Taking a Look at Windows

In a fog about choosing windows? You have to consider glazing systems, window styles and frame materials

Cart of my job as an editor is to read the hundreds of article proposals that arrive in *Fine Homebuilding*'s mailbox. For me, nothing sends up the red flag of rejection faster than seeing the word *fenestration* in a proposal letter. As in, "We tried to balance the subtleties of the *fenestration* with the implied massing of the built volumes."

Fenestration is a highfalutin word favored by architects and window manufacturers. It comes from the Latin word *fenestra*, which is the opening between the inner ear and middle ear.

Fenestration refers to the choice of windows in a wall or building. When choosing windows for a house, you'll have to decide not only the type of windows—casement, double hung, fixed, awning or slider—but also the kind of glass to use and the material used for the windows' frames. There's a lot of information, but it doesn't have to be confusing.

I've always thought that the most beautiful words—*fenestration* being an ugly one—are those that express ideas simply. So during the course of this article, I'll try to sort through all the window options without using the dreaded F-word.

Glass technology and window

styles—Historically, the evolution of window styles has coincided with technological advances in glass-making. American colonists didn't use little panes of glass in their windows because they were

trying to make their houses look like Ye Olde Gift Shoppe. Their windows had small panes because the technology of the day prohibited the manufacture of flat pieces of glass bigger than about 4 in. square.

As glass-making technology improved and the price of larger panes of glass got less expensive, windows with larger, fewer panes per window became common. In the early 18th century, it by Jefferson Kolle



Insulating glass traps air between panes. Air is a poor conductor of heat and thus a good insulator. Insulating glass is made by sealing air between two or three panes of glass. The insulating glass shown here is separated by a stainless-steel spacer that is thermally isolated by polyisobutylene, which reduces conductive losses of heat and cold.

was not unusual for a sash to have 12 panes of glass, or lites, per sash. By the beginning of this century, one-lite windows were getting popular. Float glass, a new process developed in the late 1950s, makes it possible to produce pieces of nearly flawless glass in single-lite window sizes that are limited only by the size of the wall in which you want to install them. Glass and energy-efficiency-In

the 1970s, when everyone's energyusing consciousness was raised, people began to realize that most windows were nothing more than holes in the wall into which you pour heat. Storm windows had been in use for a long time, but storm windows are often inconvenient and ill-fitting, and they don't adapt readily to all window styles; for instance, you can't open a casement window more than an inch or two if there's a storm window attached to the frame's exterior.

Insulating glass-two panes of hermetically sealed glass separated by a spacer-was invented in the first quarter of this century, but it wasn't until the 1970s that the technology came into widespread use. Air is a relatively poor conductor of heat and cold, and having dead-air space between two pieces of glass works well to improve the efficiency of a window (photo left). The wider the airspace between panes $-\frac{1}{2}$ in. to 1 in. is common-the higher the insulating value of the insulating glass. Filling the space between pieces of insulating glass with gases that are less conductive than airkrypton or argon-further improves insulating ability.

Storm windows should not be confused with storm panels. Storm panels are tight-fitting pieces of glass attached semipermanently to a window's sash, where they don't impede the window's operation. Storm panels are not insulating glass; they are not hermetically sealed to the other glass in a sash.

And a storm panel mounted over a piece of insulating glass should not be confused with triplepane glass, which is true insulating glass with three pieces of glass sealed around two spacers.

Low-E glass can work in two ways—At the Massachusetts Institute of Technology (MIT), a group of scientists who later formed Southwall Technologies (1029 Corporation Way, Palo Alto,

Calif. 94303; 415-962-9111) developed the first heat-reflective low-emissivity glass coating. Glass with this coating is known as low-E glass, and it is an option offered by all window manufacturers. The physics of how low-E glass works is beyond the scope of this article, but what it does is relevant and important.

