BOVARD STUDIO INC.

Presents a Learning Unit on Stained Glass Restoration
and Protective Covering systems

BOVARD STUDIO
STAINED GLASS

• Copyright Materials

INTRODUCTION

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- Stained glass cleaning, preservation, restoration, and protective covering systems are the subject matter of this presentation.
- You will learn about cleaning, maintenance, repair, releading, protective covering (storm windows), framing systems, structural requirements / repair, documentation, safety, and glass painting.

AGENDA

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- Stained Glass Restoration vs. Repairs
- Stained Glass Restoration & Releading. Why stained glass windows fail.
- The structural elements and techniques for stained glass restoration.
- What is lead came, the symptoms of failure, and what damages lead.
- Why stained glass windows bulge.
- Documentation of restoration of stained glass windows.
- Releading.
- Stained glass maintenance and repair.
- Replacing broken stained glass panes.
- Reinforcing Bar.
- Cleaning, maintenance procedures, and repair for stained glass windows.
- Frame and panel structure and repair
- Why improperly designed protective covering can damage stained glass windows.
- Why to use protective covering.
- What the correct design for protective covering is.
- What the different types of framing systems, and venting for protective covering are.
- When wood frame replacement is required.
- Safety, and lead exposure to workers, and the clients environment. Air filtration, and HEPA filters.
- Glass painting, and safety concerns.
- The Benefits of Bovard Studio Inc.

OVERVIEW

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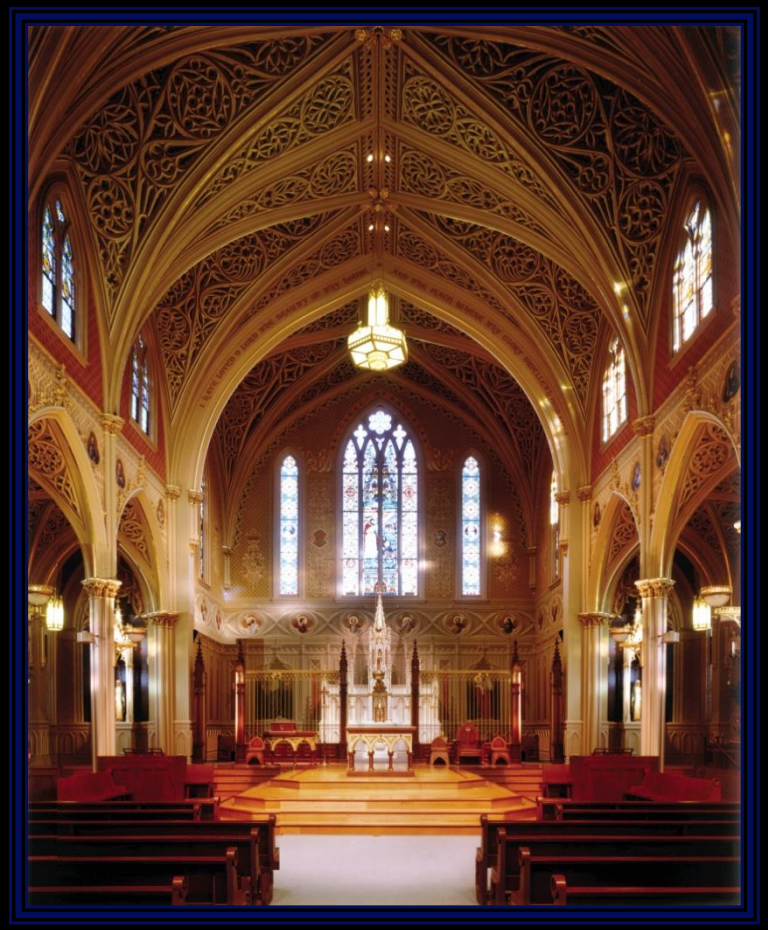
- Stained glass is very important to many whom worship. It inspires, and connects many to the divine through its use of glass, art, light, and telling of historical events linked to the divine. The combined effect of those elements often speak to the viewer of historic biblical events in a very elegant, and beautiful way. Those viewing the stained glass often will be overcome, and inspired by a glimpse into history, and The Holy Spirit. Stained glass windows have been able to bring biblical events to life in a way that would not have been historically possible otherwise. It would be very difficult to imagine where the spiritual development of mankind could have ended up if it were not for the biblical history told through the medium of stained glass windows. Which is why it is so important to preserve, and protect the worlds stained glass heritage.
- All of the individual topics we will be discussing, are all directly tied to preserving, and protecting stained glass heritage in each of our individual environments, and facilities. You will be shown how time, and the elements wear on stained glass windows, protective covering (storm windows), framing systems, and what ties them together in this presentation.



