Raw Material Management

Review of Common Practices

David C. Smith
Evergreen Engineering, Inc.

Abstract

This paper makes a few points about the impact of raw material variability on process control. The main focus is on achieving the safety and operating goals of the wood yard. Some of the best technologies are explored for receiving raw material, handling it through storage, and achieving reliable, consistent reclaim to the process. These are all discussed from the overriding perspective of mitigating fugitive dust and minimizing risks of fire.

The paper provides descriptive information from actual successful storage and retrieval systems, and from equipment manufacturers. Concept options for managing variable raw material sources are presented. Current operators will hopefully pick-up a few fresh, low-cost ideas that they can take back to their plants and implement.

Introduction

The focus of this paper is to present an overview of technology and management approaches to raw material management practiced around the particleboard and MDF industry. An in-depth look will be taken at how some industry leaders deal with the hundreds of tons of wood residues that pass through their mills every day.

This discussion of Raw Material Management in large particleboard or MDF plants is more about hard work and disciplined procedures than it is fancy technology. These mills use huge quantities of raw material. The worst assumption that can be made, but a common one to fall into, is that it is all pretty much the same.

Most supervisors of people recognize the importance of dealing with them as individuals. Wood raw material should be regarded the same way. Appreciate the diversity and variability of wood. If it isn't shown proper respect, it will (just like mistreated employees), cause performance problems. Fortunately, technology can provide some help. Its commonly recognized in the industry that all successful plants have invested wisely in good Raw Material Management Systems.

How Wood Variability Affects the Board Making Process

Without going into great detail, there are a variety of ways that wood variability will affect the board-making process. The issue is not whether or not good board can be made from different kinds and types of wood, but rather can a variable wood supply be used to make a consistent and uniform product. Invariably, the single most important quality characteristic to the industrial user of particleboard and MDF is that the product be consistent. They want every part of every panel of every load to behave the same. Consistency starts in the wood storage yard.

The first source of variability is species. This can be manifested both chemically and physically. The main chemical impact is associated with the way the wood interacts with the UF resin binders commonly used. Different wood species exhibit different acidity levels, or pH, and so have different influences on both the speed of resin cure and the quality of the resin bonds. Physically, every species exhibits different density and fiber characteristics that can affect the way the wood performs under tools, and the strength and dimensional stability properties of the composite panel.

Consistency in the "form" that the material comes in is vitally important to smooth plant operations. Chips, sawdust, planner shavings, and board trim all have different bulk densities and behave in different ways as they pass though processing equipment. Stable operating conditions demand a uniform mix of raw material geometry.

Raw material moisture content also has a major influence on how the material behaves as it moves through the process, particularly in the milling operation. Dry material tends to consume more power during milling, and results in higher dust and fines generation than with wetter wood. Screening efficiency is also affected by moisture content, and of course, dryer load is much more difficult to control if the incoming moisture content is variable.

The age of the material must also be managed. This is more of a long-term issue, and much more important with green materials than with dry residues. Wood becomes more acidic as it ages in a storage pile, particularly at high moisture content. The wood darkens, begins to rot, and losses its fiber strength. All of these factors will manifest themselves as variable board quality. In addition, the biological activity associated with rotting wood generates considerable heat. If green storage piles are not frequently rotated, spontaneous combustion can result.

Case Studies: Raw Material Receiving and Storage

We will now present some case studies of different mills to explore their approaches to Raw Material Management and some of the technology they employ.

The Tafisa mill in Quebec is now the largest particleboard plant in North America and perhaps the world. If ever a mill faced a Raw Material Management challenge, this one does. But, through discipline and technology, they have met the challenge very successfully.

The Tafisa Lac Megantic plant is rated to produce 550 million sf, 3/4" annually on two production lines. About 800 raw material trucks a week deliver the 2,200 bdt of materials it needs every day. With such a huge appetite for wood, the plant obviously needs to take low-cost material wherever it can find it. The plant's main goals regarding wood management are to be able to vary the mix to take advantage of seasonal changes in supply patterns and still make consistent product that is identical on both production lines.

Figure 1 shows an aerial view of the mill. A schematic diagram of the plant's raw material receiving and storage area is shown in Figure 2.

Figure 1. Aerial view of the Tafisa mill in Lac Megantic, Quebec

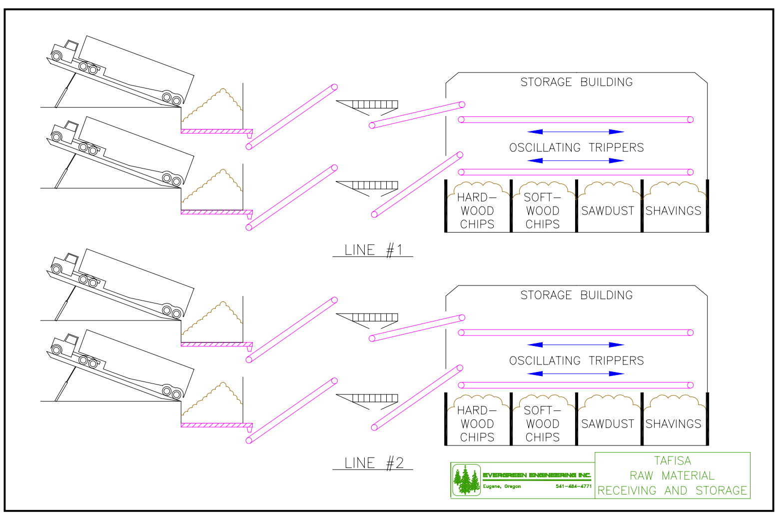

Figure 2. Tafisa raw material receiving and storage

Tafisa has a pretty large capacity to store wood, up to 10 days worth, but a very strong procurement system allows them to generally operate with only a few days of inventory. The mill classifies material into six major sorts and uses it in the following rough proportions:

