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**Online Detection and Characterization of MPB Wood furnish  
to Optimize OSB Mill Processing Efficiency**

by

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**Prepared for**

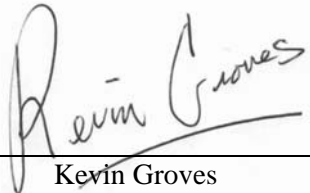


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## Summary

In the OSB manufacturing process, logs are processed to produce thin wood strands of a specific size range to maximize the final panel product properties. Today however, the wood supply is changing and there's increasing pressure for mills to use alternative species, especially in BC where large supplies of MPB pine exist. With MPB pine, mills are faced with the enormous challenges of processing significantly drier wood. This is especially evident at the strander where it is difficult to produce evenly sized strands that are needed for efficient processing and to meet final panel strength properties. The drier wood causes the strander to generate very high levels (from 5-50% of the total volume) of very small wood particles, termed "fines", which significantly reduces the mill's wood recovery. To date, there have been no online, fines measurement technologies available for industry use. To help avoid excessive fines generation, technology for online measurement of fines level and strand size classification needed to be developed to allow mill operations to detect and rectify costly problems when they occur, and provide mill operators with the important feedback needed for controlling the process variables that reduce fines generation. These include controlling: wood conditioning for optimized moisture content, wood flaking temperature, sharpness of cutting and scoring knives and log alignment in the strander.

In this project, an imaging system previously developed by Forintek, was scaled-up and optimized for online measurement of fines content in OSB mills. The vision system was comprised of a high speed video camera, lighting, and a computer for real time processing of captured images to determine fines level. There was a heavy emphasis on software programming to improve image analysis capabilities. In addition, pilot plant testing and optimization were carried-out to improve the system's versatility to operate under different mill conditions. These included scanning the surface of furnish on a flat conveyor and also scanning free-falling furnish inside conveyor transfer-point drop chutes. Test runs involved loading the conveyor system with OSB furnish containing different levels of fines, ranging from 0-50%. With the conveyor system running at mill production speeds, the vision system collected and analyzed data to measure fines level.

Pilot plants tests of the optimized system were successful with results showing strong correlations ( $R^2 > 0.9$ ) between measured versus actual fines levels under simulated mill conditions for MPB pine. The system worked equally well for aspen and birch. Based on the positive pilot plant evaluation, the vision system was set-up and tested at an OSB mill. The system worked without problems during the mill trial and the measurement results correlated well with the fines level measured by manual sampling and screen analysis.

To facilitate technology transfer, Forintek assisted an OSB mill with the permanent installation of two fines measurement units. These units are now fully operational for continuous monitoring of fines level. In addition, discussions are currently underway with an equipment supplier to commercialize this technology.

# Acknowledgements

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Forintek Canada Corp. would like to thank its industry members, Natural Resources Canada (Canadian Forest Service), British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, New Brunswick, Newfoundland and Labrador, and the Yukon Territory, for their guidance and financial support for this research.

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# 1 Objectives

The objective was to scale-up and optimize an online fines measurement system for mill testing, evaluation and demonstration to the OSB industry.

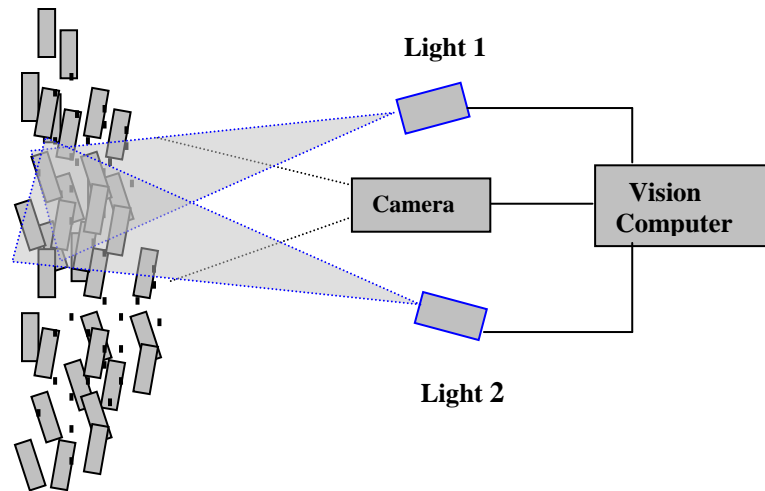
# 2 Introduction

Currently there is a high level of industry support for research to develop fines measurement technology and methods for reducing fines level. The majority of OSB mills in Canada have ranked this the number one research priority for Forintek. All OSB manufacturers in BC support this project.

For the OSB industry, the benefits to reducing fines are evident. For an average-sized Canadian mill, each 1% improvement in wood recovery through reduction in fines generation will mean a wood cost savings between \$350,000 to \$400,000/year, depending on location. In addition to wood cost savings, reducing fines content lowers resin consumption, reduces panel weight without impacting panel strength, and as a consequence of lower panel weight, lowers product transportation costs.

In 2002/2003, Forintek’s National Research Program project “Measurement of Green End Fines in OSB<sup>1</sup>” successfully demonstrated the feasibility of online fines measurement using an optical scanning system. Small scale, pilot plant test results comparing actual versus measured fines levels showed a very good correlation between actual versus measured fines level for both green and dry furnish.

In this project, the optical scanning previously developed by Forintek, was scaled-up and optimized for online measurement of fines content in OSB mills. The vision system comprised of a high speed video camera, lighting and a computer for real time processing of captured images to determine fines level (Figure 1)



**Figure 1: Fines measurement system**

<sup>1</sup> C.K. Groves 2003. Measurement of Green End Fines in OSB. Forintek report.

In addition, testing and optimization were carried-out to improve the system's versatility to operate under different mill conditions. These included scanning the top surface of furnish on a flat conveyor and also scanning free-falling furnish inside a drop chute. Test runs involved loading the conveyor system with furnish containing different levels of fines, ranging from 0-50%. With the conveyor system running at mill production speeds, the vision system collected and analyzed data to measure fines level.

Based on the successful pilot plant testing, the vision system was set-up and trialed at an OSB mill.

## 3 Staff

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## 4 Materials and Methods

### 4.1 Imaging System Optimization

During this project, the optimization of the imaging system targeted three areas for improvement including the illumination, camera and imaging software.

