“Lean and Green” at a Romanian secondary tissue paper and board mill—putting theory into practice

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Abstract

A three-year environmental project was implemented at the Petrocart S.A. paper and board mill, through the Danish Support Programme for Eastern Europe (DANCEE). The aim was to use “Lean and Green” Production to improve industrial compliance with the effluent regulations and with EU’s IPPC Directive under implementation in Romania, thereby improving the environmental conditions in the Bistrita River running through the town. The results obtained included an 87% reduction of the discharge of wastewater from 5300 to about 700 m\textsuperscript{3}/day. Previously, the effluent was subjected to primary treatment only. The reduction in flow reduced mill fibre losses and allowed discharge to an existing, underloaded, municipal treatment system, where primary and secondary treatment is operated. Further results obtained were better housekeeping (5S and Kaizen) and a Total Quality Management (TQM) organisation was implemented where product quality, environment and occupational health and safety are merged into one system. Twenty-eight TQM groups were formed, each with a representative from management and elected among workers. The mill’s employment is slightly higher today, and the gross turnover and profitability has almost tripled. Had Petrocart had the financial resources themselves carried the project through without DANCEE support, the payback time for the project would have been 3.7 years for the total of \$2 million spent. Petrocart no longer pays penalties for environmental non-compliance. The performance contributes to IPPC-approval.

The project was implemented within the framework of DANCEE’s procedures, which is based on the Logical Framework Approach (LFA) for project management. The PRojects IN Controlled Environments (PRINCE\textsuperscript{2}) model for project management was also applied. This article analyses how
the results were achieved and how Lean and Green thinking as well as good project management practices, such as LFA and PRINCE2 were applied to turn around an old Eastern European company to survive privatization.

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### 1. Introduction

The Danish Cooperation for Environment in Eastern Europe (DANCEE) – a department under the Danish Environmental Protection Agency (DEPA) – has supported the Piatra Neamț County in Romania since 1996. During 1998, the local Romanian Environmental Protection Agency in Piatra Neamț (REPA) developed a DANCEE supported programme called “Local Environmental Action Plan” (LEAP), which included environmental projects of priority in Neamț County (Neamț County, 1998). The Programme Steering Committee in Neamț County consists of representatives from the local REPA, local authorities, companies, institutions, and NGOs. This Committee reviewed and approved the LEAP. The Committee proposed 10 projects to be developed. The current Petrocart-project was ranked third in priority in the LEAP on grounds that it would significantly contribute to ensuring clean surface waters and clean drinking water in the Bistrita River, running through the town of Piatra Neamț. The objectives were to improve the environmental performance of the Petrocart recycled paper based paper and board mill and at the same time ensure its survival after privatization in order to secure jobs and prosperity in the County.

Results showed 21% increase in recycled paper consumption, 39% increase in tissue production, an 8% yield increase due to better fibre recovery, in addition to 87% water savings, 83% decrease in TSS, and 55% decrease in COD. Overall cleanliness and housekeeping improved, employment increased slightly and the profit rate and gross turnover about tripled.

#### 1.1. The Petrocart Mill

Petrocart is located on an industrial site in the western part of Piatra Neamț, on the northern bank of the Bistrita River. The company was established in 1908 and privatized in 1998, being now a 100% privately owned company with a Romanian ownership consisting of its management, employees and a local investment company.

Prior to 1989, the company had 850 employees and produced 1500 t of paper and board per month on four paper and board machines. Today, about 400 employees produce 1250 t/month on three machines. The total production at the start of the project in 2000 was 12,000 t/year, a figure, which for 2004 is expected to increase to over 16,000 t/year, mainly because the output from the tissue machine has almost doubled due to the project. Twenty percent of the total capacity is exported. Today, the annual turnover is €5–7 million with a gross profit of €600,000, which so far has been invested in mill improvements.

Raw materials used in the production process:
• Recycled paper, 95% of the total raw material needed (1000–1200 t/month). Used for recycled paper based paper board and tissue.
• Unbleached kraft pulp used for electro-technical board, purchased from the pulp mill in Dej, Romania; 5% of the total raw material needed.
• Occasionally bleached pulp may be purchased for special white-top board.

At the start of the project, stock preparation of recycled paper was a batch process, where the only modern equipment was a Swedish ‘Krima’ system for diffusing wax, glue and hot melt adhesives entering the process as contaminants in the recycled paper. This system was installed in 1997. The rest of the pulping and screening equipment was fairly old, and there was only one single line serving both the tissue and board machines. The electro-technical board machine has a separate stock preparation system, where one of the critical quality parameters is conductivity of the final board, so an exemplary washing system is needed.

At the start of the project there were four production lines with the following products:

1. Toilet tissue; 40% of the total capacity.
2. Electro-technical board (e.g. for transformers); 5–10% of the total capacity; mostly an export item.
3. Duplex and triplex board; 45% of total capacity.
4. Heavy board as by-product from recycled fibre from the mechanical fibre recovery system applied before the river outfall; <5% of capacity.

The exact fraction of each product varies with market conditions and maintenance procedures from month to month. The production systems are maintained by an on-site mechanical workshop.

The production line for duplex and triplex cardboard was built 75 years ago, the line for toilet paper 35 years ago, and the line for electro-technical board 15 years ago. Installation of a fourth production line commenced in 1990, financed by the state budget. In 1993, the installation was discontinued. In 1997, Petrocart was divided into two parts for the privatisation. The productive part (described above) was privatised and is owned by Petrocart. The partly built, dormant, fourth line was not part of the current project, but deckers, centriscreen and other equipment was purchased from it for use in the new stock preparation department, as were foils, foil boxes and low-vac boxes for PM#3.

The Petrocart process water is supplied through a filter system from the Bistria River. Since privatisation, the company has continuously improved water recycling, to reduce water consumption but at the start of the project under discussion, it was still using much more water than a mill using Best Available Techniques (BAT) as applied in the EU BAT note. In 1996, the mill used 1200 m³/h water, and in 2000 it used only 200 m³/h for the same production capacity, the rest of water required came from recirculation.

The wastewater treatment plant commenced operation in 1965, and consisted of sedimentation only. The wastewater was discharged by gravity into the Borzoghian Creek, about 100 m above its confluence with the Bistria River. The total capacity of the clarifiers is substantially greater than required for the current effluent flow and in fact only two of the basins are used and then only in emergency situations when the city sewer may flood—which has never happened during the two years of operation with discharge to the municipal sewer.
1.2. DANCEE assistance

On the basis of the priority in the REPA’s LEAP, DANCEE decided in 2000 to explore the possibility of supporting a Petrocart-project. DANCEE funding of projects requires strict procedures to be followed as described in DANCEE Project Cycle Manual (DEPA, 1998). Project preparation is the development of projects from the initial idea to the final Project Document (which is an Initiation Stage Plan). The preparation process of projects by application and of projects by tender is outlined in separate sub-sections of the manual, which also describes quite rigid procedures to be used for contracting by DEPA and the standard conditions and responsibilities of the Project Holder (the company responsible to DANCEE and which employs the Project Director). Procedures for project implementation outline the suggested project management structure and contain guidelines and procedures for reporting and monitoring. DANCEE also has procedures for project evaluation, which contain guidelines for reviews, end-of-project and post-project evaluations. DANCEE’s procedures for project identification and project implementation are based on the Logical Framework Approach, briefly described below.

2. Methodology

2.1. Project management

Project management relied on three techniques, Logical Framework Approach for the initial planning of the project as required by DANCEE, the principles of PRINCE2 for the procedures of project, and Lean Production with particular emphasis on Kaizen, 5S and 3R (explained below) as the starting points.