Hardwood chips & sawdust	25%
Softwood chips	25%
Softwood shavings	30%
Softwood sawdust	18%
Recycled urban wood	2%

Of course the "softwood" and "hardwood" do contain a mix of species, so could be segregated further. This management strategy is a compromise between complexity and practicality. Additionally, all board trim and sanderdust is burned for fuel, but reject mat trim is metered back into the process.

Tafisa is an ISO 9000 certified facility that has established a detailed quality specification for each of its forms of raw material. They have a very large group of both large and small suppliers that have all been certified to their ability to conform to the quality specifications. The receiving area is staffed with Tafisa personnel who take the time to sample and inspect every arriving load. They ensure that the material is moved properly into storage by issuing programmed "keys" to the drivers to operate the truck dumps and conveying system.

The system, depicted in Figure 3, is really quite simple:

- Each line has a separate storage building serviced by two truck dumps.
- Each dump has a dedicated conveyor distribution system, which allows two trucks to unload any material simultaneously to each building.
- Computer controls, activated by the "key", position the overhead conveyor discharge trippers, and control sequencing to be sure material is always properly sorted.

Figure 3. Tafisa's raw material handling equipment

The truck dump facility is made up of five back-in type, long-deck permanent dumps. The fifth dump is used to deliver hog fuel to the energy plant. The operation is located in an open area with no provisions for dust control, although they are currently considering options for containing fugitive losses.

Figure 4. Tafisa's storage buildings

The storage buildings (shown in Figure 4) are long, open-sided, sloped-roof structures with lateral over-head distribution conveyors.

Before reviewing more details on Tafisa, we will next turn our attention to the largest, and one of the finest, MDF plants in North America -- Plum Creek's mill in Montana. This 2-line mill with 250 million sf of annual capacity uses about 1,000 bdt of raw material a day. Plum Creek, which began operating in 1972, recently started-up their second press line.

Their new line is focused on thin board, which requires a higher portion of long fiber, so their goal is a little different than Tafisa's. Instead of striving to make identical products on both lines, Plum Creek manages their raw material mix to send a greater portion of long fiber material to the thin board line. This allows them to make a slightly coarser and stiffer product than the highly machinable thick-board product they produce on the old production line.

The capacity of their storage facility is quite small, so it requires a lot of attention. The raw material is divided into the two primary sorts of dry planer shavings and green sawdust. The sawdust, which makes up about 2/3 of the total, is further divided into a long fiber fraction, which may contain some pin chips, and a short fiber fraction. Plum Creek is fortunate to enjoy a pretty uniform and consistent supply of mixed lodgepole and yellow pine, Douglas fir, and larch from local sawmills and plywood plants. They have a large hog fuel boiler system on site that serves the thermal energy needs for the entire complex of plywood and lumber, as well as MDF, facilities. Although they used to try to reuse their board trim they have now decided that it is more cost effective to divert all trim and sanderdust to boiler fuel.

Plum Creek's management philosophy is less formal, but equally effective as Tafisa's. Instead of having written specifications for the different materials, they rely on a supplier certification process to ensure that each of their suppliers understands their quality expectations and is capable of meeting them. The number of suppliers is not large, only about 35, and most have been working with them for many years. Plum Creek treats them as partners, and is willing to invest in their facilities to be sure the right equipment is in place. The truck haulers also play a significant role in quality control. Again the relationship has been long-term and the mill has taken the time to train the drivers about their quality needs. They ask them to keep an eye out for bad loads and have empowered them to divert poor quality materials to their hog fuel area.

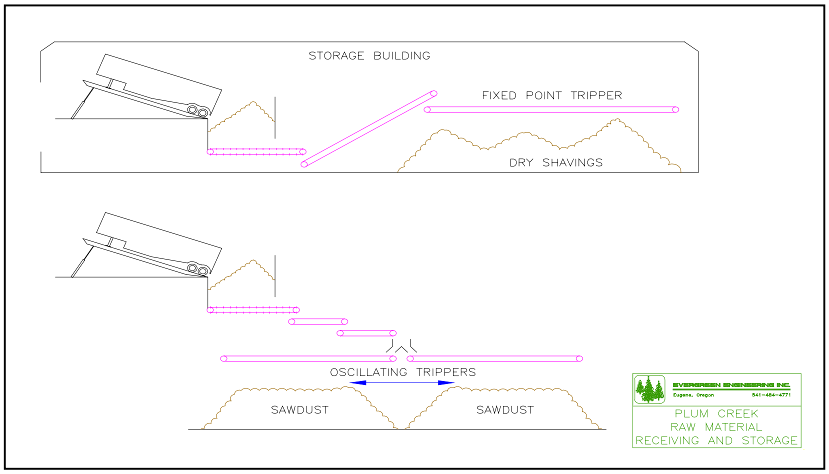

Figure 5. Plum Creek's raw material receiving and storage

Plum Creek's storage system is also pretty simple. They have two truck dumps. One handles the dry shavings, and is located inside the enclosed dry storage building, which is shown in Figure 6. The second dump is connected to the sawdust storage area, which is divided into two sub-areas. This storage area is shown in Figure 7.

