP refiner and reject process

The refiner process including the reject loop was modelled basically in the same way. Here two times are important: the time through the refiners (37 minutes) and the time through the reject loop (34 minutes). The total loop lasts 71 minutes. The outputs of a particular input at time *t* come at *t+37, t*+37+71, *t*+37+142 etc. The output fractions are calculated exactly the same as with the re-circulation loop, as are the matrix elements.

3.2.5 The description of a time variation in a linear process

For the SGW line, we have considered some variation around an average value. We used CTS data for 'theoretical' and 'real' delay times and have assumed that

- the average of the normal distribution is between the two values given by CTS;
- that the difference between the two CTS values equals to 2 standard deviations.

We used the standard Excel formula for a normal distribution. For the SGW line we calculated an average of 26,5 hours and a standard deviation of 0,4 hours. Using the standard deviation curve, we calculate the outputs for hours 25, 26 and 27 as 9,8%, 81,5% and 8,7%, neglecting the very small contribution to other hours. The first column of the transformation matrix is calculated similarly to the re-circulation example: the first column contains the mentioned figures at the positions i = 25, 26 and 27. The following columns are then simply derived from the first one by shifting downwards.

3.2.6 The overall model

Calculation steps

The calculation consists of an input vector and four matrices. Together with some parameter choices they result in the output vector. The calculation goes along the following steps.

1. First the input vector of certified roundwood logs is defined. The vector contains of the value 1 (100%) for certified logs and the value 0 for non certified logs. The number of hours with the value 1 is calculated from the stock of certified wood and the wood consumption per hour.
2. The first part of the TMP line is modelled by the matrix MAT_TMP1 which includes the refiner process as described above multiplied with *r,* the percentage of roundwood in TMP (about 80%), and into which all additional time delays until the output of the refiners have been included.
3. The second part of the TMP line is modelled by the matrix MAT_TMP2 which includes the re-circulation process in the unbleached pulp tower.
4. The total TMP line is modelled by the product of the refiner matrix and the unbleached pulp matrix: MAT_TMP_TOTAL = MAT_TMP1.MAT_TMP2.
5. The SGW line is modelled by MAT_SGW which is the matrix for the normal distribution function of the SGW line as discussed above, including all the time delays from debarking until the point where the SGW and the TMP processes join. An important parameter is the delay time between debarking and the SGW process, which should be about 10 hours so that both processes join in time.
6. The joining of the two processes is modelled by combining MAT_TMP_TOTAL and MAT_SGW. The new matrix is generated by a weighted addition of both matrices
   MAT_UNTIL_JOIN = *a* MAT_TMP_TOTAL + *b* MAT_SGW,
   in which a and b reflect the mixing ratio of TMP and SGW. In our case *a* and *b* are about 0,78 and 0,22 respectively.
7. The last part of the process has been described by MAT_END which contains the re-circulation process in the bleached pulp tower + all additional time delays. It also contains a factor for the addition of non

certified chemical pulp. In our calculation, only 93% is TMP and SGW so that a multiplication with 0,93 is part of the matrix.