"Imagine a light bulb turned on," says John Meade of Southwall. "When you touch your hand to the light bulb, you are feeling heat through conduction: The heat is passing directly from the bulb to your skin. But if you hold your hand 1 in. away from the light bulb, you still feel the heat, radiant heat this time." Conducted heat can be slowed by insulation: fiberglass batts in a wall or dead-air space between pieces of glass. Radiant heat can be reflected away from the thing being warmed. This reflection is what low-E coatings do.

Low-E glass can work two ways, depending on which way it's facing in the sash. In a cooling environment—one in which you need air conditioning to keep a house temperate—low-E glass can reflect the sun's heat away from a house. In a heating environment, low-E can reflect heat (from your heating system) back into the house instead of having it pass through the windows. The direction in which low-E reflects heat is determined by which glass surface in a piece of insulating glass the coating is applied to.

Southwall developed another technology called Heat Mirror, which is a low-E film that can be suspended in the space between the panes in a piece of insulating glass. Tweaking the chemical makeup of the film's coating allows different types of Heat Mirror films to perform different functions. Some are better at reflecting exterior heat away from a house; others are better at keeping heat inside the house. All Heat Mirror films are superb at keeping ultraviolet (UV) light out of a house. UV light is what fades your furniture and carpets. Insulating glass with Heat Mirror film blocks 99.5% of the UV light that hits the exterior surface of the glass. Low-E insulating glass blocks only around 70% of the UV light.

Armed with insulating glass, triple-pane glass, low-E coatings, Heat Mirror films and exotic gases, window manufacturers and glass companies raced to see who could stuff the most efficiencyincreasing components in a piece of insulating glass. A Canadian company, Willmar Windows (485 Watt St., Winnipeg, Man., Canada R2K 2R9; 800-665-8438) has come up with what it calls the R+12 glazing, which is two sheets of Heat Mirror film suspended in krypton gas between two pieces of glass, one of which has a low-E coating. Other companies have different systems for their most efficient glazing systems. As always, high technology and high R-values come with a high price (sidebar p. 60). Willmar R+12 glazing costs more than twice as much as regular insulating glass.

The metal spacer between pieces of insulating glass was a weak link in the efficiency of insulating glass. Metal spacers conduct the heat or cold that the insulating glass was supposed to block. Thus, the center of a piece of insulating glass might have had a pretty good R-value, but all around the perimeter where the pieces of glass



Casement windows swing like doors. Hinged on the side, casement windows swing past the plane of exterior walls. They can act as scoops to catch cooling breezes.



Six-over-six double-hung window pivots for cleaning. A handy feature of some double hungs is that the sash can be tilted into the room so that the windows can be cleaned from the interior.

touched the spacer, the values fell way off. New designs have been developed that improve the cold-edge problem by isolating the metal spacer from the glass or by employing spacers made from nonconductive materials. Every window manufacturer will tout its spacers as the best ones on the market, and currently there is a thisyear's-model immediacy in the hype that follows



Three window types ganged in a wall. Window manufacturers can gang different window types together in a wall. Shown here are trapezoidal fixed windows over casements over awning windows.

a window manufacturer's improvement on edgespacer technology.

Window styles are determined by the direction the sash move—Regardless of the season, my son's favorite bedtime story is *The Night Before Christmas.* About the 20th time I read the tale to him, he stopped me at the line "And threw



Sliding-window sash move horizontally. When they are opened, sliding windows don't protrude past a wall plane, making them perfect for locations where they open onto decks or other outside living areas. Sliding windows usually lift out of their tracks for easy cleaning.



Aluminum windows have thin frames. Because of aluminum's inherent strength, the frames and sash members are typically thinner than windows made of other materials.

open the sash," and he asked me what a sash was. I told him that a sash is one of the two basic parts of a window, the other part being the frame. I went on to explain that the window in the picture book was a casement window, but that I had seen other editions of the story where the window was a double hung. I was about to explain the difference between the casement window in the book and the double hungs in his room when my wife reminded me my son was only 3 years old and told me to keep reading.