2.2. Logical Framework Approach (LFA)

LFA is an analytical tool for objective-oriented planning and management of development projects (Mikkelsen, 1995). Its approach is target group-oriented and to be successful requires participation of all involved stakeholders.

The methodology has been developed through the 1980s by the German Agency for Technical Cooperation (GTZ), the Norwegian Agency for Development Cooperation (NORAD, 1992), the Danish International Development Assistance (DANIDA), and several other development organisations. As mentioned, DANCEE has developed its own LFA based Project Cycle Manual (DEPA, 1998), which has guided the implementation of the current project.

The project development process is seen as a sequence of development hypotheses, where available inputs are assumed to lead to activities, which are assumed to lead to outputs, then to immediate objectives and to development objectives. While the first levels are largely under management control, the certainty diminishes at the higher levels. These

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1 PRINCE2 is a trademark of APM Group in UK.
uncertainties are explained as external factors (assumptions and risks) outside the direct control of management, but have to be integrated for the development project to succeed. The Project Document is built around the elements of the LFA Matrix, as exemplified in this article. Provided the identified assumptions have been correct and the risks avoided, the project input will then lead to the desired immediate objective and contribute to the development objective. During project implementation the monitoring of indicators for outputs and objectives, and of assumptions and risks are crucial for the assessment of progress. In an organisation, such as the one exemplified in Fig. 1, it is the job of the Project Management Group/Project Board to issue progress reports on a quarterly basis (highlight reports) for this purpose and the DANCEE Programme Steering Committee (PSC) shall assess and hopefully approve the recommendations and assessments in the progress reports. DANCEE’s approval of a Project Completion Report (End Project Report) terminates the project.

Advantages of the LFA are:

• addresses fundamental questions;
• systematic and logical approach to project design;
• highlight linkages between project element and external factors/risks;
• provides a basis for monitoring risks and assumptions;
• common basis for project identification.

As with all such tools the approach must be tailored and scaled to fit the actual situation. The LFA does not provide cost–benefit analyses, time planning, impact analysis, effects on the environment, etc.

2.3. PRINCE2

PRojects IN Controlled Environments (PRINCE) was established in 1989 as a tool for managing governmental IT projects, but was soon recognised as a very useful general project management tool. PRINCE2 (P2) was therefore launched in 1996 with improved guidance for project management of all projects and is today the de facto standard for the UK government projects. The P2 manual is UK Crown copyright (OGC, 2002). P2 aims to be Best Practice at all times, and is continually improved by the joint effort of P2 practitioners.

‘Starting up a project’ in P2 requires a Project Mandate from a Programme Committee or similar, describing in high-level terms the reason for the project and what product is required. In the context of development projects, P2 may be used to develop the Project Identification in accordance with the principles of the participatory approach of LFA, and this can be an entire P2 project in itself or just the start-up process. With a draft Project Document (containing the Business Case), a tender or project-by-application procedure can be set up, and a Project Holder can be successfully contracted by DANCEE. P2 can thus be both a project planning and a project implementation tool. In this paper, comparison with the LFA approach is limited to LFA guidelines for project implementation.

Some of the characteristics of a P2 project are:

• The focus on a Business Case with activities to achieve the corresponding products.
Fig. 1. Petrocart Project Organisation in accordance with DANCEE-LFA and PRINCE2.
The organisation structure with well-defined responsibilities and accountabilities to manage the project.

- The process-oriented approach (Fig. 2) with seven major processes divided into sub-processes.
- Eight components available to support the processes, such as Business Case, Organisation, Plans, Controls, Management of Risk, Quality in a Project Environment, Configuration Management, and Change Control.
- Techniques for Product Based Planning.
- Management by exemption, guided by definition of tolerances with regard to cost, time and quality.
- Continuous updating of the Project Plan, the Business Case and the Risk Log throughout the project implementation.
- Cutting the project management and detailed planning into administrable parts of normally 2–12 weeks duration for each management stage.

Advantages of the P2 are:

- Focus on deviation management, giving degrees of freedom for the project manager on the phase level and for the Project Steering Committee on project level. This controls the project and at the same time it minimises the necessary involvement of management at steering group level and top management at programme level.
- Common terminology and frame of reference, which makes recruitment easier and stimulates development at the personal and organisational levels.
- Standard procedures for managing tenders and supplies to the project.
• Focus on roles and responsibilities—ownership by the Project Steering Committee.
• Use of a Business Case: What does it cost, what is the effect, and what can go wrong? This is base-lined from the project start on and is updated as a dynamic product throughout the project.
• A split between management phases and specialist phases of a project: the management phases allocate resources and make control spot checks, so that bad projects are stopped as early as possible.
• With the project management methodology in place in the organisation, there is a basis for managing programmes, which is an extension of the P2 method.
• P2 is easily scaled to fit the actual project without unnecessary bureaucracy (TSO, 2002).

2.4. Lean and Green

The implementation of the project followed the philosophy of Lean Production: Banish waste and create wealth in your corporation (Womack and Jones, 1996). This requires you to (i) identify the value creating activities of your corporation, put those together in (ii) a value stream, make that (iii) flow, create (iv) a pull of the flow, and strive towards (v) perfection. The essence of the process is to identify and eliminate any waste, which consumes resources, but creates no value: transport, inventory, motion, waiting, overproduction and defects, in short “do more with less and less”—less resources, less effort, less equipment, less time, while becoming closer to providing what customers actually want. To become Lean and Green one has to focus on the waste of materials and energy, and since Lean Production was a core issue for the entire project, this paper will address the “green” results of the project.

The toolbox for Lean that has been applied to a greater or lesser extent in the Petrocart-project can be summarised (Bicheno, 2004):

• Kaizen:
  ◦ Continuous incremental improvement through low-cost optimisations (Imai, 1977).
• 5S:
  ◦ A shop floor exercise to create order by sorting, simplifying, sweeping, standardising and sustaining (The Productivity Press Development Team, 1996).
• Total Productive Maintenance:
  ◦ To ensure that every machine in a production line is always able to perform its required tasks so that production is not interrupted.
• Cellular Manufacturing:
  ◦ Layout of machinery of different types to perform operations in a tight sequence to minimise transport and waiting time.
• Just-in-time (JIT) Production:
  ◦ The ultimate goal for optimising the value chain. Products are sold before they are produced. Minimise your stock.
• Six Sigma:
  ◦ Process improvement through minimisation of variances.
• 3R:
  ○ Reduce, reuse and recycle to become Lean and Green.

• Total Quality Management:
  ○ Focus on processes that lead to improvements in quality of product, environment and occupational health and safety practices.

• Lean Enterprise Supplier Network:
  ○ Supply chain management.

In this paper, the main focus is on Kaizen, 5S, 3R, Total Productive Maintenance and Six Sigma.

2.4.1. Kaizen
As opposed to Kaikaku (Womack and Jones, 1996), which means radical improvements followed by job losses, a collapse in morale among the people who experience these changes, Kaizen refers to continuous incremental improvements by working with people and creating ownership of changes at Gemba—the shop floor. Kaizen workshops and Kaizen training were used in this project to change people’s attitude towards good housekeeping and the 3R. People had to be persuaded to use recycled process water, to discharge water with caution, to take in fresh water in a sensible manner, etc.