Figure 6. Plum Creek's dry storage building

Figure 7. Plum Creek's sawdust piles

We'll also be getting back to Plum Creek later. Next we will take a look at an old mill that's moving through the process of re-inventing itself. The SierraPine particleboard mill in Adel, Georgia was built originally, and operated for many years, by Weyerhaeuser. This moderately sized, 140 million sf/year particleboard plant runs on 100% southern pine in the form of dry planer shavings and green sawdust. At present, their thermal energy needs are sufficient to allow them to burn all of their board trim and sanderdust rather than reuse it back in the board. However, they are in the process of moving away from using sawdust in favor of dry shavings. While there are quality advantages to do this, the decreased load on the dryers has resulted in excess trim for fuel, which they now need to reincorporate into the core of the board.

Twenty-percent of Adel's shavings come from a large adjacent sawmill via a pneumatic conveying line. The rest come in by truck from five major and 20 minor suppliers. With so few suppliers, SierraPine has been successful using a very simple procurement management system. They rely on the truckers to weigh in and out, and operate the dumps. No moisture or quality checks are normally made. A single moisture factor is applied to all suppliers for the purpose of determining dry weight. More scrutiny of the raw material deliveries is applied only if they start having regular processing problems.

Because such a large portion of their raw material is dry shavings, they recently installed a covered dry storage system composed of two large Clarke's Flowmatic bins. Each is served by a dedicated above-ground truck dump, Figure 8, equipped with disc screens to remove gross over-sized, and belt conveyors for transport.

Figure 8. SierraPine's truck dumps

The next plant we'll look at is Weyerhaeuser's (Willamette Industries) Duraflake mill in Albany, Oregon. This is another good example of an older mill that has remained competitive by investing in new technology. This 240 million sf/year mill uses two main raw material sorts; green and dry. They do, however, do some further segregation to keep track of some sawdust as part of the green shavings, and ply-trim and recycled wood as part of the dry shavings.

The on-site storage area depicted in Figure 9, holds only a few days worth of material, so it must be carefully managed, and is supplemented by an off-site storage pile. They use two truck dumps; both enclosed by a building to control dust losses. Because Duraflake is located in the rainy Northwest, all material is stored under roof. The green building is distributed by a tripper conveyor, while the dry building uses an oscillating radial stacker.

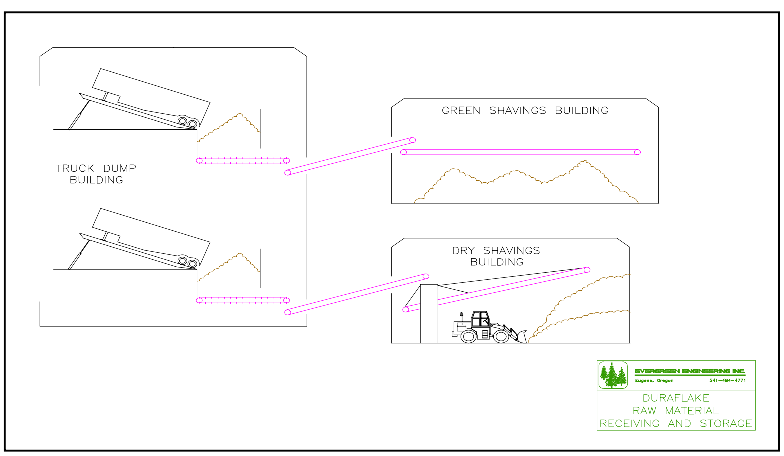

Figure 9. Duraflake's raw material receiving and storage

The dry storage building, Figure 10, was put up in the mid-1980s after the plant's original structure burned to the ground. It has a number of safety features designed into it, including 100% reinforced concrete structural members and extensive explosion relief panels on the side walls.

Figure 10. Duraflake's dry storage building

The green storage building, Figure 11, has one open side and its roofline is sloped to match the angle of response of the material pile. It is built with fortified support foundations for the roof beams to protect them from front-end loader damage.

Figure 11. Duraflake's green storage building

	Tafisa	Plum Creek	SierraPine	Duraflake
Segregation	species/form	green/dry	form/MC	green/dry
MC checks	every load	factor	seldom	factor
Quality	ISO 9000	certification	occasional	occasional
Unloading	key	trucker/by dump	trucker/by dump	trucker/by dump
Storage	continuous oscillation	oscillation alternate piles	continuous oscillation	radial stacker alternate piles

Table 1. Summary of Raw Material Management

The similarities and differences in these four operations are summarized in Table 1. Tafisa does four sorts, Plum Creek "2+", while SierraPine separates sawdust and shavings, and Duraflake cares less about form, and keeps only green and dry apart. The frequency of mix control checks covers the range from every load to almost never, as do quality checks.