The original imaging system, previously developed at Forintek, used tungsten halogen lights for illumination which have a limited lifespan of < 5000 hrs and also generate excessive heat. In many mills, halogen lights are not permitted because they are considered a fire hazard. As an alternative, LED lights (Figure 2) were investigated in this project. Unlike a high-output incandescent lamp, LEDs radiate very little heat and have an extended lifespan (>50,000 hrs). Under normal operation LED lights have a relatively low output light intensity that is not suitable for fines measurement. However, when LED's are pulsed or "strobed" at high frequency, their output is increased significantly (>10x). In this project, strobed LED light modules (constructed at Forintek) were tested with the fines imaging system. The imaging software was modified to synchronize the camera shutter with the LED strobe pulses. For each LED module, five 'Luxeon III Star' LEDs made by the 'Philips Lumileds Lighting Company' with a dominant wavelength of 617 nm were combined into a compact rugged enclosure. Combination lenses/reflectors were mounted on each LED to focus the light into a narrow cone. An electronic circuitboard inside the enclosure strobed the LEDs in response to an incoming trigger signal.

The original fines measurement system also used a conventional, black and white, analog CCD camera with a CCD chip size of 1/2 inch. The poor light sensitivity of this camera required the use of high power lighting. As an alternative, a digital CCD camera (Prosilica GE1380) was investigated for improved light sensitivity. The Prosilica has a 2/3 inch CCD chip and can operate in a "binning" mode for boosting light sensitivity by



*Figure 2: LED light setup*

combining pixels together on the CCD to create fewer but larger pixels. Binning combines the electrical charge in adjacent pixels that increases the effective sensitivity of the camera.

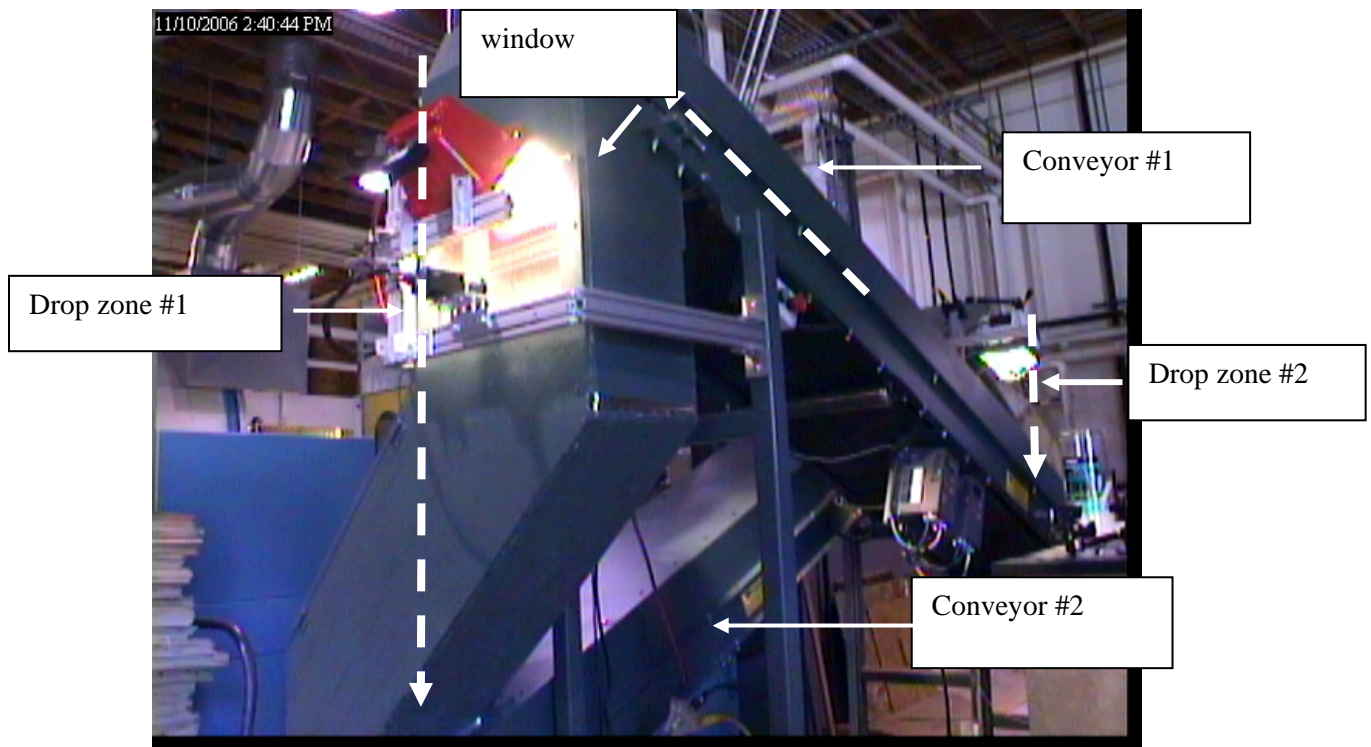
The original imaging software was programmed in C++. The user interface was difficult to operate and lacked many features. To resolve this, the software was re-programmed in LabView© for easier operation and mill installation. Improvements to the software were also made after numerous pilot plant tests to simulate different mill scenarios of furnish flow, level and speed on the production line.

## 4.2 Pilot Plant Tests

For pilot plant testing, a closed loop conveyor system was constructed for simulating mill conditions (Figure 3). This system consisted of two, 2x15-foot, crisscrossed conveyors that were connected by drop chutes at both ends. In drop zone #1, a window was installed for viewing free falling furnish.

In this study, the imaging system (Table 1) was configured for two setups. Setup #1 was for the measurement of free-falling furnish at the conveyor drop zone, with the camera scanning through a sight window (Figure 4). Both the light and camera were located approximately 25cm from the target furnish. Setup #2 was intended for measuring the top surface of furnish on the conveyor belt (Figure 5). Both the light and camera were located approximately 50cm above the furnish level.