2.4.2. 5S
The Petrocart Plant had been in operation for almost a century, so the whole factory site was encumbered with abandoned equipment, scrap metal, building waste and other materials. Also, the operating conditions around the operating equipment were poor with dirt and sludge in most production departments. The 5S philosophy has been an ongoing activity for the duration of the project, and it still is. A neat and clean factory has higher productivity, fewer defects, more equipment up-time, and is a better and safer place to work.

2.4.3. Six Sigma
The term derives from the spread of the normal distribution; restriction of variations to within ±3 standard deviations indicating a nearly perfect process. It depends on a methodology: define, measure, analyse, improve, control, which is in essence the quality cycle Plan, Do, Check, Act (PDCA). In this project Six Sigma was an unattainable goal, but it directed everyone towards variability control—it is not only important to focus on quantity, but also on constant flows, i.e. low variability.

2.4.4. 3R
This was one of the cornerstones for Lean and Green, where water use was to be significantly reduced, process water recycled, and valuable resources sold or reused, such as scrap metal.

2.4.5. Total Quality
The idea was to combine quality according to ISO 9001:2000 with environmental quality standards as described in ISO 14001 and occupational health and safety standards such as...
the OHSAS 18001. Total Quality Management (TQM) became the new phrase to be used, and the mill was reorganised along these lines. During the project period the Petrocart Mill became certified according to ISO 9001:2000 by the German certifying company TÜV.

2.4.6. The Petrocart-Project

Project Identification revealed the needs for substantial water savings, biological treatment of the remaining effluent prior to discharge into the river as well as new production equipment and more effective operating procedures. In total €2 million was foreseen from DANCEE to conduct this project in two main phases. The first phase was the installation of water saving equipment and biological treatment, and the second phase was for cleaner technology (Lean and Green) implementation. For financial reasons, DANCEE decided to support only the first phase, as it took care of the urgent water pollution problem, DANCEE’s reason to enter the project. Terms of reference for this phase were developed, and MFG was assigned as Project Holder. The Project Document (which in P2 terminology is the Business Case) split DANCEE’s support into a management part for MFG €0.2 million and an “equipment and services” part of €1.0 million Petrocart was required to match the DANCEE fund of €1.0 million in terms of working hours, installation of equipment and contractors’ work, and the project was expected to end early in 2003.

During the Project Initiation Phase, MFG proposed and DANCEE accepted a major change to overcome the restrictive financial conditions, by deciding to rely on the biological wastewater treatment in Piatra Neamt’s municipal treatment plant, which is being modernised, and to use the financial resources saved to implement a limited edition of the Lean and Green concept. The basis for substantially revising the outputs was presented in a Technical Document No. 1, and the Project Document/Business Case was reformulated to account for this. The results presented in this paper are therefore not the result of the project proposed during the Project Identification phase, but a compromise presented to and accepted by DANCEE in the Inception Report/Project Initiation Document. Petrocart will therefore have to continue implementing the Lean and Green concept during the years to come with its own funding and with particular focus on a continued process of human resource development. The leaning curve is still steep at this time of finalisation of the DANCEE project.

Technical Document No. 1 clearly revealed that major financial savings had to be achieved, because there were insufficient resources in the project for implementation of the original proposal, so it was decided to look for well-maintained second hand equipment in Romania and the EU markets. The Project Document (i.e. the Business Case) was updated and presented in the Project Initiation Report, which was approved at a Programme Steering Committee (PSC) Meeting on 28 September 2001 held at Petrocart. Consequently, the approval of the Inception Report meant that the immediate objectives, outputs, activities, and inputs described in the Terms of Reference for MFG were to be substituted by those described in the revised Project Document, dated September 2001; the objectives being defined as in Table 1 along with the corresponding indicators, assumptions for sustainability of the development objective and the external factors/assumptions for immediate objectives.
Table 1

<table>
<thead>
<tr>
<th>Development objective</th>
<th>Indicators</th>
<th>Assumptions for sustainability</th>
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</thead>
<tbody>
<tr>
<td>Application of cleaner production technology to improve industrial compliance with environmental regulations, and subsequently improving the environmental conditions in the Bistrita River running through Piatra Neamț</td>
<td>Water quality data in monitoring reports of the Bistrita River show improvement in the vicinity of Petrocart's old outfall</td>
<td>Improved municipal sewage treatment at Aqua Calor</td>
</tr>
<tr>
<td></td>
<td>No direct discharge from Petrocart into the Bistrita River</td>
<td>No new direct discharges allowed into the river</td>
</tr>
<tr>
<td></td>
<td>Increased and more efficient use of recycled paper</td>
<td>The discharge of untreated storm-water at the same stretch of the river is reduced</td>
</tr>
<tr>
<td>Immediate objectives</td>
<td>Indicators</td>
<td>External factors/assumptions</td>
</tr>
<tr>
<td>Effluent from the paper factory Petrocart SA Piatra Neamț meets the Romanian regulatory requirements for discharge to municipal sewers</td>
<td>Petrocart pays no penalties according to NTPA 001 and complies with NTPA 002 as confirmed by public authorities, concerning</td>
<td>Commitment from mill staff to make new technology work and willingness to test and try new technologies, such as using recycled process water instead of fresh water</td>
</tr>
<tr>
<td></td>
<td>Analysis of COD, TSS, BOD stated (mg/L)</td>
<td>Sufficient COD and TSS reductions will result from the water savings achieved in order to meet current regulations (NTPA 002), or NTPA 002 revised to agree with the IPPC Directive</td>
</tr>
<tr>
<td>Good Management Practices at Petrocart for integrated pollution prevention and control</td>
<td>Stable performance of paper mill</td>
<td>IPPC Directive is effectively integrated into Romanian regulations</td>
</tr>
<tr>
<td></td>
<td>New equipment and instrumentation installed and verified to be in operation</td>
<td>Aqua Calor gets external assistance to treat municipal wastewater to achieve BAT standards for WWTP</td>
</tr>
<tr>
<td></td>
<td>COD, TSS, BOD, process heat and power consumption per tonne of product</td>
<td>Production data establishing mass balances for the mill at regular intervals</td>
</tr>
</tbody>
</table>
The detailed approach to Lean and Green was subsequently developed in Technical Documents No. 2 and No. 3. It implied among others that:

1. Substantial water savings and use of recycled white water were to be obtained at:
   PM2: duplex board machine;
   PM3: tissue machine;
   ETB: electro-technical board machine.
2. A completely new stock preparation department was to be built and equipped.
3. A major programme for good housekeeping and better occupational health and safety practices was to be conducted.

DANCEE’s parameters for the project thus were:

- Amount of DANCEE funding: €1 million to be matched by Petrocart 1:1.
- Quality:
  i. <2000 m³/day maximum discharge to the municipal sewer for subsequent treatment in the municipal treatment system.
  ii. Petrocart in compliance with Romanian regulations and well underway for an IPPC permit. (The IPPC Directive of EU has to be fully implemented in Romania before 2016).
  iii. Petrocart to buy recycled paper collected in Romania at market prices, and be able to increase the consumption of recycled paper by > 50 % in line with the efforts in the county to increase the recycled paper collection.

However, already in April 2002 it became evident that construction of the new stock preparation department was a major time consuming task, and a project extension well into 2004 was approved by the PSC in August 2002 along with some minor changes between budget lines—the overall budget remaining unchanged.

The project was completed in early 2004 with essentially all immediate objectives achieved, but a year later than planned for in the original Project Document’s Phase 1.

3. Results

The four project LFA outputs, two for each of the immediate objectives are presented in Table 2.