The main thing regarding quality that all of the mills do is to have a relationship with their suppliers. This can be rigorous and formal as in the case of Tafisa, or in Plum Creek's case, simple but clear with a recognition of the need for shared success. What's most important is that the suppliers understand the mills needs, that they have the physical capability to keep material clean and segregated, and that there is some procedure in place to hold them accountable.

Fugitive Dust Control

Fugitive dust emissions, particularly with dry materials, can create housekeeping problems and complaints from the neighbors, as well as problems with the regulators. Figure 12 shows how an older plant (L-P's mill in Missoula, MT) has dealt with the problem dust clouds when unloading dry materials. The system has three elements; a cover over the truck trailer, a hood that mates with the cover and the end of the truck, and a 25,000 cfm negative air system with filter to capture the billowing dust as the material slides out of the truck.

Figure 12. LP Missoula, truck dump dust control

This same concept has been incorporated into original equipment designs by Phelps. Its key elements, shown in Figure 13, include:

- Enclosure hood that mates with tail of truck and nests with hopper
- Retracting hopper cover
- Negative air system with filter

Figure 13. Phelps' truck dump with dust containment

Figure 14. Duraflake's truck dump dust control

Willamette Industries' Duraflake facility has developed a very effective and efficient system, shown in Figure 14. This has been identified by the Oregon DEQ as BACT control, and so its performance is being held up as the expectation for new installations in the state. Its key elements are:

- Building with maximum enclosure
- Eyebrow hood over opening
- Negative air hood
- Showers to wash bumper

The hood over the building opening has several purposes. The first is to physically contain billowing dust and evacuate it away with negative draft. Duraflake has incorporated the evacuation function into the existing pneumatic transport system clearing some green shredders, so doesn't require a dedicated fan and filter. The bumper showers are mounted on the lip of the hood. These are activated by a rollover switch that fires a short burst of water when the truck exits, to clean material off the bumper and tailgate. This prevents material it from being spilled on the road after the truck leaves the mill.

Another area where dust control is a major concern is in their dry storage building. Duraflake employs this same concept of "hooded dust capture using pneumatic conveying air" to its dry storage building. The storage building has only one small opening. A front-end loader handles material re-entry by loading a reclaim hopper, which is located inside the building. A hood with an air pick-up is mounted above the opening to keep dust from billowing out. The area outside the building is shown in Figure 15.

Figure 15. Duraflake's dry storage dust control

The reclaim hopper is evacuated by an enclosed conveyor, which feeds a large shredder as the first step in the milling process. Like on the truck dump building, the conveying air used to evacuate the shredder comes mainly through the hood used to control dust losses at the door of the building.

For particleboard, dry raw materials can be highly desirable. However, they can be hard to use in large quantities because of associated explosions risks and inconsistent availability. However, a shift is currently occurring in the lumber business to more kiln dried material, which is making dry shavings more available. Dry shavings do store well for long periods of time if kept undercover. Figure 16 shows some modern thinking on the configuration of a dry storage building that is designed to hold up to 10,000 BDT dry material safely, securely, and economically. This design features a front side with short bays to allow blending and rotation, re-entry bins coupled with shredders, and pneumatic evacuation coupled with dust control hoods. The back side is designed to hold a long-term stockpile, which allows the procurement people to take advantage of supply opportunities and price fluctuations, and hold a steady mix to the mill.

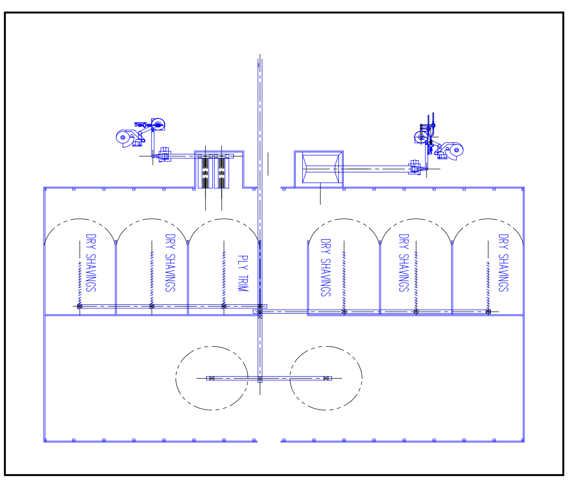

Figure 16. High capacity dry storage building design

Fire and Explosion Protection

The CPA has published an excellent and highly recommended manual on the subject of fire and explosion protection. The key concepts to managing risks when working with dry dusty material is to minimize the possibility of an explosion occurring, but also maximize the ability of the facility to survive an incident if it does occur. Some of the key elements that should be incorporated into the design of a dry storage facility include:

- Installation of ample explosion venting per NFPA Standard 68, or FM 7-76
- Provide extra protection for sprinkler risers and use welded rather than flanged pipe
- Eliminate all horizontal ledges that can collect dust
- Follow NFPA Hazard Class II lighting and wiring guidelines
- Provide good maintenance access from outside the structure to overhead distribution and conveying devices

Equally important is the design of the rolling stock intended to operate inside a dry storage building. The concepts are the same: minimize the possibility that the machine might start a fire and maximize survivability in case it does. Essential design features include:

- Totally enclosed and reinforced operator cabs
- Automatic and manual dry chemical extinguishing systems
- Non-sparking (nonferrous) scoop lips
- Totally enclosed electrical systems
- Oversized air in-take filters
- Frequent adherence to cleaning and safety checklists

The risks presented by dry materials cannot be eliminated, but can be managed. It is simply a matter of applying proper design and procedures to reduce risk to minimal and acceptable levels.