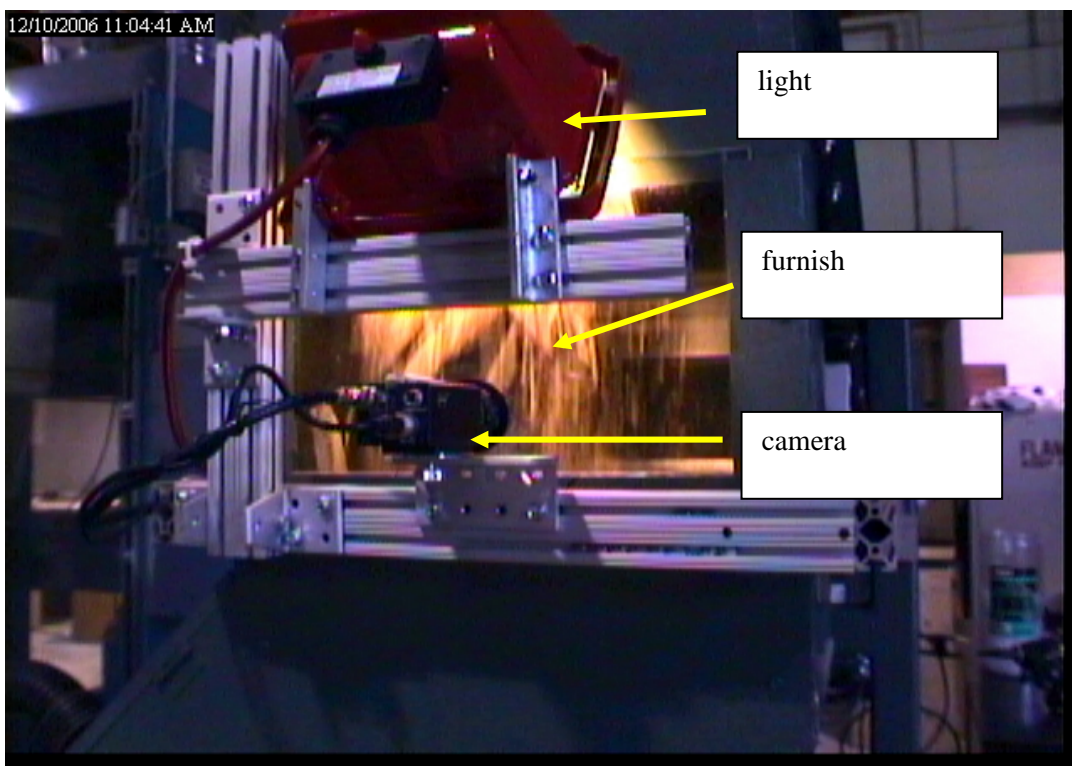
Tests were then carried-out with green furnish for each of the species including aspen, birch and MPB pine, with fines levels ranging from 0-50%, in 5% fines increments. For all tests, the conveyor was loaded with a total weight of 5 kg furnish and then operated at a belt speed of 250 ft/min to simulate mill conditions. For both camera set-ups, 500 images were analyzed for each fines level. The image capture rate was 10 frames/s.



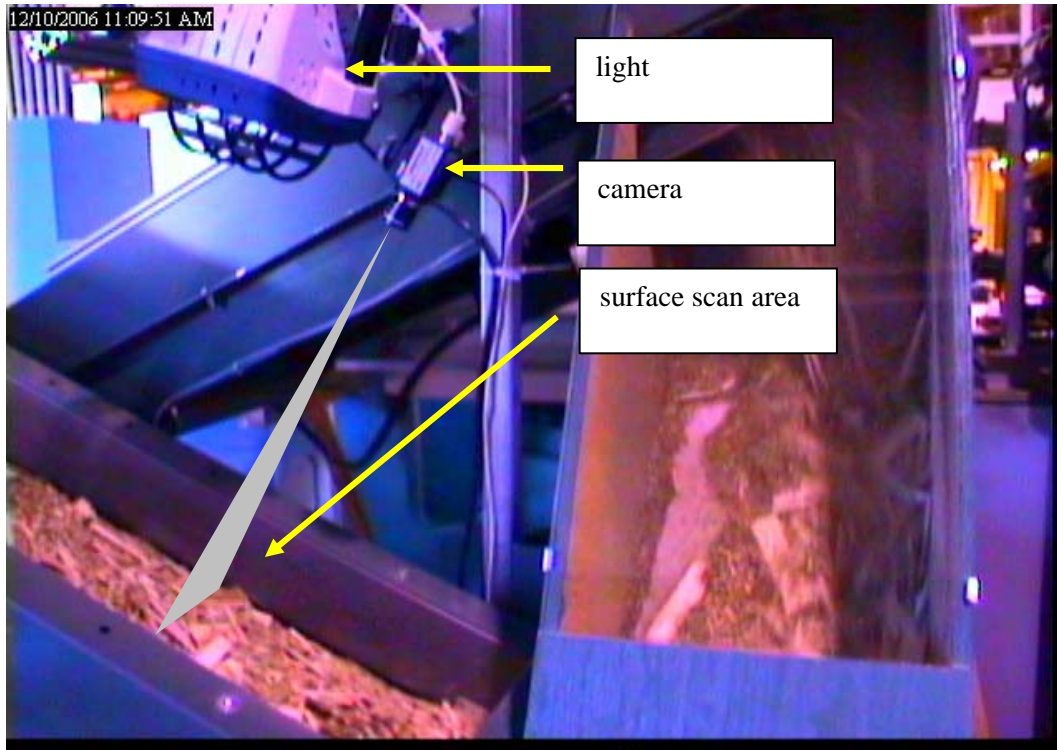
**Figure 3:** Closed loop conveyor

**Table 1: Pilot plant imaging system components**

| Component     | Description                                  |
|---------------|--|
| Camera        | Pulnix TM-200 NIR, 1/2" CCD, black and white |
| Lens          | 25mm Cosmocar/Pentax                         |
| Lighting      | 500 Watt halogen                             |
| Frame grabber | Imperx, VCE-PRO, PCMCIA                      |
| Computer      | Dell Latitude D600                           |
| Software      | C++, Fines 1.0 installed on laptop computer  |



**Figure 4: Free fall measurement setup**



*Figure 5: Top surface measurement*

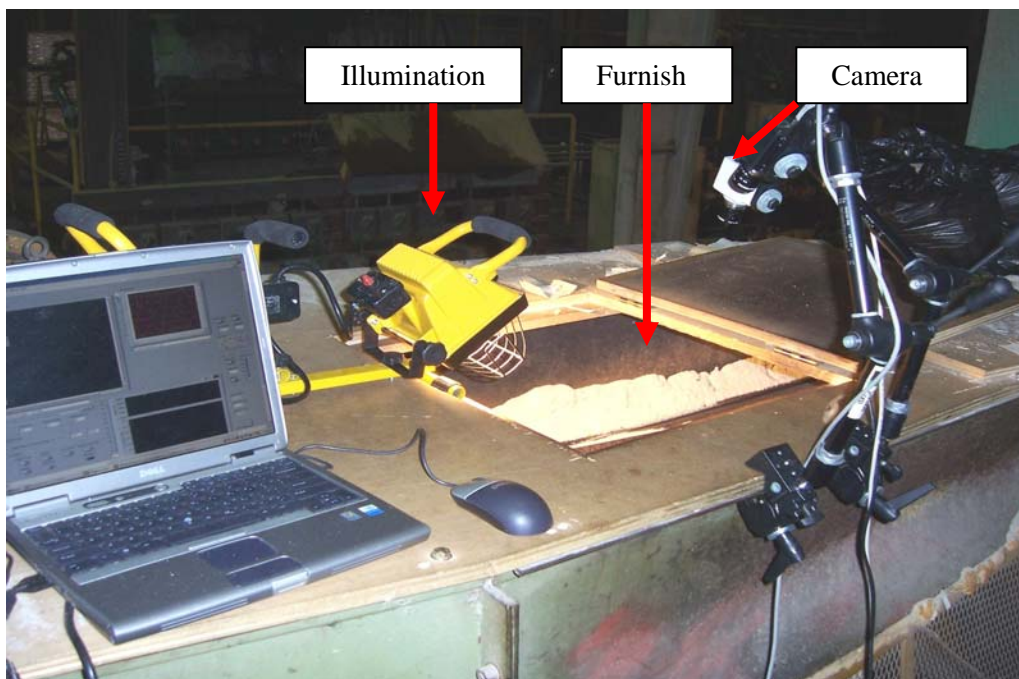
### 4.3 Mill Trial

The fines measurement system was set-up in an OSB mill to monitor the fines content of green, aspen furnish on a conveyor belt exiting the strander. The imaging system consisted of components detailed in Table 2.