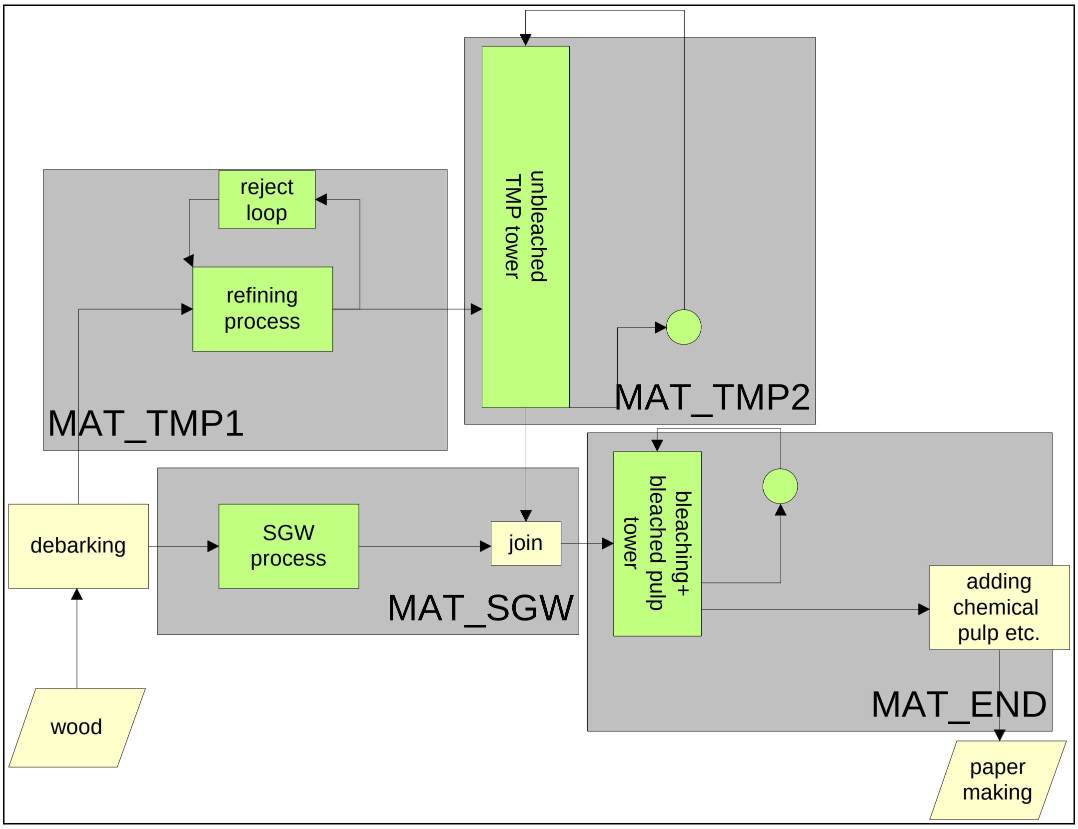


Diagram 7: Elements of the calculation

Calculating the Traceability through the Saugbrugs Mill

The total transformation matrix gives direct insight into the provenance of each output (with the precision of one hour). The i^{th} row contains the inputs at time = *j* to the output at time *i*.

3.2.7 The Excel Calculation

The above calculation has been modelled in Microsoft Excel 97. The top worksheet contains the user interface (see Diagram 8). The left hand side contains the inputs parameters, the right hand side contains the output data.