All windows are similar in that their two basic components are a sash and a frame. The sash is the part of the window that holds the glass, and the frame is the part that holds the sash. Window types are differentiated by the method and direction in which the sash moves (or doesn't move, as in a fixed window) in the frame.

Double-hung windows consist of two offset sash, mounted one over the other in the frame. The lower sash slides up, and the upper sash slides down. In a single-hung window the upper sash is fixed, and only the lower sash slides.

The sash in a casement window pivots at the side of the frame; casements operate like little out-swinging doors (top photo, p. 57). French casements are two sash hinged on opposite sides of a single frame. Typically, French casements have no center-frame member between the sash. Awning windows are like casements turned on their side so that the hinges are on the top of the frame, and the sash swing toward the exterior from the top. A hopper window is sort of the opposite of an awning window; the sash in hopper windows swing in, and they are hinged at the bottom. Sliding windows are like double hungs turned on their side; the sash slide horizontally.

Double-hung windows are the most popu-

lar-I don't spend a lot of time cleaning windows or even thinking about how easy it would be to clean a window were I so inclined. But window manufacturers give it a lot of thought. At a recent National Association of Homebuilders show, I tried the pivoting action on eight or ten windows on display. The sash on all the new double-hung windows tilted in for cleaning easily. In most cases, all you had to do was release a barrel-boltlike clip on either side of the sash, and the window tilted right in. Some manufacturers use a compression jamb that allows you to pull the sash toward you easily (bottom left photo, p. 57). Andersen Windows Inc.'s (800-313-4445) doublehung windows even have a mechanism that holds the sash at a convenient angle for cleaning after you tilt it into the room.

One way to differentiate a double-hung window is to refer to it by the number of panes of glass, or lites, in a sash. A 12-over-12 window has 12 lites in the upper sash and 12 in the lower sash. Other common double-hung window patterns are 6-over-6 and 4-over-4. The thin pieces of wood that separate the glass in a sash are called muntins. Anything other than a 1-over-1 sash is referred to as having divided lites.

Divided lites and energy-efficiency—The energy crisis of the 1970s threw a curveball at the divided-lite, double-hung window. There was no

denying the importance of energy-efficiency—all anyone had to do was to wait in a gas-station line—and there was no denying the fact that insulating glass was going to save homeowners on their heating and cooling bills.

The first insulated-glass windows typically had one large piece of insulated glass per sash. This design meant no divided lites. Architectural purists were in a quandary: how to get an efficient window and maintain a look they wanted.

Manufacturers came up with the snap-in grille. Snap-in grilles are grids—similar in appearance to a ticktacktoe setup—made of thin pieces of wood or plastic that snap onto the inside of sash and rest against the inside panes of insulatedwindow glass. There was one problem with snapins: They looked as fake as a cheap wig.

Another solution was to make sash that had individual pieces of insulating glass mounted in the rectangles formed by the muntins. But in order to cover the spacers that held apart the two pieces of insulated glass, the muntins had to be uncharacteristically wide. Muntins more than $1\frac{1}{2}$ in. wide were common. Not only was the look inauthentic, but the wide muntins severely reduced the glass area in the sash. Another problem resulted from the increase in metal spacers themselves, which are the most inefficient area of insulated glass. For example, in a six-lite sash, there would be 24 cold edges—four around each piece of glass—instead of a single cold edge around the four sides of the sash's perimeter.

Manufacturers are constantly fiddling with the problem of true divided-lite sash. Some companies do offer sash with individual pieces of insulating glass captured by wood muntins, and some companies offer true divided-lite sash with affixed storm panels. But the more common method of dealing with the problem is to simulate the look. There are several different simulation tactics involving grilles that snap onto the interior of the insulating glass, ones that snap onto the exterior and ones that are sandwiched between the pieces of glass. Most manufacturers offer the previous solutions in combinations: You can order some windows with interior, exterior and sandwiched grilles.

Aside from the obvious energy advantages, another benefit of snap-in grilles (some grilles are permanently attached to the glass) is that some of them are easily removed when it comes time to paint the sash or clean the glass.