The camera was mounted to view furnish on the conveyor belt, through a hatch opening (Figure 6). Due to the fast line speed (250 ft/min) the camera shutter speed was set to 1/10,000 s to minimize image blurring. Images were captured and analyzed at a rate of 10 images/s over a period of four hours. At periodic intervals, samples (approx. 2 kg each) were retrieved by mill personnel and bagged for screen analysis (Gilson classifier), to determine the actual fines content.

**Table 2: Mill Trial imaging system components**

| Component     | Description                                |
|---------------|--|
| Camera        | Pulnix TM-200 NIR, ½” CCD, black and white |
| Lens          | 25mm Cosmocar/Pentax                       |
| Lighting      | 250 Watt halogen                           |
| Frame grabber | Imperx, VCE-PRO, PCMCIA                    |
| Computer      | Dell Latitude D600                         |
| Software      | LabView© on laptop computer                |



**Figure 6: Mill trial setup**

## 5 Results

### 5.1 Fines Measurement System Development

Tests of the strobed LED lights failed to provide the level of illumination required for fines measurement at typical online mill speeds. However, tests of the digital CCD camera were very successful. When operating in 2x2-pixel binning mode, the camera's sensitivity to light was increased dramatically. In this mode of operation, much lower power illumination, including LED's, could be used effectively.

The fines measurement software was developed using the LabView programming environment (Figure 7). Features now include:

1. Fines level running average
2. Historical data
3. Calibration settings for different species
4. 0-5 VDC output signal for connection with mill computer

Optimized system components of the fines measurement system are summarized in Table 3.

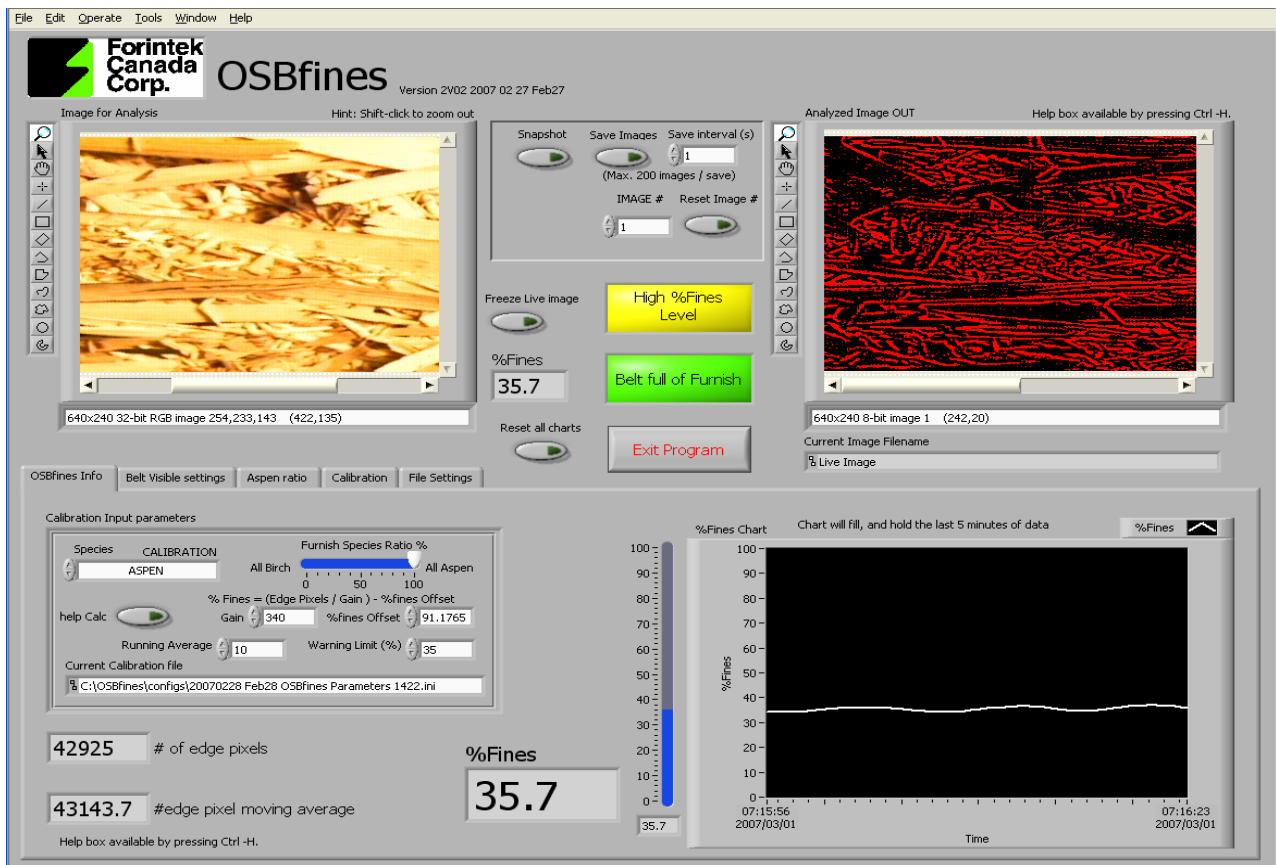


Figure 7: Software user interface

**Table 3: Summary of imaging system optimized components**

| Description of required system improvement | Original components    | Reason                          | Optimized components       |
|--|------------------------|---------------------------------|----------------------------|
| Illumination                               | Tungsten halogen       | Too hot, limited life           | Light Emitting Diode (LED) |
| Camera                                     | Analog B&W, ½ inch CCD | Poor light sensitivity          | Prosilica GE1380           |
| Imaging Software                           | C++                    | Difficult to modify and operate | LabView                    |

## 5.2 Pilot Plant Evaluation

Results from the free-fall, aspen furnish tests (Table 4 and Figure 7) show a strong linear correlation ( $R^2 > 0.95$ ) between the average measured and actual fines levels from 0-50%. The standard deviation was relatively high, ranging from 13 - 31 % fines. Results from the top surface tests with aspen, birch and MPB pine (tables 5-7 and figures 8-10, respectively) show better linear correlations with  $R^2 > 0.96$  between the average measured and actual fines levels compared to the free-fall test results. The standard deviations were also relatively high, ranging from 12 - 30 % fines.