ST. PETER'S, SAN FRANCISCO, CA.

VOCABULARY

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- Stained Glass: colored glass used to form decorative or pictorial designs, notably for church windows, both by painting and especially by setting contrasting pieces in a lead framework like a mosaic.
- Relead: The disassembly, cleaning, and rebuilding the stained glass window with an all new lead matrix, conserving the original stained glass.
- Protective Covering: Storm window, or protective glazing over a stained glass window that is designed to protect it from the elements or vandalism.
- Repair: Fixing what is broken to maintain the stained glass window
- Restoration: To make like new. It involves releading the stained glass window.
- Cement: A glazing compound that goes between the lead and glass. Glazing cement seals the window, and adds strength, and seals the window from the weather. It also prevents the movement, or rattle of the individual panes of glass in the lead matrix. Traditionally made from plaster of paris, whiting, lamp black, linseed oil, and turpentine (sometimes window putty is used).
- Rebar: Steel reinforcing bars attached to the stained glass window for structural reinforcement, and to prevent premature bulging.
- Lead Came: A slender grooved rod made of lead, and used to hold together panes of glass often in a stained glass window.
- Solder: A fusible metal alloy used to join together lead came by melting it with a soldering iron, and having a melting point below that of the lead came.
- Flux: a substance applied to lead came joints that are to be joined by soldering; flux cleans the surface of the lead came, and results in a better bond. Acid free flux is the preferred flux for stained glass windows.

RESTORATION VS. REPAIRS

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- Restoration is to make like new.

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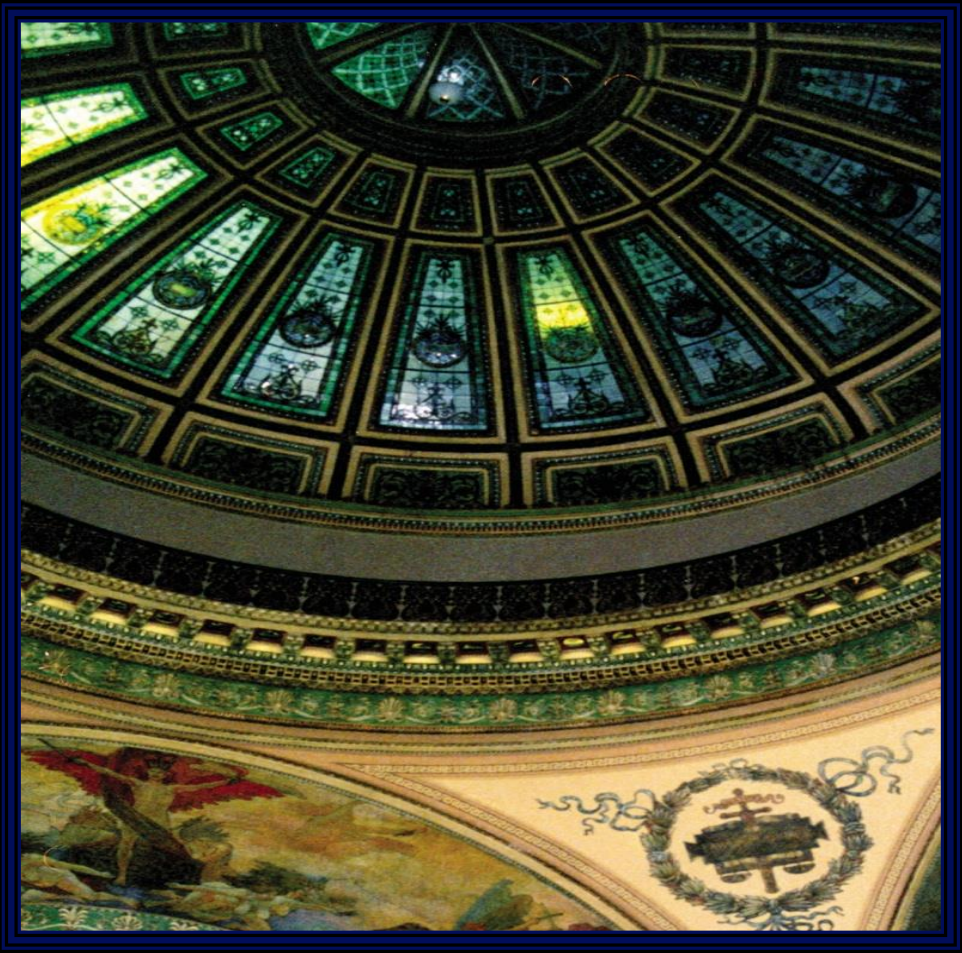
- Repairs are fixing what is broken to maintain the stained glass window