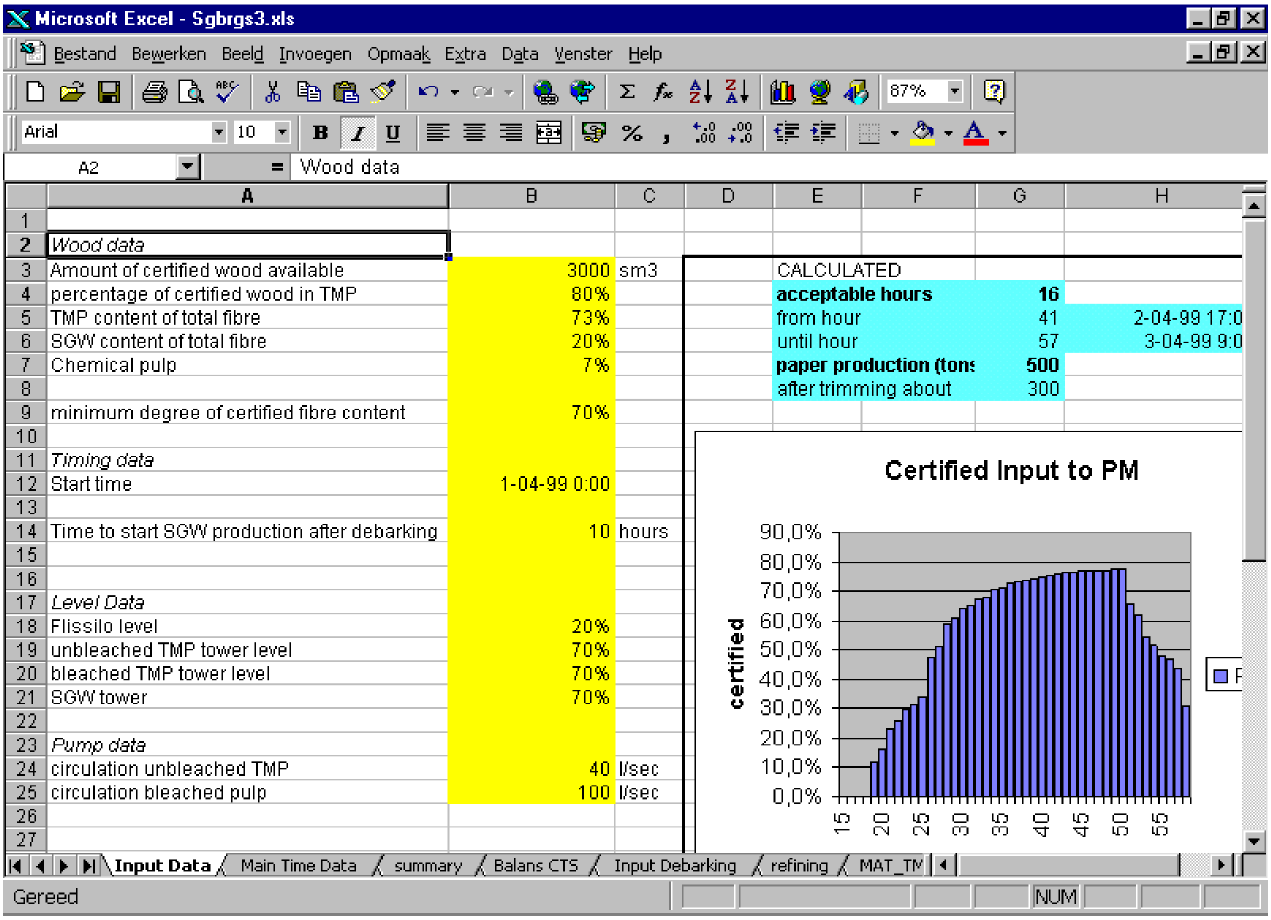


Diagram 8 : The User Interface

	A	B	C
1			
2	*Wood data*		
3	Amount of certified wood available	3000	sm3
4	percentage of certified wood in TMP	80%	
5	TMP content of total fibre	73%	
6	SGW content of total fibre	20%	
7	Chemical pulp	7%	
8			
9	minimum degree of certified fibre content	70%	
10			
11	*Timing data*		
12	Start time TMP process	1-04-99 0:00	
13			
14	Time to start SGW production after debarking	10	hours
15			
16			
17	*Level Data*		
18	Chips silo level	20%	
19	unbleached TMP tower level	70%	
20	bleached TMP tower level	70%	
21	SGW tower	70%	
22			
23	*Pump data*		
24	circulation unbleached TMP	200	l/sec
25	circulation bleached pulp	220	l/sec
26			
27			

Input Data / Main Time Data / summary / Balans CTS / Input Deba

Gereed

Diagram 9: The Input Section

In the input section, the values of the following parameters have to be typed in by the plant operator:

- Data relating to the wood & the paper recipe:
  - the amount of certified wood available,
  - the percentage of certified wood in TMP,
  - the TMP content of the total fibre;
  - the SGW content of the total fibre
  - the chemical pulp content
  - the minimum percentage of certified fibre that is acceptable for certified paper

- Time data: the delay time between debarking and feeding the wood into the SGW process. Note that times in this calculation have the precision of one hour and cannot be calculated more precise.
- Levels of the main storage tanks in the system:
  - the chips silo
  - the unbleached TMP tower
  - the bleached pulp tower
  - the SGW tower
- Re-circulation speeds
  - unbleached TMP tower,
  - bleached pulp tower.