3.1. Output 1.1: water savings

The main task was to replace existing low pressure, high flow fresh water showers for felt cleaning on the three machines with high pressure, low flow fresh water showers including high pressure pumps, etc. After competitive bidding ThermoFiberTek (Kadent) equipment was installed on PM2 and PM3 in July 2002 and has operated successfully ever since. The ETB was retrofitted in September 2003.

The next task was to install strainers to remove large fibres from the overflow stream of the conical settling tower (Palnia 2), and similarly from the overflow stream from (Palnia
Table 1

<table>
<thead>
<tr>
<th>Project outputs</th>
<th>Indicators</th>
<th>Means of verification</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Effluent from the paper and board factory Petrocart SA Piatra Neamt meets the Romanian regulatory requirements for discharge to municipal sewers</td>
<td>1.1 Process water saving technology installed and in operation</td>
<td></td>
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<tr>
<td></td>
<td>PM2 and PM3 running with &lt;2400 m³/day of combined effluent</td>
<td>Monitoring data from progress reports</td>
<td>Collaboration from potential suppliers on equipment performance, price estimates, etc. Necessary equipment purchased and in operation</td>
</tr>
<tr>
<td></td>
<td>1.2 Effluent discharged by the paper and board factory Petrocart SA Piatra Neamt reduced to meet requirements by Aqua Calor and the Municipality of Piatra Neamt, e.g. (NTPA 002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Petrocart runs mill with effluent discharge to the municipal sewer with the acceptance/approval by the municipality and Aqua Calor (now Apaserv)</td>
<td>Minutes from Project Steering Committee meeting</td>
<td>TSS and COD concentrations are kept within the NTPA 002 limits or the directive is not being strictly enforced</td>
</tr>
<tr>
<td></td>
<td>All discharge to municipal sewer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Good Management Practices at the paper and board factory Petrocart SA for integrated pollution prevention and control</td>
<td>2.1 New equipment installed and operating to meet IPPC standards</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good performance of mill: increased/stable production with reduced discharges and energy consumption</td>
<td>Monitoring data in progress report</td>
<td>Sustained market condition for board and tissue</td>
</tr>
<tr>
<td></td>
<td>Removal of obsolete/unused equipment, painting repairs, cleaning of production area</td>
<td>Pictures “before” and “after”</td>
<td>Commitment of mill management and staff to continue efforts after project is finished</td>
</tr>
<tr>
<td></td>
<td>Establishing Total Quality Management system</td>
<td>TQM organisation established</td>
<td>TQM Audits</td>
</tr>
<tr>
<td></td>
<td>Good working environment</td>
<td></td>
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</tr>
</tbody>
</table>

3). Strained fibers from Palnia 2 was recycled to PM3, while the recycle from Palnia 3 could go to PM2 or the recycled paper pulpers. Three companies were invited to bid for the strainers, and ThermoFiberTek (Kadent) was awarded the contract for two model 4015 strainers. Petrocart completed the installation in July 2002, permitting the use of strained white water instead of fresh water on wire cleaning showers of PM2, and on deckle showers and low pressure (3 bar) roll lubricating showers on PM3. The installation of strainers also made it possible to convert all vacuum pumps to use strained white water instead of fresh water, and it was now possible to recover the effluent from the ETB by pumping it to the strainer for PM3.
The progresses of water savings from the base-line study in July 2001 and until today are shown in Table 3. When interpreting the data it is important to differentiate between the three types of products made by the three machines. The tissue machine uses a fair amount of fresh water, but contributes less to the daily tonnage compared to the board machine PM2. The board tolerates many impurities that would not be acceptable in the tissue product. The ETB machine used a great deal of fresh water until autumn 2003, but at the same time was frequently shut down, e.g. in June 2003 when the white water system was rebuilt. The ETB still uses a relatively large quantity of fresh water, but the daily production rate modest.

The data from March 2004 indicate the highest production rate in one month since the project started with all three machines running and with the use of the new stock preparation department.

3.2. Output 1.2: discharge to municipal sewer

Petrocart and the operator of the municipal effluent treatment plant (Aqua Calor) agreed on a contract allowing Petrocart to discharge up to 2500 m³/day of wastewater and signed it in April 2001. Petrocart has discharged 700–1300 m³/day directly to the sewer since August 2002 without any problems, objections or complaints from the municipal sewage treatment authorities. Petrocart pays no penalties for non-compliance with the NTPA 002 decree. The CD machine that utilised the primary fibre sludge from the treatment plant to make thick board became superfluous in August 2002 when the primary treatment plant was also idled and is now dismantled. The basins for emergency protection against short-term effluent surges that Aqua Calor required Petrocart to install in order to hold back wastewater in case of a flooding of the municipal sewer system have never been used.

The picture in Fig. 3 shows the situation before and after connecting to the sewer.

3.3. Output 2.1: new equipment operating

The old stock preparation department had to be operated until the end of 2003 when the new department became available. Therefore, the existing stock preparation had to be improved. The Belcor screen needed repair, the feed system to the tertiary centriflicaner had to be changed and proper operation of the outdated equipment needed to be enforced. Essentially, all the problems that could be solved with the old stock preparation department were solved as of May 2002.

It was decided to set up the new stock preparation department in an existing building. However, this building needed major renovation and maintenance before any of the equipment could be installed. Initially, the building was supposed to be ready by 31 March 2002 to receive the new equipment, but in reality the task was much bigger than anticipated. It was decided to take the time to do it right rather than setting up new and renovated equipment in an inappropriate manner, but this led to revised timetables with more than a year of delay.

Meanwhile, usable second hand equipment was identified in Norway and Sweden. Also, equipment from Duplexcart, the abandoned project adjacent to Petrocart, was incorporated into the new stock preparation department.
### Table 3
Progress in water savings during the project period