During the conveyor tests, it was observed that fines would continually build-up and fall-off the conveyor drop-chute walls. In addition, the furnish distribution on the conveyor was relatively homogeneous at the beginning of each test, but then began to clump as the test progressed. This may have contributed to the high degree of standard deviation. Throughout all tests, the imaging system functioned reliably with no maintenance requirements.

**Table 4: Free fall test results with aspen**

| target fines % | fines weight (g) | total strand weight (g) | total furnish weight (g) | Images scanned | fines meas. (% fines) | fines meas. standard deviation | 95% confidence interval |
|----------------|------------------|-------------------------|--------------------------|----------------|-----------------------|--------------------------------|-------------------------|
| 0              | 0                | 5000                    | 5000                     | 500            | 0.1                   | 13.7                           | 1.1                     |
| 5              | 250              | 4750                    | 5000                     | 500            | 4.6                   | 13.2                           | 1.0                     |
| 10             | 500              | 4500                    | 5000                     | 500            | 10.4                  | 13.2                           | 1.1                     |
| 15             | 750              | 4250                    | 5000                     | 500            | 13.7                  | 16.5                           | 1.1                     |
| 20             | 1000             | 4000                    | 5000                     | 500            | 19.8                  | 19.3                           | 1.6                     |
| 25             | 1250             | 3750                    | 5000                     | 500            | 25.0                  | 20.4                           | 1.5                     |
| 30             | 1500             | 3500                    | 5000                     | 500            | 32.0                  | 19.9                           | 1.7                     |
| 35             | 1750             | 3250                    | 5000                     | 500            | 37.1                  | 24.3                           | 1.7                     |
| 40             | 2000             | 3000                    | 5000                     | 500            | 42.6                  | 25.4                           | 2.0                     |
| 45             | 2250             | 2750                    | 5000                     | 500            | 45.9                  | 28.9                           | 2.7                     |
| 50             | 2500             | 2500                    | 5000                     | 500            | 50.0                  | 29.5                           | 2.7                     |

**Table 5: Top surface test results with aspen**

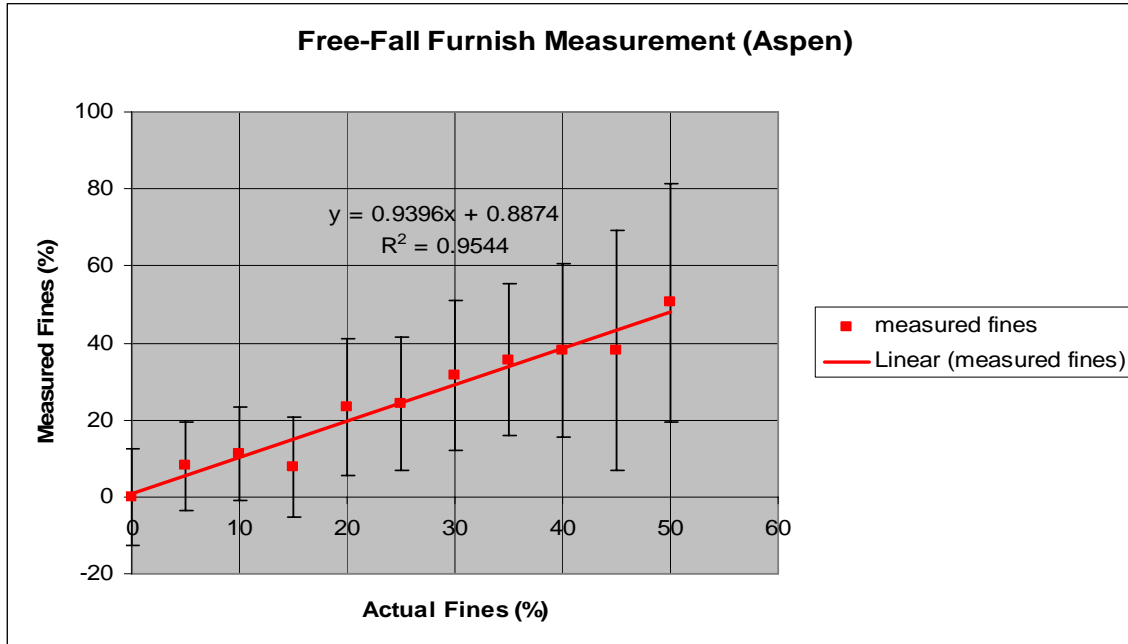
| target fines % | fines weight (g) | total strand weight (g) | total furnish weight (g) | Images measured | fines meas. (% fines) | fines meas. standard deviation | 95% confidence interval |
|----------------|------------------|-------------------------|--------------------------|-----------------|-----------------------|--------------------------------|-------------------------|
| 0              | 0                | 5000                    | 5000                     | 500             | 0.0                   | 13                             | 1.2                     |
| 5              | 250              | 4750                    | 5000                     | 500             | 8.1                   | 12                             | 1.2                     |
| 10             | 500              | 4500                    | 5000                     | 500             | 11.2                  | 12                             | 1.2                     |
| 15             | 750              | 4250                    | 5000                     | 500             | 7.7                   | 13                             | 1.4                     |
| 20             | 1000             | 4000                    | 5000                     | 500             | 23.3                  | 18                             | 1.7                     |
| 25             | 1250             | 3750                    | 5000                     | 500             | 24.3                  | 17                             | 1.8                     |
| 30             | 1500             | 3500                    | 5000                     | 500             | 31.6                  | 19                             | 1.7                     |
| 35             | 1750             | 3250                    | 5000                     | 500             | 35.6                  | 20                             | 2.1                     |
| 40             | 2000             | 3000                    | 5000                     | 500             | 38.0                  | 23                             | 2.2                     |
| 45             | 2250             | 2750                    | 5000                     | 500             | 38.1                  | 31                             | 2.5                     |
| 50             | 2500             | 2500                    | 5000                     | 500             | 50.4                  | 31                             | 2.6                     |

**Table 6: Top surface test results with birch**

| target fines % | fines weight (g) | total strand weight (g) | total furnish weight (g) | Images measured | fines meas. (% fines) | fines meas. standard deviation | 95% confidence interval |
|----------------|------------------|-------------------------|--------------------------|-----------------|-----------------------|--------------------------------|-------------------------|
| 0              | 0                | 5000                    | 5000                     | 500             | 0.0                   | 11.8                           | 1.0                     |
| 5              | 250              | 4750                    | 5000                     | 500             | 6.4                   | 12.0                           | 1.1                     |
| 10             | 500              | 4500                    | 5000                     | 500             | 14.1                  | 15.8                           | 1.4                     |
| 15             | 750              | 4250                    | 5000                     | 500             | 17.5                  | 16.0                           | 1.4                     |
| 20             | 1000             | 4000                    | 5000                     | 500             | 23.5                  | 17.7                           | 1.6                     |
| 25             | 1250             | 3750                    | 5000                     | 500             | 25.9                  | 17.8                           | 1.6                     |
| 30             | 1500             | 3500                    | 5000                     | 500             | 32.0                  | 22.0                           | 1.9                     |
| 35             | 1750             | 3250                    | 5000                     | 500             | 36.2                  | 21.5                           | 1.9                     |
| 40             | 2000             | 3000                    | 5000                     | 500             | 40.0                  | 22.2                           | 2.0                     |