Storage Management and Blend/Mix Control

So far we've seen how most mills use a raw material storage strategy of segregating by "type" to some degree, then use different kinds of transport and distribution equipment to homogenize the material to blend out variability. Now we'll turn our attention more toward management to achieve the goal of delivering a consistent mix to the mill.

This next section will look at different types of equipment systems for rotating stock and retrieving it from storage, and strategies to manage the blend of different types of material.

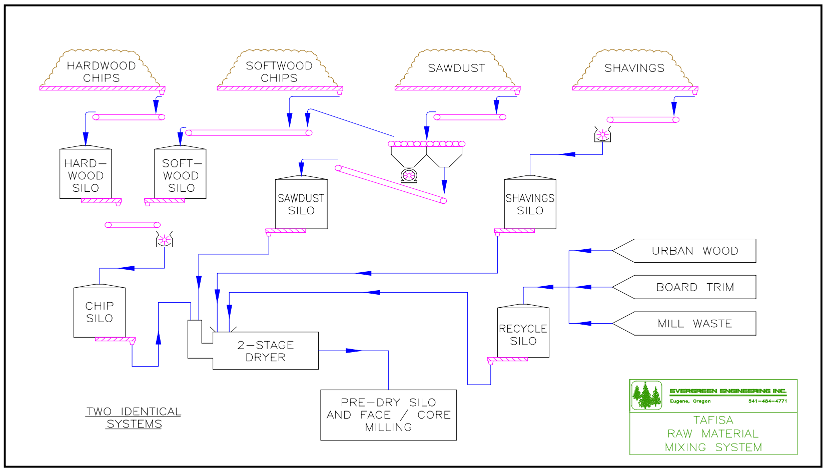

Figure 17. Tafisa's mix control system

The system used by Tafisa is described in Figure 17. It begins with their long storage buildings that use overhead distribution conveyors to segregate types of material. A consistent mix of these different material types is achieved in the following manner:

- All materials are reclaimed from storage by under-pile retrieval screws and placed in silos
- the two types of chips are metered and siloed,
- sawdust and shavings are pre-processed and siloed,
- different sources of recycle are also combined in silos,
- then these five materials are mixed with ratio control in the pre-dryer.

Figure 18. Tafisa's under-pile retrieval

Tafisa uses cantilevered screws under their storage building. Four screws like the one shown in Figure 18 are used in each of the two buildings. The screws, however, only extend halfway across the width of the material pile, so they also have a loader operator on duty full time in each building to assist the mixing action and push material from one side of the building to the other. Each retrieval screw discharges onto a dedicated belt that brings material through its pre-processing system and fills the silos. While under-pile retrieval is great for rotating and blending stock, it's not really controllable enough to do proportional metering. Therefore, it isn't a good idea to create a mix by having different retrieval screws all drop onto a common conveyor.

Another example of a commercial under-pile retrieval system is Rader's tubefeeder, shown in Figures 19 and 20.

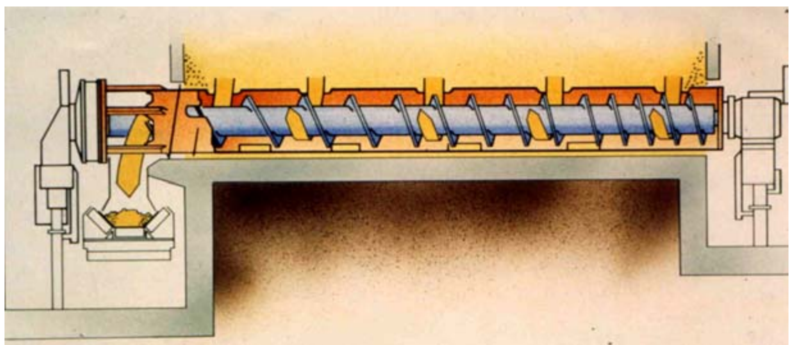

Figure 19. Rader Tubefeeder™, principal of operation

Figure 20. Tubefeeder™ in open pile

Instead of an exposed screw, this device consists of an outer tube and an inner screw. The device is supported at both ends and has two drives. The speed of the slotted outer tube is variable and controls the traversing rate and rate of reclaim. This allows the inner screw to run at a constant speed and simply move the collected material to the discharge end. The result is a much lower total horsepower requirement compared to an open screw.

One of the disadvantages of all underpile systems is the cost associated with building the access tunnels. The heavy concrete work on the tunnel roof needs to cantilever over the conveyor ends and over the entire traverse span, while holding the weight of the material pile above it. The guide rails and traversing equipment hang from the ceiling of the tunnel. The Tubefeeder™ system is supported on both ends, so it requires two support tunnels, while the cantilevered system used by Tafisa needs only a single tunnel.

The Tafisa people are very happy with the way their storage system has worked out. The retrieval screws have been very reliable, but in the event they do have trouble with them, the layout provides good access to clear them with a front-end loader. Overall the system has provided good mix control, along with the flexibility to respond to changes in supply patterns.