ALLEN COUNTY COURTHOUSE, FT. WAYNE, IN.

RESTORATION & RELEADING

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- Age and Materials
- Structurally weak design
- Oversized panels. Panels over about 12 square feet are prone to failure.
- Improper reinforcing system
- Stained glass windows with many small panes are weak and, in designs like concentric circles, are prone to premature bulging

THE STRUCTURAL ELEMENTS AND TECHNIQUES FOR STAINED GLASS RESTORATION

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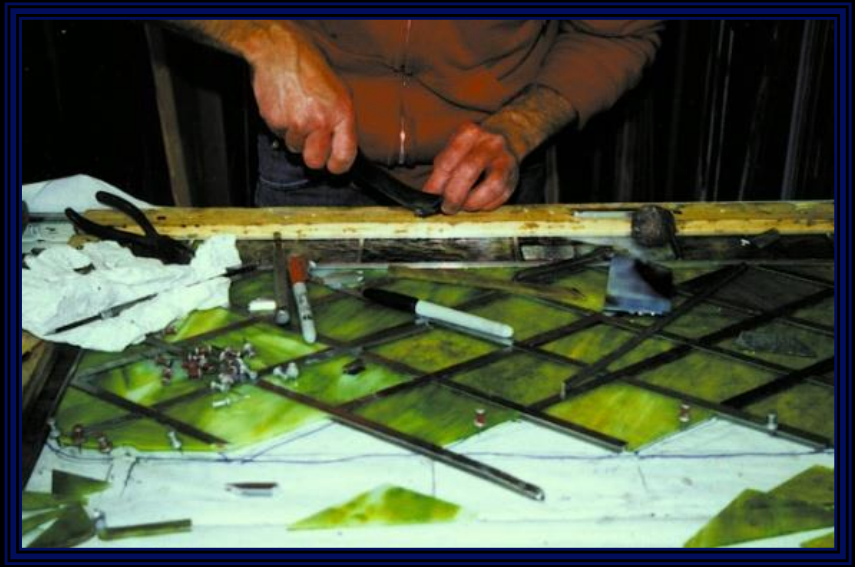
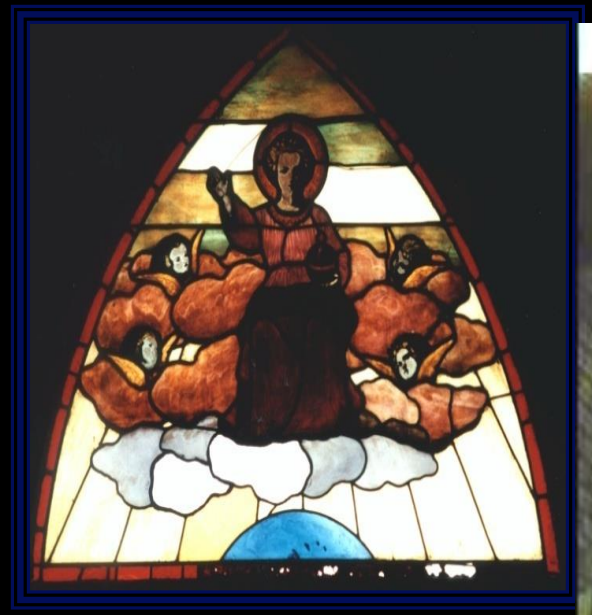
- Small straight rows of rectangular or square glass panes and diamond patterns are prone to bulging, unless they are fabricated into a special woven lead matrix tucked and soldered to the heart of the lead came



- Paint failure from improper kiln firing of glass, unstable formulas, or washing stained glass windows with acid based cleaners such as vinegar