**Table 7: Top surface test results with MPB pine**

| target fines % | fines weight (g) | total strand weight (g) | total furnish weight (g) | Images measured | fines meas. (% fines) | fines meas. standard deviation | 95% confidence interval |
|----------------|------------------|-------------------------|--------------------------|-----------------|-----------------------|--------------------------------|-------------------------|
| 0              | 0                | 5000                    | 5000                     | 500             | 0.0                   | 9.5                            | 0.8                     |
| 5              | 250              | 4750                    | 5000                     | 500             | 3.1                   | 10.1                           | 0.9                     |
| 10             | 500              | 4500                    | 5000                     | 500             | 8.7                   | 11.8                           | 1.0                     |
| 15             | 750              | 4250                    | 5000                     | 500             | 9.1                   | 11.4                           | 1.0                     |
| 20             | 1000             | 4000                    | 5000                     | 500             | 11.1                  | 13.1                           | 1.2                     |
| 25             | 1250             | 3750                    | 5000                     | 500             | 20.0                  | 14.3                           | 1.3                     |
| 30             | 1500             | 3500                    | 5000                     | 500             | 23.3                  | 12.8                           | 1.1                     |
| 35             | 1750             | 3250                    | 5000                     | 500             | 29.8                  | 15.3                           | 1.3                     |
| 40             | 2000             | 3000                    | 5000                     | 500             | 38.7                  | 17.8                           | 1.6                     |
| 45             | 2250             | 2750                    | 5000                     | 500             | 41.6                  | 17.7                           | 1.5                     |
| 50             | 2500             | 2500                    | 5000                     | 500             | 50.2                  | 17.7                           | 1.5                     |