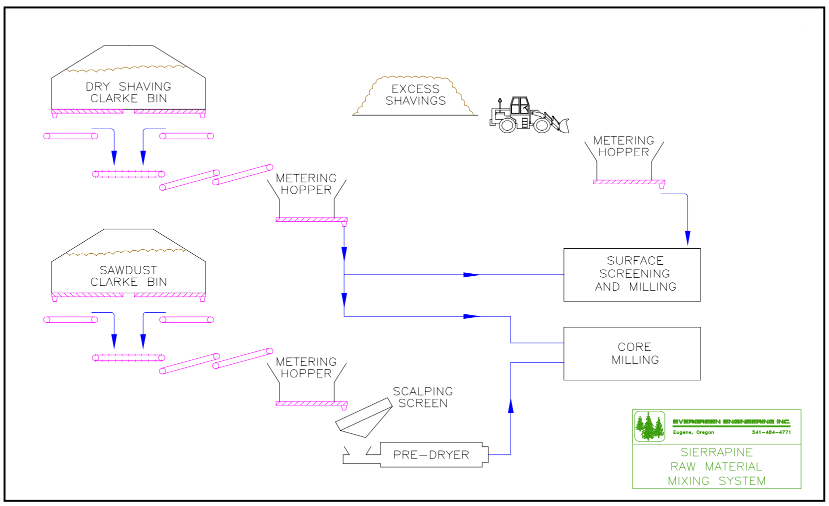

Figure 21. SierraPine's mix control system

SierraPine's Adel mill employs another variation of retrieval and mix control (Figure 21). They use two large Clarke Flo-matic bins with traversing screw bottoms to feed metering hoppers. No mixing is done on the surface side, as only dry planner shavings are used for surface furnish. The core mix is made by metering sawdust through a predryer and mixing that material with shavings. All board trim and sanderdust is used for fuel rather than raw material.

Each of the two Clarke bins, Figure 22 and 23, is 240' long and holds about 1,500 bdt, or 3-4 days worth of material. Each bin is fed by a dedicated truck dump. Conveyors deliver material to the overhead distribution system that utilizes a continuously traversing tripper car to deposit the material across the width and along the full length of the bin.

Figure 22. Clarke's Flo-matic bin at SierraPine

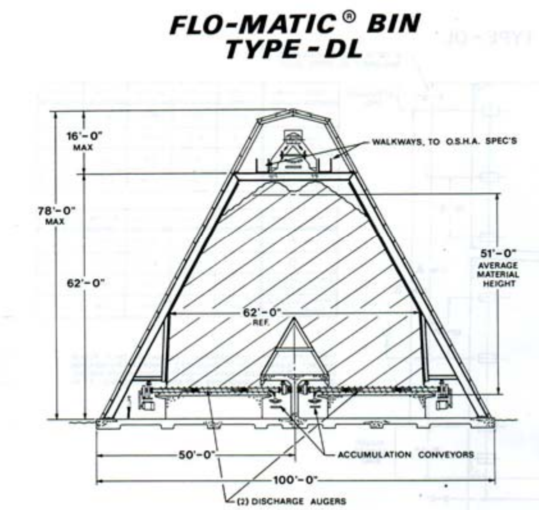

Figure 23. Clark's Flo-matic bin

For reclaim, two independent traversing screws work each side of the pile to give redundancy and improve the blend.

The screws are controlled to move at rate of about 10 feet per hour, so take about 24 hours to travel the length of the bin. Both ends of the screws are accessed through tunnels (Figures 24 and 25) and the accumulation conveyors are housed in the center. The two accumulation conveyors discharge onto a common drag chain for transport to the metering bin. If necessary, the screws can be removed through the side of the structure. The job of the retrieval system is simply to keep the metering bins full.

Figure 24. SierraPine's Clarke bins

Figure 25. SierraPine's Clarke bins

SierraPine has had these bins in service for over five years now and couldn't be happier with them. They've had no significant problems, except the sawdust screws wore down and had to be changed.

As nice as underpile retrieval systems are, many mills still use front-end loaders and re-entry bins to bring wood into the process. The Plum Creek system, shown in Figure 26, uses a common storage facility to feed its two MDF lines, but separate sets of metering bins to allow them to control the mix to each line independently. Each set of metering screws discharges into a common mixing screw to blend the dry and green materials together. Then, the material transfers to a belt conveyor equipped with a non-contacting moisture meter. The moisture readout is displayed in large numbers so that it is visible to the loader operator. This allows the operator to keep eye out for material changes and adjust the speeds of the metering screws to maintain a consistent mix.