<table>
<thead>
<tr>
<th>Period</th>
<th>PM2 (m³/day)</th>
<th>PM3 (m³/day)</th>
<th>ETB (m³/day)</th>
<th>Total (m³/day)</th>
<th>PM2 (m³/t)</th>
<th>PM3 (m³/t)</th>
<th>ETB (m³/t)</th>
<th>Total (m³/t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 2001</td>
<td>12.1</td>
<td>20.3</td>
<td>3.5</td>
<td>35.9</td>
<td>1856</td>
<td>967</td>
<td>837</td>
<td>4205</td>
</tr>
<tr>
<td>November 2001</td>
<td>17.2</td>
<td>20.8</td>
<td>3.0</td>
<td>41.0</td>
<td>1265</td>
<td>754</td>
<td>745</td>
<td>3512</td>
</tr>
<tr>
<td>March 2002</td>
<td>15.4</td>
<td>20.7</td>
<td>2.9</td>
<td>39.0</td>
<td>1472</td>
<td>642</td>
<td>768</td>
<td>3512</td>
</tr>
<tr>
<td>June 2002</td>
<td>14.2</td>
<td>18.3</td>
<td>2.6</td>
<td>35.1</td>
<td>1123</td>
<td>672</td>
<td>742</td>
<td>3512</td>
</tr>
<tr>
<td>August 2002</td>
<td>14.7</td>
<td>20.3</td>
<td>2.7</td>
<td>37.7</td>
<td>274</td>
<td>298</td>
<td>451</td>
<td>1302</td>
</tr>
<tr>
<td>(January 2003)</td>
<td>9.3</td>
<td>20.6</td>
<td>2.4</td>
<td>32.3</td>
<td>138</td>
<td>128</td>
<td>372</td>
<td>782</td>
</tr>
<tr>
<td>February 2003</td>
<td>14.0</td>
<td>22.7</td>
<td>3.2</td>
<td>39.9</td>
<td>159</td>
<td>148</td>
<td>450</td>
<td>1057</td>
</tr>
<tr>
<td>March 2003</td>
<td>11.3</td>
<td>21.9</td>
<td>3.1</td>
<td>36.3</td>
<td>64</td>
<td>129</td>
<td>358</td>
<td>863</td>
</tr>
<tr>
<td>(June 2003)*</td>
<td>15.5</td>
<td>22.5</td>
<td>4.2</td>
<td>35.1</td>
<td>53</td>
<td>135</td>
<td>359</td>
<td>607</td>
</tr>
<tr>
<td>August 2003</td>
<td>15.5</td>
<td>18.7</td>
<td>3.0</td>
<td>35.2</td>
<td>36</td>
<td>39</td>
<td>511</td>
<td>1106</td>
</tr>
<tr>
<td>(September 2003)</td>
<td>11.6</td>
<td>21.0</td>
<td>2.0</td>
<td>34.6</td>
<td>47</td>
<td>46</td>
<td>542</td>
<td>1048</td>
</tr>
<tr>
<td>(January 2004)</td>
<td>12.9</td>
<td>24.2</td>
<td>2.4</td>
<td>39.5</td>
<td>54</td>
<td>28</td>
<td>484</td>
<td>1280</td>
</tr>
<tr>
<td>February 2004</td>
<td>14.5</td>
<td>24.1</td>
<td>2.7</td>
<td>41.3</td>
<td>75</td>
<td>33</td>
<td>405</td>
<td>980</td>
</tr>
<tr>
<td>March 2004</td>
<td>15.8</td>
<td>24.1</td>
<td>3.4</td>
<td>43.3</td>
<td>64</td>
<td>38</td>
<td>346</td>
<td>850</td>
</tr>
</tbody>
</table>

*No ETB production for 15 days.

For PM3 fresh water: water for felts and water for cooling ventilators (fans).
After detailed preparation during the spring and summer of 2002, a bid for instrumentation was conducted in the autumn 2002 among four companies and a contract was signed with Metso in the first quarter of 2003. Equipment was shipped in May 2003.

To adapt to the local situation, where technical knowledge of personnel was below Western European standards, training was included by instrument suppliers for procedures during start-up and operation. This was embedded in their contracts.

The new stock preparation department started up at the end of 2003, and after two months of staff adapting to the new processes, the final base-line study for the project was implemented in March 2004.
3.4. Process description of the new stock preparation

The new stock preparation system was designed, and the required machinery, material and instrumentation/controls procured to enable Petrocart to up-grade the quality of the furnish to the paper machines by being better able to handle and control the steadily deteriorating quality of the basic raw material, i.e. the recycled paper, and the also steadily rising quality expectations of its customers.

The new system meets in all respects the requirements of a modern installation with reliable components, including basic automation comprising the necessary instruments and controls Fig. 4.

The raw pulp delivered by the existing slushing operation of the hydrapulpers is first controlled to the appropriate consistency and then run through the high density cleaner, which removes most coarse, heavy and abrasive particles. From there it is directly fed to a fiberizer for removal of all larger, but light contaminants as, e.g. plastic, water resistant paper, etc. the accepts from the fiberizer are directly metered to the centricleaners, where fine contaminants with a higher specific gravity than water are separated.

The resulting slurry is dewatered on deckers with the drained white water returned to the process, the resulting pulp consisting mostly of cellulose fibres and dissolved organic substances from the recycled paper. However, coming from a very mixed raw material, the pulp consists of a wide variety of different quality fibres. In order to produce quality products on the paper machines, the useful fibres have to be separated from less desirable components, which are achieved in the fine screening operation.

The latter is accomplished in pressure screens, where the pulp slurry is forced with pressure and turbulence through screen baskets with either small round perforations of 1.2–3.0 mm in diameter or narrow slots of 0.15–0.45 mm in width. Accepts from this process are used for the production of tissue products and the rejects together with some good quality fibres are used for the production of board.

The building preparation, erection, piping, instrumentation and controls as well as all electrical work, and components were integrated in the plan for the new stock preparation area. This was the main reason for extending the project to 2004. By April 2004, all equipment purchased with funds from DANCEE was installed and is operating. However, Lean and Green is a long-term process, so this does not imply that the operation is optimal, which remains an ongoing concern.

3.5. Output 2.2: site cleaning and OSH improvements

In Lean Production, this output is a Kaizen/5S activity. A respective plan-of-action including a timetable was developed in the fourth quarter of 2001.

<table>
<thead>
<tr>
<th>Due date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 January 2002</td>
<td>Establish a Total Quality Management (TQM) organisation</td>
</tr>
<tr>
<td>1 February 2002</td>
<td>Elect people to TQM Groups</td>
</tr>
<tr>
<td>1 March 2002</td>
<td>Conduct training of TQM Groups</td>
</tr>
<tr>
<td>1 March 2002</td>
<td>Elect two persons to TQM Committee</td>
</tr>
<tr>
<td></td>
<td>Remove outdated equipment from new stock preparation building: clean-up and prepare building for receiving new equipment</td>
</tr>
</tbody>
</table>
At Petrocart it was considered optimal to combine the OSH organisation with quality management and environmental protection in what may be called Total Quality Management. This involved building on the already existing quality organisation, linked to Petrocart’s ISO 9000 certification, and combine those with the existing occupational health and safety organisation, the latter needing to be updated and adapted for its extended function (Fig. 5).

The purpose of such an organisation is to facilitate communication and collaboration between employees and management concerning the health and safety of all employees. To this end, the safety organisation has to organise its work in a systematic way to integrate itself and support the operation of the company.

The TQM manager is the representative of the TQM Committee in daytime shifts. His functions and authority should be well defined in his job description. Petrocart should specify its aims and goals in the areas of occupational health and safety, quality and environmental performance; the TQM Committee has to define the tasks to be achieved and the means to achieve them. The TQM manager should have access to a budget appropriate to solving the problems and achieving the tasks. His job description:

- daytime manager for the TQM activities;
- responsible for communicating TQM problems to the Petrocart Management; tasks to be solved by the TQM Committee, etc.;
- a consultant for the entire enterprise regarding TQM, particularly assisting the TQM groups with their workplace assessments;
- responsible for the training programme of the TQM groups and the TQM Committee for these to function properly;
- responsible for internal audits of Total Quality and ISO 9000 audits in accordance with the quality manual, and for OSH and environmental audits (workplace evaluations, safety precautions, sufficient knowledge, near-accidents reported, adequate instructions and training, manuals for machinery, etc.).

The TQM committee must plan, manage, and coordinate the safety and health programme as well as the quality and environmental protection activity for Petrocart:
Fig. 4. Block diagram of stock preparation.
• establish procedures for TQM work and ensure that the TQM groups have been given sufficient means to carry out their duties;
• conduct activities ensuring that the procedures for TQM are followed;
• register OSH, quality, and environmental accidents, problems and incidents;
• assist (supervise) the Petrocart management on TQM issues;
• establish a plan for the TQM organisation with names and responsibilities stated;
• plan of TQM work, including new or changed production, purchase of safety and other TQM equipment, purchase, use and handling of chemicals and products, changes in processes and work methods;
• control and audit TQM working procedures;
• investigate accidents and change procedures to prevent their happening again;
• publish annual statistics of OSH, quality and environmental accidents, problems and incidents;
• keep up-to-date on TQM issues, including training and education;
• participate in communication with authorities; be present during such visits;
• have regular meetings once every quarter and in case of any accidents.