**Figure 8: Measurement results of free falling aspen furnish**

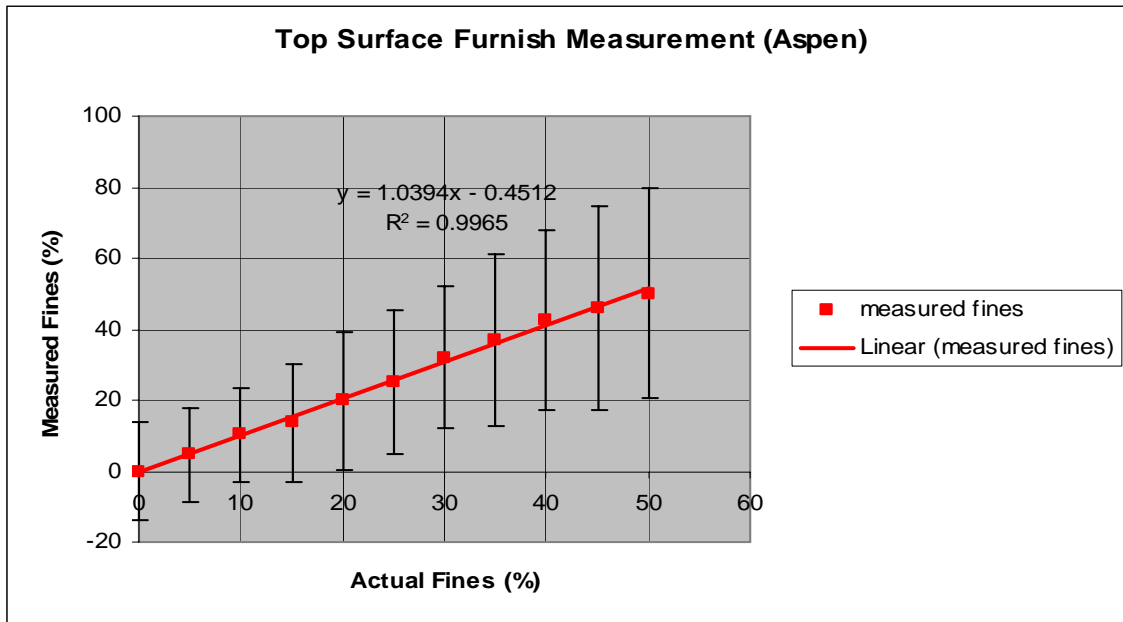


Figure 9: Measurement results of top surface aspen furnish

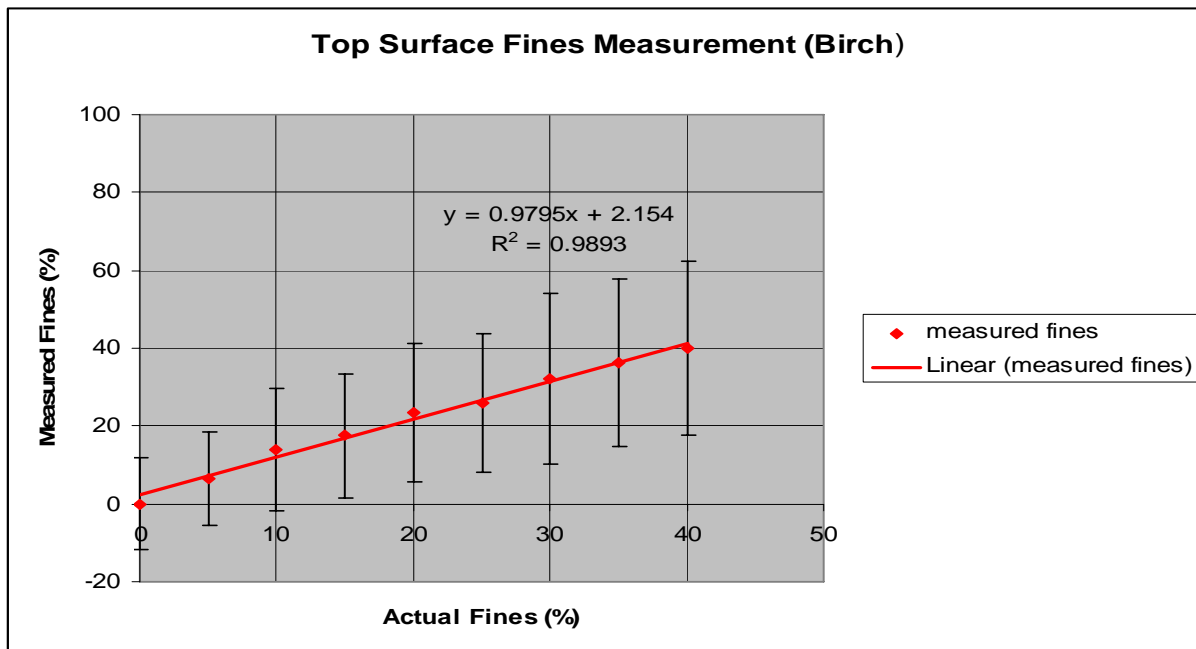


Figure 10: Measurement results of top surface, birch

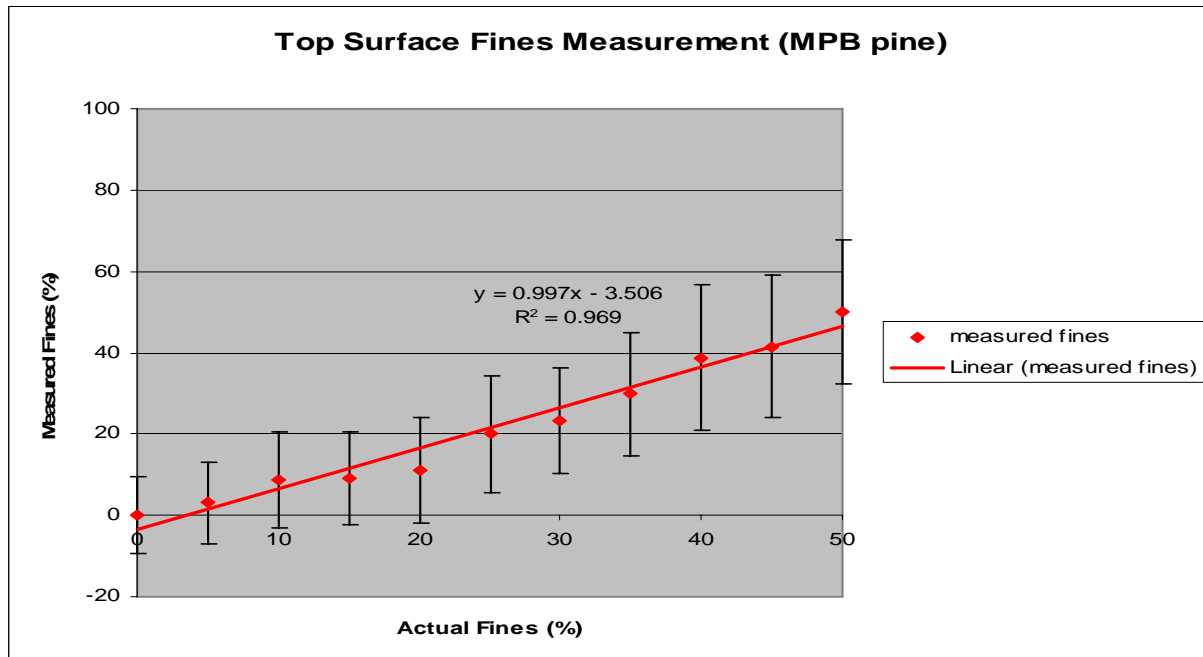


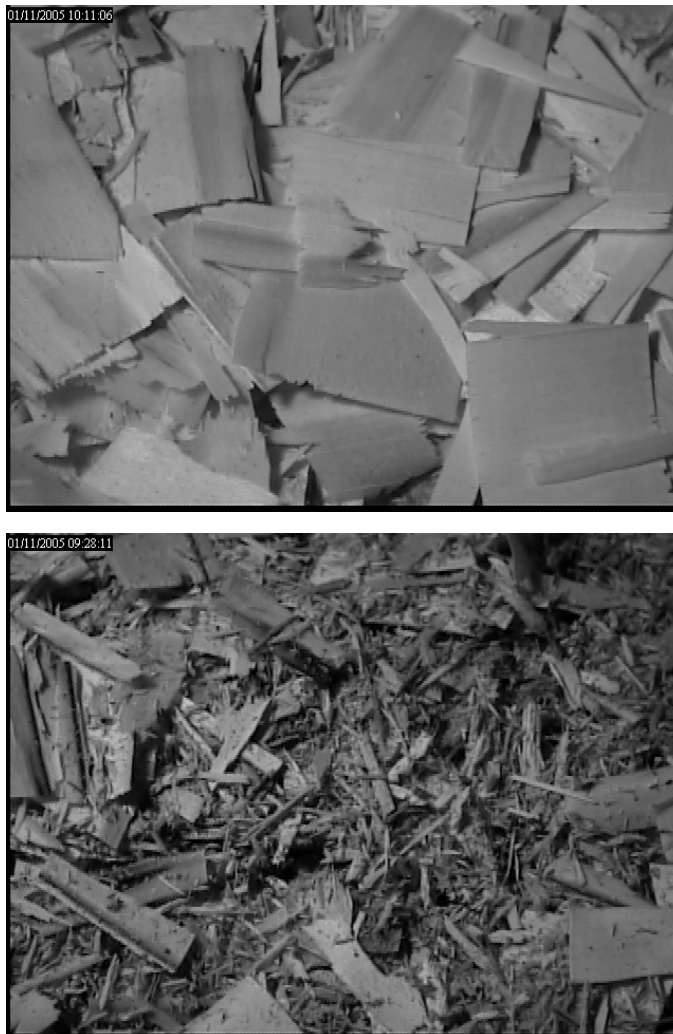
Figure 11: Measurement results of top surface, MPB pine

### 5.3 Mill Trial

Originally, the mill trial was planned for the Canfor, OSB mill in Fort Nelson. However, due to the unpredictable closures at this mill the trial was switched to an alternative site, namely the Louisiana Pacific OSB mill in Chambord, Quebec which processes mainly aspen. Conducting the trial with aspen instead of MPB pine was not expected to compromise the results of the project since previous pilot plant tests showed little difference between aspen and MPB pine results.

Figure 12 shows examples of images from the mill set-up with low and high fines content. Figure 13 shows the fines level trend of data gathered from the mill set-up. At approximately 10:20 AM the strander knives were changed, corresponding with a drop in measured fines level. For the remaining 3 ½ hours, the trend reverses, showing an increase of 23% fines. The following upward trend in fines may reflect the increasing knife wear over time.

During the test period, a total of six 6 furnish samples were gathered for screen analysis. The results are plotted along side the measured fines trend in Figure 13. Although few in number, the fines from the screened samples show a good correlation with the imaging system measured values. Throughout the mill trial, the imaging system functioned reliably with no maintenance requirements.