Divided-lite sash and simulated divided-lite sash are available from some companies in all their different window styles, not just in their double-hung styles.

Casement windows are hinged on the side—Casement windows were the dominant

window style in this country and abroad until the beginning of the 18th century, when the single-hung window came into fashion. Today, casement windows are second in popularity only to double hungs. The hinge side of a casement sash pivots toward the center of the frame when it is opened. When the window is open, you can reach both sides of the glass for washing.

Typically, casements are opened by turning a small crank on the bottom of the frame. Their

Sorting through window ratings

Shopping for an energy-efficient window used to be like trying to buy a used car in a foreign country; you couldn't be sure whether you were being sold a lemon, and you couldn't understand the language. Some window manufacturers spoke of their products' insulation values; some spoke of air infiltration; some spoke of frame conductivity; and some spoke of solar gain. The result was an apples-tooranges comparison that left you scratching your head.

The NFRC rates windows according to U-values—The National Fenestration Rating Council was started in 1989 to establish a standard energy rating for windows, doors and skylights. NFRC rates windows according to their insulating abilities. Independent testing facilities use computer modeling and actual laboratory tests using windows installed in wall sections to assign a U-value to a window. U-values are the inverse of R-values, so a lower U-value means a higher insulating value.

The NFRC is a nonprofit organization. Its revenues come from selling NFRC stickers with assigned U-values to window manufacturers that put the stickers on their windows.

Critics of the NFRC ratings say there is more to a window's energy-efficiency than its U-value. Air infiltration is important when judging a window's performance. A leaky window with a high insulating value is like a car that gets high gas mileage but leaks fuel all over the driveway.

Canadian ratings also consider air infiltration and solar gain—In terms of window ratings, Canada seems to be ahead of the United States. The Standard of the Canadian Building Code has established an energy-rating (ER) system that incorporates not only insulation values but also air infiltration and solar gain. ER ratings assign a number to a window. Windows are rated on a simple numerical system. A window with a negative ER loses energy, and one with a positive ER contributes energy. A window with an ER of 0 is neutral in its energy consumption because it contributes as much energy through solar gain as it loses during a heating season. The shortcoming of the Canadian ER system is that it is only applicable to a climate where heating is the predominant energy cost; in the deserts of the United States, where air-conditioning costs are high and heating costs are negligible, solar gain is something to be avoided.

A new rating system is on the way-But take heart. The NFRC is working on a new system that will fill the needs of most all residential consumers. Brian Crooks is an NFRC researcher who works for Cardinal IG (7115 W. Lake St., Minneapolis, Minn. 55426; 612-929-3134), a company that has produced more than 500 million sq. ft. of insulating glass, According to Crooks, the new NFRC system will assign two numbers to a window: a fenestration heating rating (FHR) and a fenestration cooling rating (FCR). The numbers are based on calculations of a window's U-value, its air infiltration and its solar gain. Crooks said that "the numbers represent a percentage of total heating or cooling savings for one window versus another." So if one window is assigned a 10% FHR and another window has a 15% FHR, consumers will be able to tell at a glance that by using the second window they can expect an energy savings of 5% over that of the first window.

As of this writing, the new rating system is awaiting approval by the NFRC. Crooks said the new stickers with both FHR and FCR will be on windows early in 1996.

Between now and the time that the new NFRC ratings appear, your best bet is going to be to use the current NFRC U-value stickers and then spend a fair amount of time reading through manufacturers' catalogs, trying to sort out their convoluted test results. It's probably a good indication that if a manufacturer is forthcoming with its results that its window did pretty well in the tests. If no information is available from the manufacturer, you might ask why.—J. K.

ease of operation makes casement windows perfect for locations where sliding sash up or across is inconvenient if not difficult: over a kitchen counter, high up on a wall, etc.