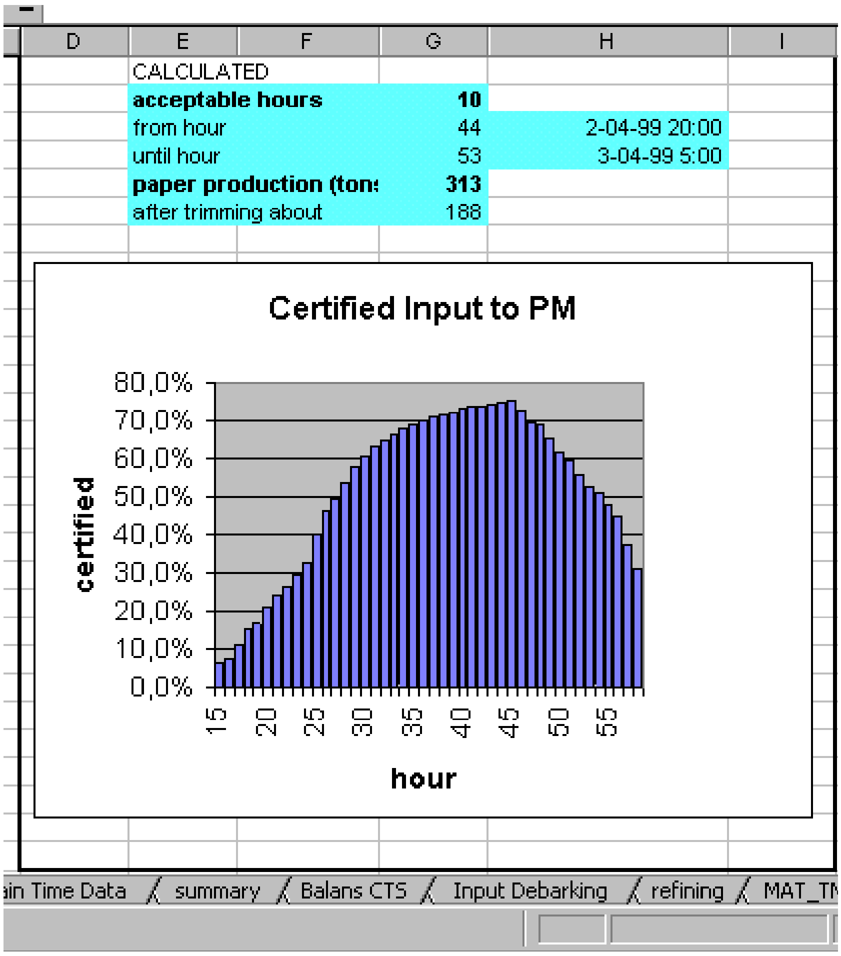


Diagram 10 : The Output Section

The output section contains a graph of the certified output and the times at which the certified content is above the level specified in the input section. It is also indicated how much certified paper will be at the mother roll and a conservative estimate is made of how much will be left after trimming (see Diagram 10).

In addition, there is a graph of the distribution of inputs to a particular output. This shows the back-traceability of the fibre from the paper to the certified wood input. If the distribution is narrow, there is back-traceability: the paper can be linked to a sub-set of the total range of input deliveries.

Calculation results

The output curve for a standard calculation with 3000 sm^3 of certified wood is show in Diagram 11. The levels of the three towers (unbleached TMP, bleached pulp and SGW) are 70% and the chips silo level is 20%. There is a time delay of 10 hours between debarking and the SGW line. Re-circulation pumps are working normally. We have assumed a production start on April 1st, 0 hours. The first certified paper comes out 44 hours later (April 2nd, 20.00 hours) and there will be 10 hours certified paper production or 313 tons on PM6.

CALCULATED		
acceptable hours	**10**	
from hour	44	2-04-99 20:00
until hour	53	3-04-99 5:00
paper production (tons)	**313**	
after trimming about	188	

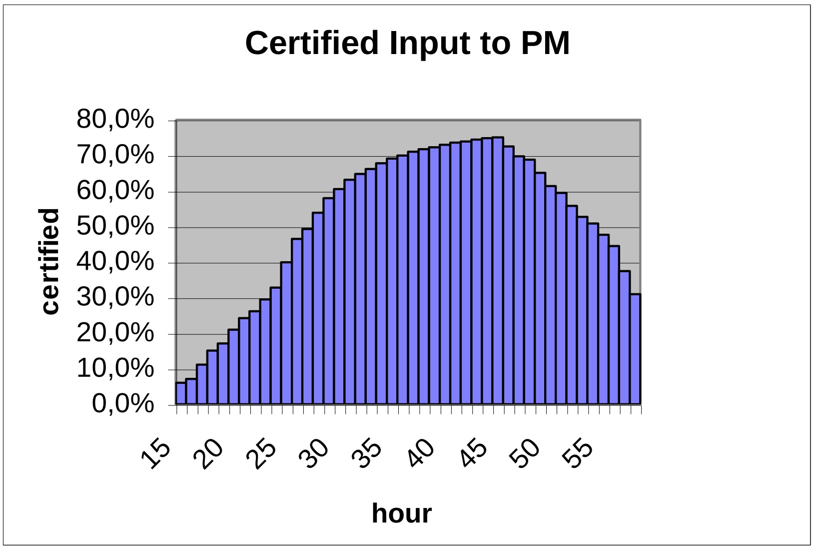


Diagram 11: Output for Standard Calculation with 3000 sm^3

We have re-calculated with the following variations:

- using more or less wood: 2500 sm^3 or 3500 sm^3
- switching off the bleached pulp circulation,
- additionally reducing the unbleached TMP re-circulation pump speed from 200 litre/sec to 40.

The outcomes are listed in Table 1. With normal circulation, about 2100 sm^3 is needed before we can produce the first ton of certified paper. Therefore we need some 3000 sm^3 to have some reasonable production. If we stop the bleached pulp tower re-circulation, the start-up quantity is reduced to some 1750 sm^3 .

If we additionally reduce the circulation in the unbleached TMP tower to 40 liter/sec, the start-up quantity is reduced to some 1000 sm^3 . This option has not yet been proved to be feasible and will be studied further if there is a need for having a higher yield of certified paper. If there is enough certified wood available, the option should not be considered for quality reasons. Switching off the bleached pulp re-circulation for some time has been applied earlier and does not appear to have quality implications. This is an interesting option since it provides more than 100 tons of additional certified paper, see Table 1.