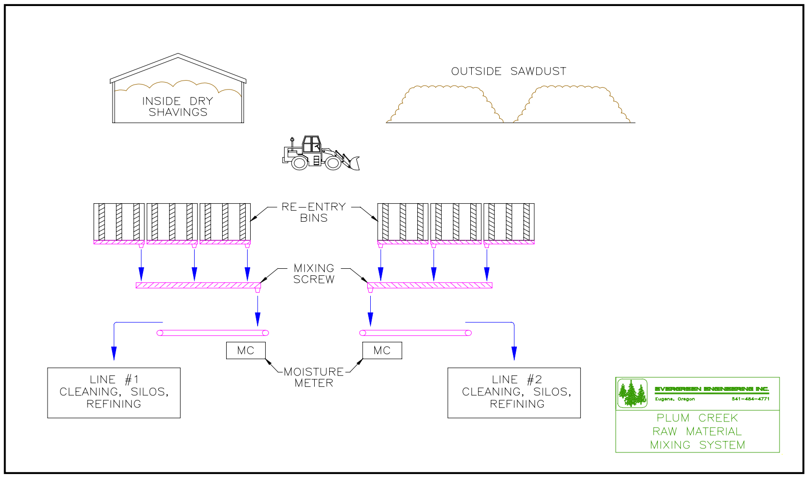

Figure 26. Plum Creek's mix control system

The mixed material is then conveyed through screens to remove oversized pieces, and into air density separators to drop out heavy contaminates. The ADSs discharge through cyclones into silos that hold several hours of capacity. This system arrangement is shown in Figure 27. The time in the silos provides the opportunity for moisture exchange between the green and dry materials, which improves refining performance. The silos discharge to belt conveyors for conveying to the refiner infeed bins on each line.

Figure 27. Plum Creek's re-entry area

To summarize Plum Creek's raw material management strategy:

- They have good tools in place to blend out truckload to truckload variability.
- They use moisture as an indicator of the consistency of feed to the silos.
- The area operator is charged with delivering a consistent performing mix and uses his metering bins, silos, and moisture feedback, to keep things lined out.
- The system is simple, low cost, and efficient; but has the flexibility to give good service.

Duraflake's system, Figure 28, is set-up to meet their goal of having the board from the plant's two press lines be indistinguishable from each other. They achieve this by preprocessing green and dry material separately, then use silos to meter the materials together, along with reclaimed board trim, in the screening and milling area. They then prepare face and core furnishes, which are stored in large silos before dispersing to the two production lines at required rates.

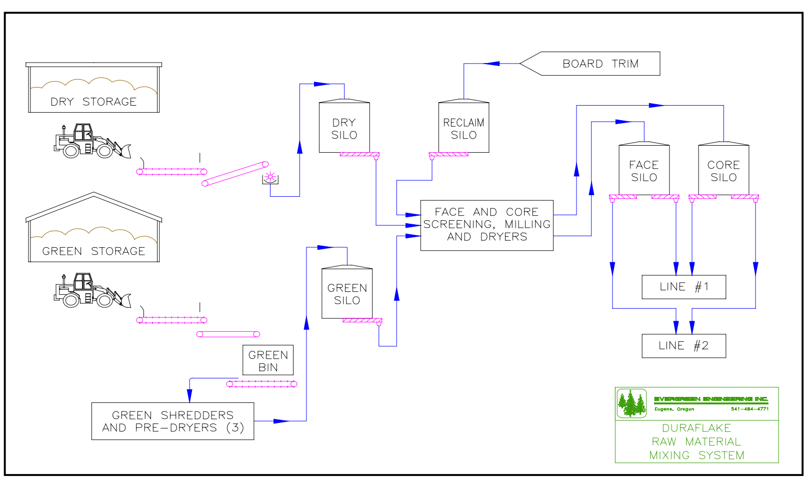

Figure 28. Duraflake's mix control system

by David C. Smith
Evergreen Engineering, Inc.

Weyerhaeuser's (Willamette Industries) MDF mill in Eugene also uses the material discharge from silos to create their wood mix (Figure 29). What's unique about this mill is that they process different materials sequentially. In roughly equal portions, they reclaim either shavings or sawdust, or recycled urban wood chips from storage, process them through appropriate screening and cleaning equipment, and place them in silos. From there, they are metered out in controlled portions along with board trim to feed the refining operation.

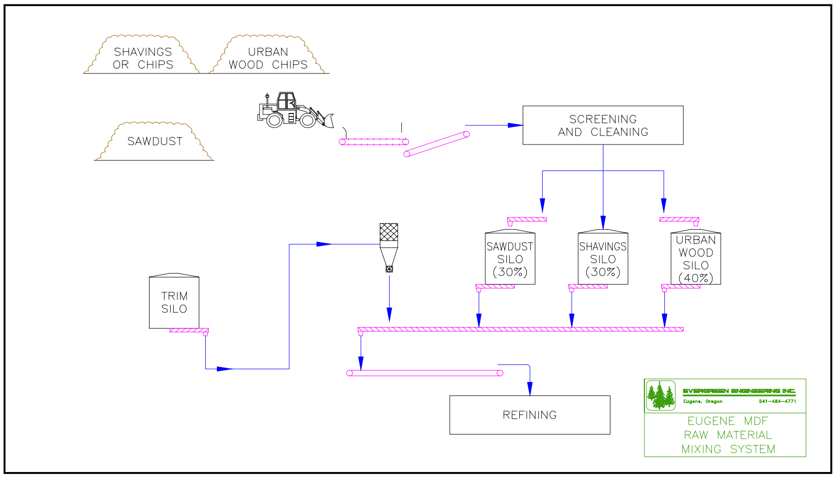

Figure 29. Weyerhaeuser's MDF mix control system

The Weyerhaeuser silo installation, along with the addition point for recycled board trim, is shown in Figure 30. The three silos and trim are all deposited onto a common conveyor, then mixed as they transfer across two other conveyors on their way to the refiner silo.