***Figure 12: Images showing low (top) and high (bottom) fines content***

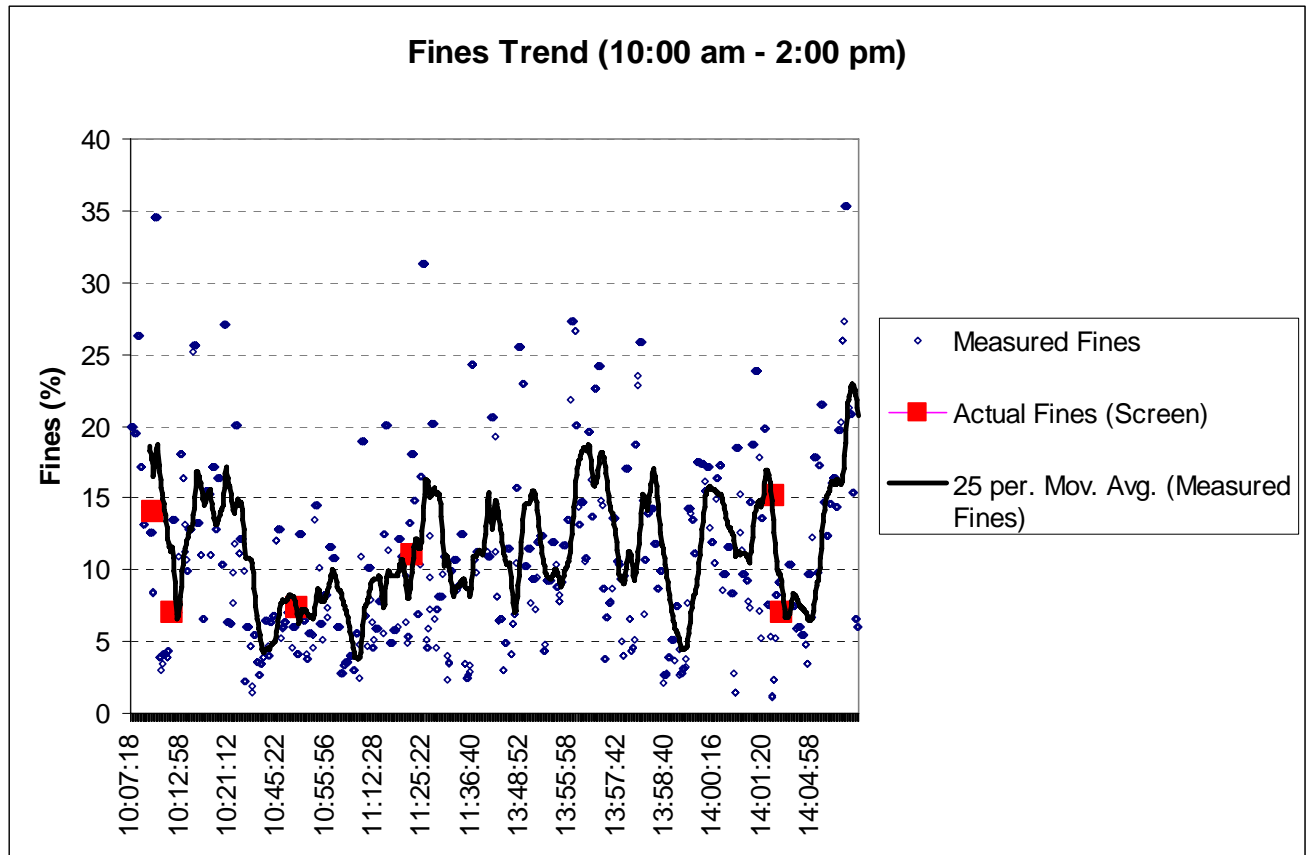


Figure 13: Mill trial results

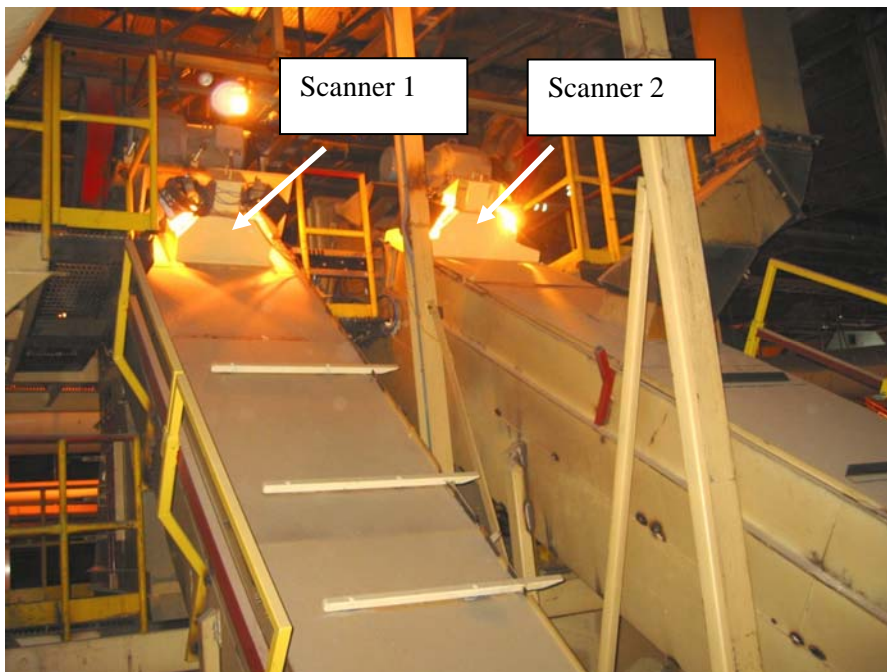
## 6 Discussion

The high degree of standard deviation of fines measurements in the pilot plant and mill tests suggest that the best way to interpret this data would be to use a running average. Indeed, pilot plant tests showed that the averaging of 500 image measurements/fines level showed a very good correlation to actual fines level. In practice, using a 500 point running average translates into data averaging over a period of 50 seconds, based on a camera capture rate of 10 frames/s. This can then be used for effective online trending of fines level in mills.

The effects of using species with different wood brightness and colour were also investigated in this project. Aspen (light coloured), birch (dark coloured) and MPB pine (stain discolourations) were chosen. Test results showed that all three species performed equally well with very good measurement correlations to known fines levels, indicating that the visual differences between species does not significantly affect measurement accuracy.

## 7 Technology Transfer

To facilitate technology transfer, Forintek assisted an OSB mill with the permanent installation of two fines measurement units (Figure 14). These units are now fully operational for continuous monitoring of fines level. In addition, discussions are currently underway with an equipment supplier to commercialize this technology.



**Figure 14: Permanent mill installations**

## 8 Conclusions

1. Pilot plants tests of the optimized system were successful with results showing strong correlations ( $R^2 > 0.9$ ) between measured versus actual fines levels under simulated mill conditions for MPB pine, aspen and birch. The system worked equally well for all three species.
2. Mill test results showed a good correlation between the imaging system measured values versus actual (screen - 3/8") fines levels recorded at the green-end, flaker location of the mill.
3. High power, halogen lighting can be replaced with a combination of LED lighting and a high sensitivity, digital CCD camera.
4. The fines measurement technology tested in this project has been successfully installed for permanent operation in a Canadian OSB mill.