- Improperly designed exterior glazing systems lead to premature failure

LEAD CAME

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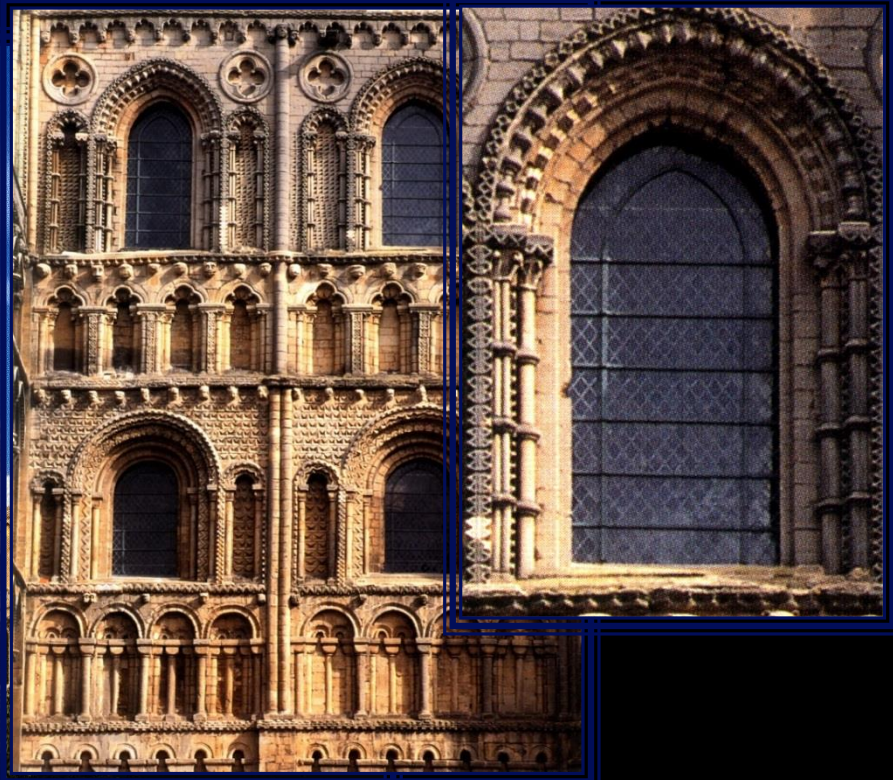
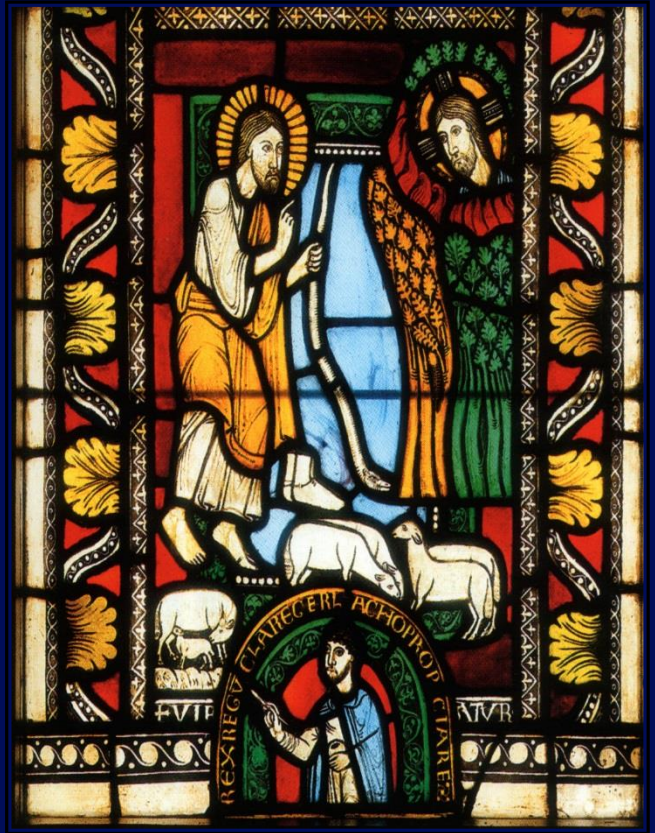
Many American stained glass windows through the 1950's were made with pure drawn or milled lead. This lead usually lasts 70 to 100 years before serious metal fatigue sets in. Drawing or milling can stress the pure lead.





Europe's great cathedral stained glass windows were made with cast lead with impurities (trace elements). Some of the lead in these stained glass windows lasted much longer than those made with pure drawn or milled lead.