Casement windows lock by means of small levers on the nonhinge side of the frame that clamp the sash to the frame. This clamping action makes casement windows highly resistant to air infiltration, and the harder the wind blows, the tighter the sash is pushed against the frame. Taller casement windows usually have two lever locks, one above the other, and this upper lever can prove to be an impediment to people in wheelchairs. Peachtree (Box 5700 Norcross, Ga. 30091-5700; 800-477-6544) and Andersen offer optional hardware that allows the lower lever to control both locks. Taller casements made by Pella (102 Main, Pella, Iowa 50219; 515-628-1000) have two locks controlled by a single lever mounted low on the frame. Casement windows

Comparing window costs

The information in this chart is based on a double-hung window 2 ft. 8 in. wide by 4 ft. 6 in. tall with 1-over-1 sash and a jamb width of 4%/16 in. Prices exclude screen, auxiliary muntins or options of any kind. Optional accessories add considerable cost to any window. Not all manufacturers make a window of these exact dimensions, so for comparative purposes, the windows closest to the stated dimensions were used.

The list prices are an average of the prices quoted from several lumberyards around Newtown, Conn., and from manufacturers. The prices are meant to be used as a point of relative comparison between windows made of different materials and using different glazing configurations. Window prices vary depending on place of purchase, number of windows purchased and other factors.

U-values are the inverse of R-values, so the lower the number the better. U-values in the chart were averaged from manufacturers' catalogs and from National Fenestration Rating Council literature.—J. K.

	Single pane*	Insulated glass	U-value	Low-E insulated glass	U-value	Gas-filled low-E insulated glass	U-value	Heat Mirror	U-value
Wood	\$150	\$210	.51	\$235	.39	\$250	.35	\$301	.36
Vinyl	N/A	\$225	.49	\$250	.36	\$260	.34	N/A	
Aluminum	\$140**	\$190	.74	\$200	.62	\$220	.59	N/A	
Vinyl-clad	N/A	\$250	.51	\$270	.39	\$280	.35	N/A	
Aluminum-clad	N/A	\$260	.54	\$285	.41	\$295	.36	\$380	.39
Fiberglass	N/A	\$360	.50	\$376	.40	\$390	.36	N/A	

* U-values are not available for single-pane glazed windows. ** Aluminum-window prices and U-values are for single-hung windows.

can be hinged on either side. And when they are opened, casement windows swing past the plane of an exterior wall. For ventilation they can act as scoops to direct air indoors. Therefore, when you're ordering casement windows, it's important to know the direction of prevailing summer winds in your area because you can order your windows hinged on whichever side takes the best advantage of the natural convection.

Specialty windows—Installing an awning window under a large fixed window can provide ventilation. And placed high on a wall, awning windows can let in air and light while affording privacy. Because they swing outward (top photo, facing page), they can deflect light rain so it doesn't get into a building. Awning windows placed low on a wall can deflect winds hitting the side of a house up into a room.

Windows with horizontally sliding sash are called different things by different manufacturers: gliders, sliders, slide/bys. Both sash slide in a horizontal sliding window, and they usually lift out of their tracks for easy cleaning. On all horizontal sliding windows, the right-hand sash (viewed from the interior) slide on the inside track, and the left-hand sash slide on an outside track (top photo, p. 58). The sash slide past each other, but the window can be locked only with the inside sash to the right. Because they don't swing past the plane of a wall like casement windows, sliders are great for locations where you want a window facing a deck or outside space.

Inoperable windows are also referred to as fixed windows, and their shape is, as one catalog says, "only limited by your imagination." Manufacturers have thousands of sizes of fixed windows, and a lot of companies will make a fixed window in any shape you want. Aside from the more common rectilinear fixed windows, most companies have standard sizes of halfround, elliptical and trapezoidal windows. Trapezoidal windows often are installed so that their sloped side is parallel with the slope of a roof (bottom right photo, p. 57). Because their sash don't open, fixed windows generally resist water and air infiltration well. Window manufacturers spend a lot of time perfecting weatherstripping around operable sash because this location is where water and air tend to invade. A fixed-sash window often is less expensive than an operable window of equal size. For a wall location where it might be hard to reach a window to open it, and where views and light are more important than ventilation, fixed windows can be a money-saving alternative.