Production of certified paper in different scenarios			
	2500 sm^3	3000 sm^3	3500 sm^3
normal circulation	156	313	531
no bleached pulp circulation	281	438	625
+ reduced unbleached pulp circulation	531	688	875

Table 1: Certified Paper Production in Different Scenarios

In all our calculations, we have assumed that paper with at least 70% of certified fibre (as a percentage of total fibre) will be accepted as ‘certified’. Theoretically the maximum percentage is 78%, as is shown in the calculation below. In our standard calculation values do not reach this maximum but stay below 76%.

	paper recipe	certified	contribution to certified content
TMP	73%,	80%	58%
SGW	20 %	100 %	20%
Chemical pulp	7%	0%	0%
TOTAL	100%		78%

Table 2: Maximum Certified Fibre Content

Back-traceability through the Saugbrugs mill

In Diagram 12, we have shown an example calculation of back-traceability of a particular output. We here see that for the output at t_{out}=55 there is a whole range of inputs from t_{in}=0 to t_{in}=33.

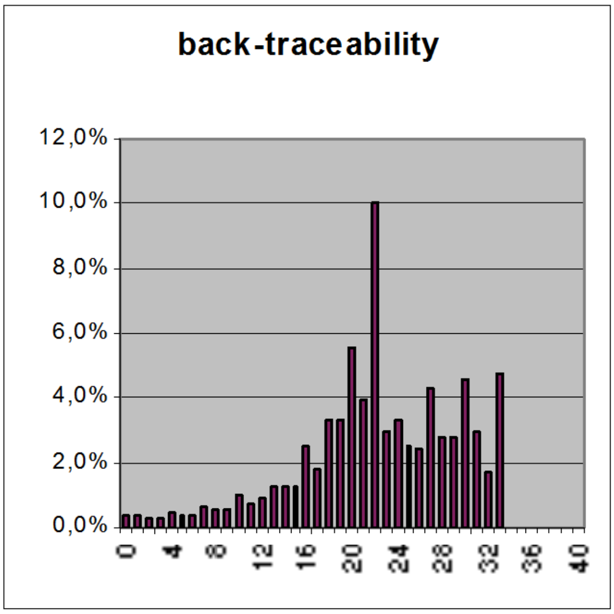


Diagram 12: Back-traceability

If we only count those inputs that contribute more than 2% to the output, we can limit the inputs to a period of 17 hours out of a total certified input time of 32 hours. In principle we can limit the list of suppliers to this particular output to about half the total list. Evidently there can be no link between a particular piece of paper and a particular supplier. This calculation shows the obvious: paper making is a very efficient mixing process.

3.3 Paper Production for Springer and Otto

Trimming

Paper at PM6 is produced at a width of 862 cm. PM6 is mostly producing for more than one customer at the same time. Experience has shown, that to produce 500 tons of paper, in some cases an additional 485 tons is necessary in order to trim the paper machine.

For the productions planned for Axel Springer and Otto Versand, this figure may be more favourable, see below.

Production for Axel Springer (Familie & Co.)

- For the production of one issue of the elected Axel Springer Journal, there is a need for 134 tons of certified paper on the average.
- Additional quantities needed for trimming depend on the widths for Familie & Co and the possibilities to combine with width for other clients. An example of widths for the Familie & Co Journal is given below.
- Actual trimming data cannot be defined on beforehand, only some rough guesses. If, for example, only 236 cm is being used. Then three widths of 236 cm could be produced, if there happens to be a client for the remaining 154 cm. In that case 708 cm of the mother reel goes to Axel Springer. But it is more realistic to assume that only two widths can be produced for Axel Springer, leaving 390 cm for other clients, which gives an effective production for Axel Springer of only 55%. With three paper rolls of 207 cm on one mother reel, leaving 241 cm for another client, there could be an effective production for Springer of even 72%. In some cases, combining the different widths for Axel Springer (and Otto Versand) could give even more favourable figures. In our calculations we stay on the safe side by assuming 55% as an average.
- For one issue of Familie & Co, there will be a need for 244 tons of paper on the mother reel.
- For production we need
  - With normal circulation we need 718 sm^3 + 2117 sm^3 for change-over = 2835 sm^3
  - With circulation stopped in the bleached pulp tower we need 718 sm^3 + 1749 sm^3 for change-over = 2467 sm^3.
  - With 3250 sm^3, we could easily produce two issues at one time: 531 tons of paper.