Figure 30. Raw material silos at Weyerhaeuser's MDF mill in Eugene

Silo based mixing systems are obviously very popular. In order for them to perform well, the silo dischargers must be able to reliably deliver at steady reproducible rates, regardless of silo level. Laidig silo dischargers have an excellent track record of providing good service. Their two-stage discharger, shown in Figure 31, gives consistent metering performance by separating the discharge function from the metering function, to minimize the affect of silo level on bulk density, and mass flow rate.

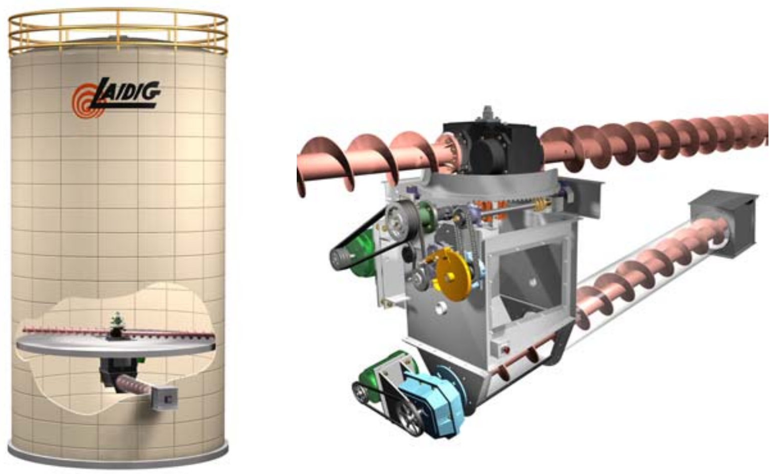

Figure 31. Laidig silo discharger

Laidig and others offer a whole line of dischargers designed to handle different types of materials. Conical bottom silos work well with free flowing materials like sanderdust. Some materials like coarse and compactable board trim need more aggressive dischargers, such as track models which can also be equipped with serrated or toothed flights on the auger screw.

The most important feature of silo dischargers is that they turn over the entire silo volume (Figure 32). Otherwise rat-holing or bridging can occur.

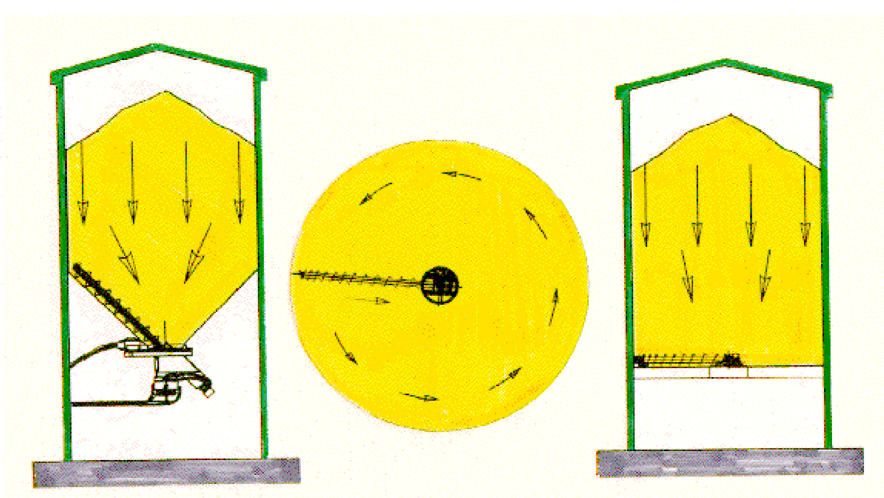

Figure 32: Silo flow characteristics

Summary

This review of what various mills do shows that there are a variety of ways to be successful. The fewer the raw material sorts there are by type, the easier it is to manage. But wood types that exhibit significant differences in processing characteristics must be recognized and segregated. A good strategy is to minimize the number of sorts, but invest in equipment that makes it easy to homogenize the material in storage.

There are a lot of good reasons to use dry materials, especially for making particleboard, but it presents a number safety risks and housekeeping challenges. Truck unloading stations can and should be equipped with dust containment devices, and large enclosures can be designed to protect and safely store very large quantities of dry material.

It is very desirable to keep material inventories rotated, especially green materials. A variety of designs of under-pile retrieval systems are available, and offer some real advantages.

It is essential that operation managers pay attention to what's coming in – both through the gate, and back into the process. Strong relationships with raw material suppliers are very important to ensure that they have a clear understanding of the mill's quality expectations, and are motivated and capable of meeting them. In order to maintain a consistent mix quality, it can very helpful to continuously monitor some key property, such as moisture, as a means of gauging minute to minute and hour to hour consistency.

Most particleboard mills wait until after pre-dry to make their mix, while some MDF plants find it desirable to mix green and dry materials and store them for several hours to allow moisture acclimation before refining.

The utilization of board trim and sanderdust must be done very carefully. Many feel these make better fuel than raw material, but, if for environmental or economic reasons they must be used, good processing and metering equipment can help avoid problems with process and product variability.

Most importantly, recognize that product variability starts with raw material variability. Its significance should not be underestimated. Every mill should equip itself properly to manage the huge volumes of material it must deal with everyday. There will be a quick and significant payback in smoother and safer operations and more satisfied customers.