Window catalogs are rife with photographs of huge walls of windows, walls that seem to be more glass than drywall. Ganging windows together is a common practice (bottom right photo, p. 57), and window manufacturers sell windows ganged in standard configurations. But windows don't have the strength of a stud wall; there are also wind loads to think about. If you envision a wall of windows for your house, it might behoove you to consult an engineer before you face the likelihood of getting turned down by a building inspector.

Wood windows need maintenance—In the earliest windows, metal was used to hold the glazing in place. By the 18th century wood was the most popular window-frame material, and today, wood windows still command about 50% of the residential-window market.

Until recently, wood has been a plentiful and relatively inexpensive material. And because wood is a poor conductor of heat, wood windows score high on energy-efficiency. But even though all of the parts of a wood window are treated with a preservative prior to assembly, wood windows require maintenance. In order to keep the windows looking good, you're going to have to get out your scrapers, putty and paint every couple of years and have a go at the exterior of a wood window. Some manufacturers will paint the exterior of your wood windows in the factory, and some of their paint jobs come with a good guarantee. Both Weather Shield (1 Weather Shield Plaza, Medford, Wis. 54451; 715-748-2100) and Kolbe & Kolbe Millwork Company Inc. (1323 S. 11th Ave., Wausau, Wis. 54401-5998; 715-842-5666) warrant that their factory-applied coating will last ten years.

Clad-wood windows have a lot to offer—A fellow could get pretty hot and bothered when it comes time to maintain that "warmth and beauty" of his wood windows every couple of years. The perfect answer might be wood windows that are covered on the exterior with either vinyl or aluminum (bottom left photo, facing page). Many manufacturers make clad windows, and they do have a lot of advantages; you get a relatively maintenance-free exterior with a wood interior. Weather Shield even offers windows with oak or cherry on the interior

Although all windows with wood interiors are referred to as clad windows, cutaway photographs in manufacturers' catalogs-and all catalogs show cutaway views-show that there are different ways to clad a window. Some manufacturers attach the cladding by gluing it onto a wood frame. Others have designed their cladding so that it snaps onto a wood frame. Other companies make a vinyl or aluminum frame to which a wood interior is attached. Andersen has a unique system for its vinyl-clad sash: After the wood pieces for the windows are milled, they are covered along their length with a vinyl extrusion. The vinyl-covered pieces then are cut and fit into finished sash. Andersen Windows says that the wood adds strength to the vinyl. Andersen vinyl-clad frames are made by covering an assembled wood frame with an injection-molded vinyl sheathing.

Aluminum-clad windows don't suffer from the energy disadvantages of all-aluminum windows. That's because the heat-conducting properties of the aluminum are broken by the wood interior (photo bottom right, facing page).

The look of real vinyl?—A lot of people think of vinyl windows in the same way they think of vinyl siding: Vinyl is a material appropriate for a trailer, not a house. But vinyl windows are typically a lot less expensive than wood windows. And they never need painting. All-vinyl windows should not be confused with vinyl-clad windows. In the past, some vinyl windows experienced problems. Vinyl expands and contracts at a different rate than glass, and on some windows, repeated thermal cycling caused the vinyl to distort and to pull away from the seals around the glazing. Faulty seals can affect a window's ability to withstand air and water. Dark-colored vinyls absorb more heat than white or light-colored vinyl, and it was the dark-colored windows that had the most problems. One solution to combat the distortion/expansion problem is to form darkcolored vinyl over a light-colored vinyl core.

Vinyl is a brittle material that's 80% salt. In order to make vinyl pliable, a plasticizer is added so that it can be molded. With time, as the plasticizers evaporate, the vinyl gets brittle. New vinyl formulas, called uPVCs (unplasticized polyvinyl chlorides) are supposed to be more stable and resistant to distortion and movement.