Paper Family & Co July 97 - June 98				
Edition	Width = 236,0 cm	Width = 207,0 cm	Width = 177,4 cm	
07/97	147 tons			147 tons
08/97	0 tons	131 tons		131 tons
09/97	137 tons			137 tons
10/97	80 tons		60 tons	140 tons
11/97	74 tons		57 tons	131 tons
12/97	82 tons		59 tons	141 tons
01/98	146 tons			146 tons
02/98	82 tons	48 tons		130 tons
03/98	86 tons	50 tons		136 tons
04/98	80 tons	46 tons		126 tons
05/98	76 tons		37 tons	113 tons
06/98	131 tons			131 tons
total	**1121 tons**	**275 tons**	**213 tons**	**1609 tons**
average				**134 tons**

Table 3: Familie & Co Data

<u>Production for Otto Versand</u>

- For the production of one special catalogue for Otto Versand, there is a need for 100 tons of certified paper on the average.
- Additional quantities needed for trimming depend on the widths for Familie & Co and the possibilities to combine with width for other clients. An example of widths for the Familie & Co Journal is given below.
- Actual trimming data cannot be defined on beforehand, only some rough guesses. In our calculations we stay on the safe side by assuming 55% as an average, although 77% effective production could be realistic, see diagram below.

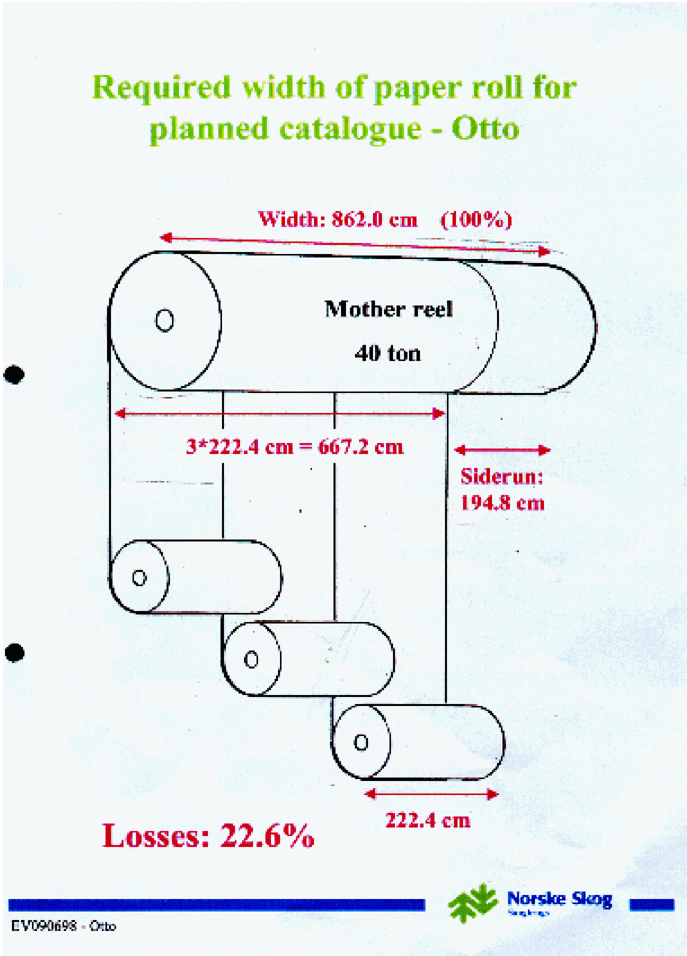


Diagram 13: A Trimming Example

- For one catalogue, there will be a need for 182 tons of paper on the mother reel.
- For production we need
  - with normal circulation we need: 535 sm3+ 2117 sm3 for start-up. In total: 2652 sm^3 per issue.
  - with circulation stopped in the bleached pulp tower: 535 sm^3 + 1749 sm^3 for start-up. In total: 2284 sm^3 .
  - It would be better to combine this production with a production for Axel Springer.

Demand for certified wood

Since switch-over quantities are substantially higher than the quantities of wood that we need for the actual production of certified paper, there are good reasons to combine two issues of the AS Journal or an issue of the journal with an Otto catalogue. With 12 editions of the journal and 2 catalogues, there will be 7 production runs. With no changes in the bleached pulp circulation, we will have a maximum need of 3554 sm^3 of certified wood on the wood yard per run. If we switch off the circulation in the bleached pulp tower, there will be a maximum need of 3186 sm^3.

With more efficient trimming 3000 sm^3 can be sufficient for any scenario.