The most prestigious cathedral **Ely Cathedral**, first half of the twelfth century, England.

LEAD CAME (CONTINUED)

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Today we call some of these impurities alloys (tin antimony, silver, copper). We add them on purpose. We extrude our lead. Pure drawn or milled lead has an elongated molecular construction, which results in lead that is less subjected to expansion. Extruded lead has a greater density of construction and is subject to greater expansion than pure drawn or milled lead; therefore, it must be stretched prior to use in a stained glass window to prevent premature bulging.

Symptoms of failure:

- **Cracked and broken solder joints**
- **White powder on the surface of the lead (oxidation)**
- **Cracks in the surface of the lead came**
- **Expansion and contraction cycles can cause deflection of the flute…(bulging)**
- **Serious deterioration of glass painting**

Note: Preserve as much of the historic stained glass as possible when releading.

WHAT DAMAGES LEAD?

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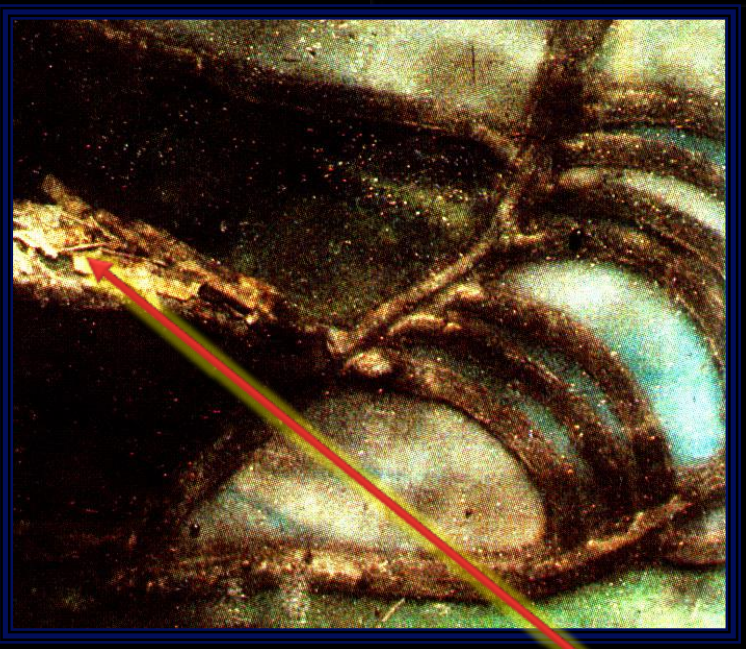
This damage is from improperly designed and installed protective and exterior glazing systems.

When protective covering is unvented, or improperly vented solar gain, and condensation are trapped between the protective glazing and the stained glass window. Dust also naturally accumulates in the space. The dust and condensation mix, creating hydroscopic dust (which will never fully dry out due to the lack of ventilation). The solar gain causes excessive expansion and contraction (which can also lead to premature bulging in the stained glass), as well as heating up the hydroscopic dust, turning it into bacteria. The bacteria secretes acids which attack the lead and window framing. This dramatically shortens the lifespan of the stained glass and window frames.



The white smudge on the left of the image is what remains of severely damaged lead came due to oxidation. When the protective glazing was installed, it was placed flush against the stained glass. Due to condensation build up between the protective covering and the stained glass window, a caustic micro environment formed causing rapid deterioration of the lead came due to oxidation.

WHY DO STAINED GLASS WINDOWS BULGE?

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- **Heat build up**

- Stained glass is darker than regular clear window glass, therefore attracting more heat, which leads to significantly more solar gain. Solar gain causes expansion and contraction. The more heat the more expansion. More expansion leads to more bulging, unless there is room for the stained glass to expand in the framing system it is installed into.
- Unvented or improperly vented protective covering will trap heat between the stained glass and the protective covering. This can lead to solar gain being trapped, and increase the expansion, and the expansion cycle. Even during the coldest months of the year windows that are not in the shade, and exposed to sunlight will have significant solar gain. (Place you hand on a south, or west facing window while the sun is hitting them and you can feel the heat.)
- Designs with concentric circles tend to be weak, and bulge more often unless properly engineered, and reinforced.
- Diamonds and other grids made with flat came are weak if not tucked and woven, or fabricated with half round leads as they have more strength. Proper engineering, and reinforcement is also required.
- Extruded lead came has a low modulus of elasticity and must be stretched prior to use. If not, it will contribute to premature bulging.