Fig. 5. Basis for TQM Organisation at Petrocart.
4. Discussion

4.1. LFA versus P2

LFA and P2 models are not contradictory, but to some extent supplementary (Tables 4 and 5). There are differences in terminology, but a glossary can care of that, Table 6. DANCEE-LFA is very focussed on a participatory approach and on creating ownership and consensus of the planning process right from the beginning. DANCEE-LFA is also focussed more on specialist and technical products (Outputs) than on good management procedures. DANCEE-LFA simply assumes that Project Holders have good management procedures in place, and that a procedures manual is developed for the project specifying:

- project organisation, institutional relationships and responsibilities;
- lines of communication;
- system and procedures for filing and documentation;
- staff rules;
- project monitoring;
- financial procedures;
- project assets;
- quality assurance.

DANCEE requires a procedures manual is to be drafted in the LFA Inception Phase (P2-stage: Initiating a Project). However, except for the financial procedures, the P2 manual gives general guidance and rules for Best Project Management Practices for all of these items, and is based on a level of international collaboration and a quantity of man-hours that no Danish Organisation can match. Only a few procedural clarifications are needed to P2 to provide a clear line of communication and responsibility. Thus, major resources can be saved, if development organisations require procedures to generally follow the P2 manual instead of using different procedures manuals developed by individual consulting companies.

During implementation of a DANCEE project the roles of the personnel involved are quite clear: only the DANCEE executive can approve budget changes, changes in time or changes in quality, and approval of the Project Completion Report, i.e. the role of the P2 Programme Management Chairman. Also, the Project Holder is solely responsible for achieving the desired quality of the project, in time, and within the budget, i.e. the role of the P2 Project Board Executive (PBE) Committee. The local beneficiary is responsible for its own financial inputs, but the PBE is responsible for matching inputs required by the beneficiary.

A DANCEE Project Steering Committee consists of four persons and two or more observers:

- the Local Project Director (Chairman, appointed by MoE);
- a representative from the beneficiary (Deputy Chairman, appointed by the beneficiary);
- the Project Director (appointed by the Project Holder);
- a representative from the Danish MoE (appointed by DANCEE);
<table>
<thead>
<tr>
<th>LFA (DANCEE)</th>
<th>PRINCE2 (P2)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programme</td>
<td>Programme</td>
<td>A portfolio of projects selected, planned and managed in a co-ordinated way. In LFA the programme immediate objective is the projects development objective.</td>
</tr>
<tr>
<td>Development objective</td>
<td>Programme objective</td>
<td>The higher-level objective towards which the project is expected to contribute.</td>
</tr>
<tr>
<td>Immediate objective</td>
<td>Part of project brief</td>
<td>The effectiveness of the project is judged by an assessment of the extent to which the project has achieved its immediate objectives. This is developed in the P2 business case component.</td>
</tr>
<tr>
<td>Indicators</td>
<td>Forms part of plans (component) developed in the planning process</td>
<td>LFA: measures to verify to what extent outputs and objectives are achieved.</td>
</tr>
<tr>
<td>Means of verification</td>
<td>Controls (component)</td>
<td>LFA: measures to verify to what extent outputs and objectives are achieved.</td>
</tr>
<tr>
<td>External factors, assumptions</td>
<td>Management of risk (component)</td>
<td>The result that can be guaranteed as a consequence of a set of activities (work packages). While LFA outputs focus on the specialist products, P2 is very stringent in separating management and technical/specialist stages.</td>
</tr>
<tr>
<td>Outputs</td>
<td>Specialist products</td>
<td>LFA differentiates between internal risks, which are under the control of the project environment and external risks, which are the likelihood of assumptions not being fulfilled. P2 does not have this rigid distinction, but these assumptions can be addressed in the risk component.</td>
</tr>
<tr>
<td>Activities</td>
<td>Managing product delivery (process)</td>
<td>The sum of activities leading to an output (LFA) or a technical/specialist product (P2).</td>
</tr>
<tr>
<td>Input</td>
<td>Means to work on technical/specialist products</td>
<td>Resources, money, time, manpower, etc. Inputs are resources needed for activities, which in turn are needed for each output. P2 separates LFA inputs and activities in a managing product delivery process to allow manager and third-party suppliers.</td>
</tr>
<tr>
<td>Project Document</td>
<td>Project initiation document</td>
<td>The reasons for a project, updated through the progress. This document is base-lined in the project initiation document (P2/Inception Report (LFA)).</td>
</tr>
<tr>
<td>Organization</td>
<td>Organization</td>
<td>LFA: Steering Board is required, otherwise more degrees of freedom. P2: well defined roles for Project Board, Project Manager and Team Managers.</td>
</tr>
<tr>
<td>Procedures manual</td>
<td>PRINCE2 manual (OGC, 2002)</td>
<td>A procedures manual setting out the management procedures including the monitoring system. In LFA a proposal for a table of contents exists, but is not specified or mandatory. The P2 manual can easily be adapted to fulfill these requirements, and it gives a uniform, time-saving, best practice manual for project management.</td>
</tr>
</tbody>
</table>
Table 5  Stages in LFA and PRINCE2

<table>
<thead>
<tr>
<th></th>
<th>LFA (DANCEE)</th>
<th>PRINCE2 (P2)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project identification</td>
<td>Developing a Project Mandate</td>
<td>In both cases based on a terms of reference. The LFA process may start with a separate project elaborating the process leading to a Project Mandate. LFA results in a draft Project Document, in P2 called a project approach, which includes a plan for the initiation stage. DANCEE normally requires a Project Holder to be different from the project identifier. P2 assumes that the Project Holder is normally the same as the one that will implement the project.</td>
<td></td>
</tr>
<tr>
<td>Project preparation</td>
<td>Starting up a project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inception phase</td>
<td>Initiating a Project</td>
<td>Identical. P2 ends with a Project Initiation Document (PID), while LFA requires an Inception Report, but the contents are essentially the same, although more elaborated in P2</td>
<td></td>
</tr>
<tr>
<td>Project monitoring and reporting</td>
<td>Controlling a stage</td>
<td>P2 is much more stringent in terms of management products, processes and responsibilities between involved parties.</td>
<td></td>
</tr>
<tr>
<td>Conducting activities</td>
<td>Managing product deliveries</td>
<td>Identical. P2 directs technical activities and delivery of specialist products in the process ‘Managing product deliveries’ (MP), which is separate from the process ‘controlling a stage’ (CS).</td>
<td></td>
</tr>
<tr>
<td>Preparing progress reports for approval by the Project Steering Committee</td>
<td>Managing stage boundaries</td>
<td>LFA procedures require quarterly progress reports to be made and base its management on input control, activities and outputs. P2 has a very accurate description of the process leading to the end of a stage and the start of a next stage, and the management process is more independent of the product delivery/outputs. This provides for shorter management stages and better planning/control.</td>
<td></td>
</tr>
<tr>
<td>Preparing Project Completion Report</td>
<td>Closing a project</td>
<td>LFA and P2 processes are easily merged</td>
<td></td>
</tr>
<tr>
<td>N/a</td>
<td>N/a</td>
<td>In LFA it is left to the DANCEE Project Holder to manage his own project. P2 provides extended guidance on the responsibilities of the Board Executive (Project Director) and the Project/Team Managers.</td>
<td></td>
</tr>
<tr>
<td>N/a</td>
<td>Planning</td>
<td>In LFA it is left to the DANCEE Project Holder how to plan his own project. P2 provides extended guidance on this issue with suitable techniques that can be applied</td>
<td></td>
</tr>
</tbody>
</table>

- the Local Project Manager (observer, appointed by the beneficiary).
- the Team Leader (observer and secretary, appointed by the Project Holder).