Month	Paper demand (untrimmed)		Production batch	wood needed sm3	
	AS	Otto	tons	normal	bleached pulp circulation off
1	244		488	3554	3186
2	244				
3	244	182	426	3372	3004
4	244		488	3554	3186
5	244				
6	244		488	3554	3186
7	244				
8	244	182	426	3372	3004
9	244		488	3554	3186
10	244				
11	244		488	3554	3186
12	244				

Table 4: Demand for Certified Wood

3.4 Quantities of Traceable and Certified wood

Quantities

[Details are included in the full version of this report]

The different inputs differ by ecological standards, traceability and the possibility of performing checks:

- all wood coming from Norway and Sweden can be assumed to conform to high ecological standards.
- all wood coming by truck is traceable, as either Norwegian of Swedish supplier numbers are known, when the truck arrives at the measuring station at Kasa wood yard.
- only wood coming from Norway may be subject to a Saugbrugs checking system. It will not be easy to perform such checks in Swedish forests.
- wood coming by train from Norway has the same ecological standard as other Norwegian wood, but tracing is difficult and cannot be organised without considerable difficulties and costs.
- chips cannot be traced.

Wood Available for Special Productions

Only wood coming by truck from Norway can be traced and checked. As the project goal includes both traceability and the establishment of a checking system, *special productions should be made from Norwegian wood coming by truck only*.

Maximum wood input for the special production on a annual basis would be some 72000 sm^3 [1].

The vast majority (more than 90%) of the wood coming by truck from Norway comes from Nedre Glommen & Haldenvassdraget. Therefore the

[1] in **Fout! Verwijzingsbron niet gevonden.**, the figure of 72000 sm^3 has been mentioned. This is a relatively low figure, could become higher again.

most practical option has been chosen: to use only Nedre Glommen & Haldenvassdraget wood, not from Glommen and Mjøsen. This has simplified the contract aspect: standards and checking need only apply to these two associations. Mjøsen and Glommen wood are being treated as 'Swedish wood' in this project.

Regularly special productions of about 200 tons of paper can be made for AS/OV. They contain a maximum of about 70% traceable and certified fibres. The checking system is applied to the suppliers of Norwegian roundwood, supplied by truck.

Wood on the Kasa wood yard should not be stored too long, preferably not longer than 10 days. If we look at the statistical variation of deliveries from Haldenvassdraget and Nedre Glommen, we see that during the winter time, it will be generally possible to have 3000 sm^3 or even more collected within 10 days. During the rest of the year there is a need for some additional planning to ensure that enough wood comes to Kasa:

- Norske Skog supply should make arrangements with the two forest owner associations to deliver more wood in certain weeks;
- Additional wood can be brought from the other side of the Oslo Fjord from forest owner association Nidarå. The transport has to be done by ship.

This relative shortness of certified wood supply stresses the importance to reduce the number of production batches by intelligently combining the paper needed for different issues of the journal and the catalogue. Making more batches will only slightly reduce the amount of wood needed per batch but will have the effect that planning problems both in wood supply and in paper production will occur more frequently.

4. The Paper Chain of Custody

this chapter is contained in the full version of the report only.

5. Checking the Logging Sites

5.1 Forestry Standards

5.1.1 Provisional Standards

The challenge of this project was to create a tracing system combined with ecological standards for the wood used in the special production for Axel Springer Verlag and Otto Versand. The ecological forestry standards had not been defined yet before the project start. They were defined in the first phase of the project.

As the project's philosophy is that the partners in this project are pioneers ecological trend-setters in their own area, the project partners have looked for several options to be ahead of industry's main-stream developments. Originally it was considered to be useful to define a set of Saugbrugs criteria before there was an officially agreed set of Norwegian standards. But, as the Levende Skog criteria became available during the course of project preparations, there was no alternative: the Levende Skog standards were taken as the basis for the requirements to be put into the contracts with the forest owner associations and for the checking system.

A preliminary version of the Living Forest criteria was discussed in Norway in early 1998 in an advisory committee meeting. A consensus on the final standards has been reached on April 1st 1998. In the course of 1998, requirements for certification were defined and when the first productions in this project for Axel Springer Verlag and Otto Versand started, there were some Norwegian forest associations were already certified according to Levende Skog standards and the ISO 14001 system.

The project partners have decided not to wait for the establishment of a fully developed official standard and certification system but to use those elements that could be implemented rapidly. The resulting 'Saugbrugs' standard is a sub-set of the Living Forest standards that can be checked *after the actual logging*.

The standards have been implemented through the contract system: the contract between Norske Skog Supply and the forest owner associations and the contract between the forest owner associations and their members. The checking is performed by third party inspection, see Chapter 5.