An important feature to look for in vinyl windows is welded corners, rather than simple mitered-and-screwed corners. Vinyl corners are welded by heating both sides of a miter until they melt. The melted edges are pressed together; they then cool into one piece.

Vinyl windows are chasing hard at the heels of wood windows in popularity. Vinyl has always been popular for replacement windows, but the market for solid-vinyl windows in new residential construction is growing rapidly. Vinyl windows accounted for almost 16% of the windows sold for new construction in 1994. That number has risen from 3% in 1989.

Aluminum windows have gotten a bad rap-At least that's the opinion of Ralph Blomberg, president of Blomberg Window Systems (1453 Blair Ave., Sacramento, Calif. 95822; 916-428-8060). Blomberg points out that in recent years, some people have steered from aluminum windows because they are not energyefficient. And some state energy codes have prohibited the use of some solid-aluminum windows. Aluminum is a good heat conductor and, consequently, a poor insulator. But, Blomberg contends, aluminum windows have some advantages, and they remain popular in the temperate West Coast climates. Aluminum windows are typically less expensive than wood windows or vinyl windows, and they shouldn't require much maintenance.

Aluminum can be painted, and a lot of manufacturers offer their products with a factory-applied colored coating. Another advantage of aluminum is that because of its inherent strength, you get a much larger glass area per window size (bottom photo, p. 58) than you can receive with vinyl or wood. And let's face it, you put a bigger window in a wall not so you can see more of the frame and muntins, but so you can look through more of the glass.

Fiberglass is not just for boats and surfboards—Odds are you've never seen a rusty Corvette or a rotten Boston Whaler motorboat.



Awning windows are hinged at the top and swing outward. Awning windows often are grouped below larger fixed windows to provide ventilation in a room. Marvin's Integrity windows, shown here, are wood, clad with fiberglass.



Clad windows should never need painting. The advantage of vinyl-clad windows is that they have a wood interior and a maintenance-free exterior.

That's because both are made of fiberglass, and the stuff is almost impervious to the ravages of weather. Marvin Windows (P. O. Box 100, Warroad, Minn. 56763; 800-346-5128) recently introduced its Integrity line of windows clad with what Marvin calls Ultrex, a fiberglass material. And Blomberg Window Systems has recently introduced a line of all-fiberglass windows.

Fiberglass is not a new material, but only recently was the technology developed to pultrude fiberglass in the thin-walled, complex profiles needed for today's complex windows. Pultrusion is the process in which glass fibers are pulled through a resin bath and then into heated dies that cure the fiberglass.

Fiberglass has advantages as a material for both window frames and sash. Fiberglass expands and contracts at almost the same rate as window glass. This condition is advantageous because different degrees of movement during temperature fluctuations can cause the seals between glass and sash to rupture, which in turn can let in air and water. Other benefits are corrosion-resistance and dimensional stability; a fiberglass window on the south side of a house won't warp and twist. Fiberglass doesn't need much maintenance, although it can be painted. Also, the technology for pultruding fiberglass currently is limited to straight pieces.

Aluminum on the exterior, wood on the

interior. Wood's nonconductivity acts as a

thermal break for the aluminum, mitigating the

energy disadvantages of all-aluminum windows.

Making an intelligent choice of windows-

After you read this article, it's unlikely that you'll know which windows to buy for your next project. And that wasn't the intent any more than a general article about automobiles could tell you what car to buy next.

Before you decide on windows, do what you'd do before buying a car: Go to several dealers; take catalogs home and study them; and go back for another look. Are insect screens optional? Do you want to pay the extra cost of snap-in grilles or spend extra money for more efficient glazing?

Robert Wood at Hurd Millwork Company (575 S. Whelen Ave., Medford, Wis. 54451; 715-748-2011) made a telling comment: "When someone tells me that they don't want to spend a lot of money on windows, I tell them that windows typically account for between 3% and 5% of the cost of a new house. That's not a lot to pay for something you're going to look at and look through every day of your life."

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