The steering committee may be expanded as appropriate to include:
- representatives of regional and local authorities;
- other ministries;
- private organisations;
- research and educational institutions;
Table 6
Glossary for LFA and PRINCE2

<table>
<thead>
<tr>
<th>LFA (DANCEE)</th>
<th>PRINCE2 (P2)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Director</td>
<td>Senior supplier</td>
<td>In DANCEE’s terminology the Project Director is an appointed executive from the line organisation of the project holding company, and he sits in the Project Steering Committee.</td>
</tr>
<tr>
<td>Team Leader</td>
<td>Project Holder’s Project Board Executive</td>
<td>In DANCEE’s terminology the Team Leader is appointed by the Project Holder to manage the project, i.e. the Project Steering Group Chairman according to P2. In P2 terminology a Team Leader is responsible for Managing Technical/Specialist Product Deliveries.</td>
</tr>
<tr>
<td>Project Manager</td>
<td>Beneficiary’s Project Manager</td>
<td>This is the same person in both terminologies. However, in P2 the Project Holder may appoint its own Project Manager to assist the Project Board Executive.</td>
</tr>
<tr>
<td>Project Steering Committee</td>
<td>Programme Steering Committee</td>
<td>DANCEE issues a contract with a Project Holder, which is responsible for DANCEE funds for the project. The Project Steering Committee described in DANCEE’s Project Cycle Manual is more like an Advisory Committee with limited formal authority. Budget changes and changes in the scope of the Project Document need approval from the DANCEE Executive.</td>
</tr>
<tr>
<td>Project Management Group</td>
<td>Project Board</td>
<td>There are three roles for Project Board members of P2 projects, the Executive, who owns the project, the senior user, who benefits from the project and the senior supplier, who has major deliveries to the project. Only the Executive is mandatory in P2.</td>
</tr>
</tbody>
</table>

- NGOs;
- representatives of other donors (in the case of co-financed projects).

According to the DANCEE manual (DEPA, 1998), “the key responsibility of the Project Steering Committee is to monitor and supervise project implementation. The committee will do this by approving project reports, i.e. the Inception Report, the progress reports and the final report. This implies that the steering committee should have four yearly meetings as the progress reports are submitted quarterly by the Project Holder.” However, in practice the DANCEE Project Steering Committee is an advisory committee for the DANCEE Programme Executive, who is the only person with authority to change the parameters of the project. DANCEE suggests that another Project Advisory Committee may be established to assist the Project Board, and as the name implies—the role is much more clear in this case.

4.2. Lean and Green at Petrocart

Since Petrocart was privatised, management has taken the company on a path of continuous improvement towards optimization by shutting down unprofitable and/or obsolete production facilities. In the process, direct labour has been reduced from 850 to about 400 people, while maintaining production capacity at about 12,000 adt/year. Because of the poor
physical condition of the machinery at the time of privatisation and consequently frequent breakdowns, this capacity was never fully reached in production. Slowly, worn out machinery has been upgraded or replaced and capacity has been increased at a pace set by the revenue the company was able to generate. This revenue was restricted by high specific consumptions of raw and auxiliary materials, water and energy, and by the fact that the company had to pay penalties for non-compliance with environmental regulations.

This evident to both management and the environmental authorities of Neamt County, and the mill was given high priority in the Local Environmental Action Plan, not least because Petrocart was one of the larger companies in terms of employment opportunities. So, when DANCEE was willing to commit money, project management and technical know-how, the mill management took advantage of the opportunity. Fighting competition on the market, the mill had established excellent customer contacts by operating its own truck fleet for rapid delivery, in response to customer requests provided the product was in stock or could be produced in the time span available.

Apart from the need for better machinery, the mindset of the mill’s labour and professionals also had to be improved. Instead of engineering by improvisation, trial and error, personnel had to follow standard procedures, make decisions based on well-proven engineering principles, calculations, flow sheets, drawings, etc. Maintenance and shop crews were often quick to fix breakdowns, but pro-active maintenance had to be introduced, and total up-time of equipment improved by predictive maintenance. This involved professional execution of work assignments, proper working procedures, lubrication schedules, roll schedules for the paper and board machines, appropriate quality of applied materials, etc.

The project support manager spent the major part of his time during the project on the supervision of this change, including on-the-job training. Awareness has been raised among mill staff and the will to do a better job has been there, but better operations and better maintenance is an ongoing effort even today with room for improvements.

Bernt Treu, the Project Support Manager and Jens Folke, the Project Board Executive have developed the principles for a new mill organisation that may assist the Lean implementation (Fig. 6). The basic idea is to separate core value processes from support processes and ensure a clear line of duty and responsibility. This is not implemented at the time of writing.

The development of the mill over the course of the project can be seen in several distinct phases. The following is based on the daily log from the Project Support Manager. It provides an indication of the size of the project undertaken at a small mill with limited resources and the significant change in attitude among employees during the time period, truly Lean Production:

Phase 1: Middle of 2001

Old stock preparation area:
- Basic mass and energy balance established by N. McCubbin working for MFG and using WinGEMS software.
- Designing flow sheet for a new stock preparation system, allowing for:
  - final product requirements;
  - raw material quality and its trend toward more OCC;
  - qualification of operators, maintenance crews and local sub contractors.
• Adjusting equipment settings as pressures and box levels in Centricleaner installation, changing perforation sizes in Jonsson vibrating screen, setting correct shower flows and directions.
• Eliminating obvious mechanical deficiencies as worn out pump internals, misalignment of pump/motor combinations, lack of lubrication.
• Explaining to operators and supervisors required operating parameters as pressures, flows and consistencies in different stages of process

Phase 2: First half of 2002

New stock preparation system:
• Analysing situation how existing installation of stock preparation area could be modified to comply with modern technology.
• Decision taken to put existing stock preparation area back into operating shape, but abandon it for the long term.
• Erect a new stock preparation area along with modern clean technology lines in another building.
• Analysing space requirements for equipment, chests, tanks and control stations and settling on a specific building.
• First project completion schedule for project, listing major tasks to be tackled.

Existing mill systems:
• PM#3: replacing wire section table rolls with foils from Duplexcart.
• Installing low-vac boxes from Duplexcart in wire section.
• Installing valves and vacuum gauges in all suction equipment.
• Suggesting better design/construction of all wire and felt rolls.
• Deciding on building for the installation of the new stock preparation.
• Laying out flow sheet for new stock preparation area, and integrating required chests and pits into new building.
• All the while insisting on improving maintenance procedures and planning.

Phase 3: Second half of 2002

New stock preparation system:
• Finalising flow sheet for the new stock preparation system, including equipment, instrumentation and control specifications.
• Writing tenders for offers from different suppliers.
• Slow progress reconditioning selected building, because, priority had to be given to maintaining operations running
• Fresh water savings using the new high pressure and low flow showers and auxiliary equipment.

Existing mill systems:
• Establishing and enforcing proper operating conditions in old stock preparation system.
• Old stock preparation system put into operable condition using proper procedures and techniques.
• Many of the maintenance mechanics replaced, with the experience that the remaining and new crew delivered better work.
• Most people know how work satisfactorily, but the good practices must enforced, recognized and appreciated by management.
• Change procedures to avoid undesirable practices such as controlling flows by throttling the suction valves of pumps, because it results in breakdowns and unplanned stops.