In Table 5, the standards that were derived from the Levende Skog standards have been listed. The originally proposed standard for “old growth forest” was left out, since it was not seen to be a clearly defined operational standard. Levende Skog standards that were left out are not less important but were not applied since they could not be checked easily after the logging has taken place. The application of the preliminary Saugbrugs standards only represents a transition situation. Within a number of months all Saugbrugs suppliers will have a Levende Skog certificate and through the Levende Skog certification system, all Levende Skog standards will apply, not only this temporary sub-set. This is already the case for Nidarå. Nedre Glommen will be certified in the course of 1999. Certified wood suppliers will not be checked by the project’s own checking system.

Table 5: Detailed Standards

Standard	Goal	Description
1. *No wood from nature reserves may be used in any of Saugbrugs productions* No LF standard.	• To prevent logging in already protected areas • To highlight the awareness of protection rules	• The reserves are all given detailed boundaries on maps. • All forest owners have been informed individually .
2. *No wood from areas under consideration for protection may be used in any of Saugbrugs productions.* No LF standard	• To prevent logging in areas that official authorities have listed as potential nature reserves, while monitoring and evaluating.	• County authorities have made “Bruttolister” for potential coniferous forest reserves. There are no legal prohibits against logging in these areas. • Draft boundaries are marked on maps with varying precision. • All forest owners have been informed individually. • County and municipality plans contain series of area types for potential nature protection. • Draft boundaries are marked on maps with varying precision • All forest owners have been informed individually or collectively.
3. *Wood from Oslomarka*	• Oslomarka, 170 000 ha, is the most intensively used	• Oslomarka has detailed boundaries on maps. • All 2000 forest owners have been informed.

shall be harvested according to the codes of practices (Forskrifter til §17b) No LF standard	recreation area in Norway. Special codes of practices were developed in 1977 to reduce logging activity, to make landscape planning possible. The goal is to increase recreational values and to protect biodiversity.	• Application necessary for all logging operations. • NGOs have the right to appeal decisions made by local authorities
4. *Areas of biological importance -* *Key biotopes.* (LF standard)	Many rare and endangered species are dependent on dead wood to live and breed. Registration of key biotopes will be implemented and their values maintained	• Areas with stable local climate, considerable numbers of special trees, dead stems or special locations, are probable habitats for rare and endangered species. • Research is going on in order to develop clear definitions of key biotopes.
5 (LF standard) *Older large sized trees and dead wood*	• To secure continuous support of dead wood in all degrees of destruction in all reforested areas. • To protect existing and to secure continuous support of dead wood in all degrees of destruction in all reforested areas.	• when logging, 5-10 life cycle trees pr ha, shall be left on the site or in a connected border zone. • As life cycle trees, old or/and special trees, trees containing nests etc. have priority. • Dead life cycle trees shall remain in the forest. Dead stems older than 5 years shall not be removed or damaged. • Damage to dead trees during their middle and late deterioration stage must be avoided by any forest operation.
6. *Border zones* (LF standards) - *Culture landscape* - *Bogs and forest wet land* - *Aforestations* - *Water protection*	• To cover several biological and recreational functions: - habitats - shelter - aesthetic	• The with and the composition of the border zones depend on purpose and local conditions. • Border zones shall be left or when missing, created along streams, creeks, lakes, marshland and agricultural fields.
7. LF standards: *Forest affected by fire*	• Many rare and endangered species are dependent on burned wood to live and breed.	• Fire struck areas less than 0,5 ha shall be left untouched. • In larger areas minimum 0,5 ha shall remain untouched.
8.	• To maintain the quality of the	• Old growth forests has no specific description.

Old Growth forest/Natural forests (large virgin like forest areas of special importance to biological diversity).. (LF standard) -*Areas of biological importance (key biotopes)* -*Forest area protection* - *Cutting systems* - *Mountain forest* - *Forest roads* - *Bogs and wetland forest* (Project standard 1 & 2*)*	natural forest within the productive forest area.	Old growth contains a variation of old and younger trees, dead trees and has a stabile local climate. No signs of harvesting should be found or known.
9. (LF standard) *Terrain transport*	• Damages to terrain during the log terrain transport that are visually negative and that may cause water run-off and erosion must be avoided.	•
10. (LF standard) *Waste disposal*	• The least possible waste and spill should occur on the logging site after harvesting.	•

5.2 The Checking System(D)

It was decided to have an external auditor for performing the checks on logging sites and the tracing system used in this project. On the basis of proposals from WWF, SGS, KPMG and Norske Veritas, Norske Veritas was asked to perform the checking, with an assignment to WWF's biologists.

The use of third party checking was preferred by the German project partners because of higher credibility.