Phase 4: Second half of 2002

General system:
• Maintaining pre-determined operating parameters in stock preparation and PM#3.
• Old stock preparation area: Establishing proper operating parameters and having installation rebuilt to the point where it can be manually controlled meeting required parameters, in spite of Monday through Friday shut-downs from 08:00 to 10:00 and from 17:00 to 22:00, due to electric power limitations.
• Instead of repairing equipment on a break-down basis, maintenance is promoted during the twice daily shut-downs in stock preparation and by following proper maintenance and repair procedures.
• PM#3 supervisor developing knowledge of operating conditions of PM, but the more she learns, the more there are variables to be taken under control.

New stock preparation system:
• Finalising negotiations with suppliers of equipment, instrumentation and controls.
• Placing orders for above.
• Engineering for new stock preparation not up to requirements, progress needed.
• Progress of project on site is slow:
  ◦ production break-downs naturally have higher priority than construction and
  ◦ with many active projects, cash flow may not be sufficient to support more thrust for new stock preparation system.
• Project manager responsible for technological aspects:
  ◦ stretched far too thin with numerous other functions to be able to get into all details;
  ◦ keeps project under control from a higher level.
• A project engineer keeps track of civil work, machinery erection and piping.
• Sole person to keep details under control is instrumentation supervisor, who spearheads the project from a technical point of view.

Phase 5: First half of 2003

New stock preparation system:
• Building work is progressing more consistently, but interfering with machinery being installed, piping laid, instrumentation integrated.
• Old chests and associated agitators and pumps are being reconditioned, but late for planned start-up, which finally takes place in October.
• Quality of workmanship needs constant surveillance and supervision, which is not always appreciated by supervisors and sometimes solved only after personal intervention by mill management.

Phase 6: Second half of 2003

New stock preparation system:
• Check-out of the installation to avoid unnecessary breakage of equipment. New system is explicitly laid out for continuous operation with corresponding automation provided. An excellent, detailed and easy to follow synoptic panel was implemented as part of the instrumentation installation.
• The constant power cuts rendered the start-up difficult and were mostly done after 22:00 into the early hours of the day, supported by the supervisors, who were working 12 h on—12 h off, for the first few weeks without breaks. Constant help from the supervisors to the operating crew was needed to operate the system.

Phase 7: First Quarter 2004

New stock preparation system:
• The new stock preparation system is operating smoothly with the sole exception of the first stage fine pressure screen, which is incapable of handling the desired consistency of 4% and therefore capacity is limited.
• The system is laid out for an operating rate of 70–75 adt/day to produce the required 40–45 adt/day of 24-h production during the available 17 h/day. However, in order to follow the old routine of operating 12 or 13 h/day the new system would have to operate at a rate of roughly 100 adt/day. This option was originally considered but discarded.
• The capacity of the screen is limited to around 50 adt/day with a worn internal basket. The previous owner of the screen insists that with a rebuilt basket the screen should have a capacity of around 75 adt/day of accepts.
• The problem is inherent with all second hand machinery, which is sometimes discarded for problems, which one inherits in buying it. Pressure screens are a particularly notable example and in spite of the required precautions, the first stage screen is not working as designed and claimed by the previous owners, providing the baskets have been rebuilt.
• The condition is aggravated by the fact that the hydrapulper area is delivering pulp at 1.5–4% consistency. The feed conveyor to the hydrapulpers is basically undersized and may have to be replaced.
• The following dump chest is amply sized, but the agitator needs to be run continuously.
• In order to realise further water savings, the conical white water settling tower, Palnia 3 has to be properly integrated and operated (Fig. 7). Particularly, the discharge to the sewer, which goes through Palnia 3 shows unacceptably high peaks, resulting in fibre loss and inappropriate white water management. This may require a level indicator controller and valve in one line.

Clearly, all the Lean disciplines have to continue in the time to come. But the dedication to the project from all involved was exemplary, and Petrocart seems well suited to undertake new projects in the future, which will bring them safely into the EU market that Romania is destined to enter in 2007.

5. Conclusions

1. PRINCE2 (P2) can be a valid guidance document for DANCEE’s LFA procedures manual, which will ensure Best Practice for project implementation.
2. DANCEE’s guidelines for the size and role of the Project Steering Committee are not as accurate and stringent as normal P2 principles.
3. DANCEE’s requirements are generally on the interface between the P2 Project Board and the Programme Committee. Therefore, a Project Holder can apply P2 without
Table 7
Situation at project start and project end

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Start of project September/2000</th>
<th>End of project May/2004</th>
<th>Percent change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycled paper input</td>
<td>t/day</td>
<td>44</td>
<td>56</td>
<td>+21</td>
</tr>
<tr>
<td>Recycled paper yield</td>
<td>wp/product</td>
<td>1.3</td>
<td>1.2</td>
<td>+8</td>
</tr>
<tr>
<td>Tissue sold</td>
<td>t/day</td>
<td>18.5</td>
<td>27.0</td>
<td>+39</td>
</tr>
<tr>
<td>Board sold</td>
<td>t/day</td>
<td>18.5</td>
<td>16.7</td>
<td>−11</td>
</tr>
<tr>
<td>Electro-technical Board sold</td>
<td>t/day</td>
<td>3.9</td>
<td>3.2</td>
<td>−22</td>
</tr>
<tr>
<td>Effluent</td>
<td>m³/day</td>
<td>5239</td>
<td>700</td>
<td>−87</td>
</tr>
<tr>
<td>TSS</td>
<td>kg/day</td>
<td>1918</td>
<td>326</td>
<td>−83</td>
</tr>
<tr>
<td>COD</td>
<td>kg/day</td>
<td>2905</td>
<td>1116</td>
<td>−65</td>
</tr>
<tr>
<td>BODs</td>
<td>kg/day</td>
<td>−</td>
<td>399</td>
<td>+7</td>
</tr>
<tr>
<td>No. of employees</td>
<td>No.</td>
<td>394</td>
<td>419</td>
<td>+6</td>
</tr>
<tr>
<td>Gross turnover</td>
<td>Ratio to 1999</td>
<td>1.36</td>
<td>3.54</td>
<td>+160</td>
</tr>
<tr>
<td>Profit before tax</td>
<td>Ratio to 1999</td>
<td>2.48</td>
<td>6.90</td>
<td>+178</td>
</tr>
</tbody>
</table>

Data from 9 best days in the 18-day monitoring periods.

* BOD analysis was not reliable at project start.

much of a problem with regard to DANCEEs Project Cycle Manual. However, resources could be saved in the Inception Phase (Project Initiation Stage) by requiring Project Holding Companies to apply P2 as the basis for the Project Procedures Manual.

4. Petrocart has reduced its water consumption by 87% and at the same time net profit has almost tripled since 2000. Lean and Green has provided solid evidence for the often-stated principle that pollution prevention pays (Table 7).

5. In order to realise further water savings, the conical white water-settling tower, Palnia 3 has to be properly integrated and operated.

6. The combination of LFA, P2, and Lean and Green principles has been the key to the success of the project. However, for Petrocart this is a continuous process, and the years to come will be the true challenge to prove that results are sustainable.

7. The approach for support to Petrocart may well be applicable to other small recycled paper based mills or other types of small-scale industries in Romania, such as food industries, dairy, beer, etc., in Bulgaria or in other parts of Eastern Europe.

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