***Note:**

- Protective covering does not conserve stained glass windows, is not a substitute for maintenance, repair, restoration, and is not an economic benefit in terms of R-value.
- However, without protective covering, stained glass windows leak wind driven rain. Condensation will form on the interior surface of the stained glass window resulting in puddles on the window sills, and air will infiltrate the stained glass window.

DOCUMENTATION FOR THE RESTORATION OF STAINED GLASS WINDOWS

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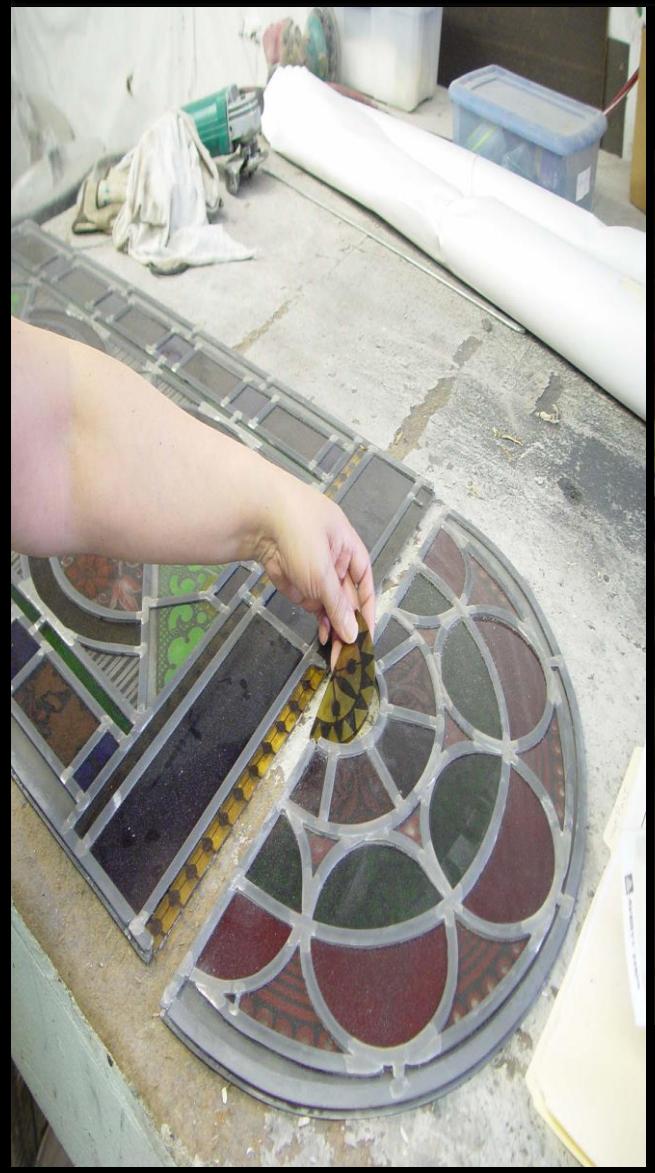
Documentation includes:

- Photographing the windows.
- Measuring panel sizes.
- Measuring rebar placement.
- Determining lead type and sizes.
- Collecting glass samples.
- Select glass for any glass replacement that may be required.
- Make two rubbings (one for disassembly, the other for reassembly).
- Make a material list.



RELEADING

- Releading is the disassembly, cleaning, and rebuilding the stained glass window with an all new lead matrix, conserving the original stained glass.

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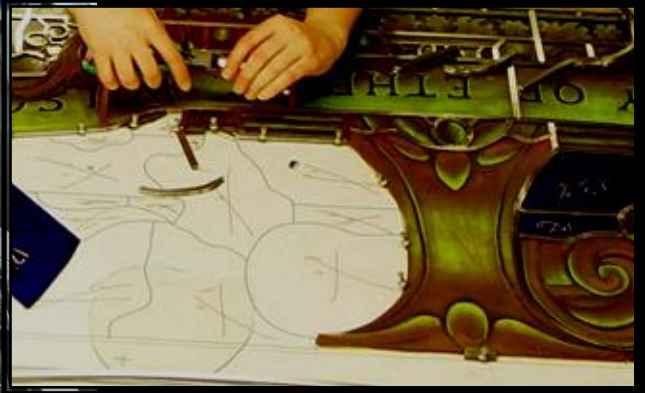

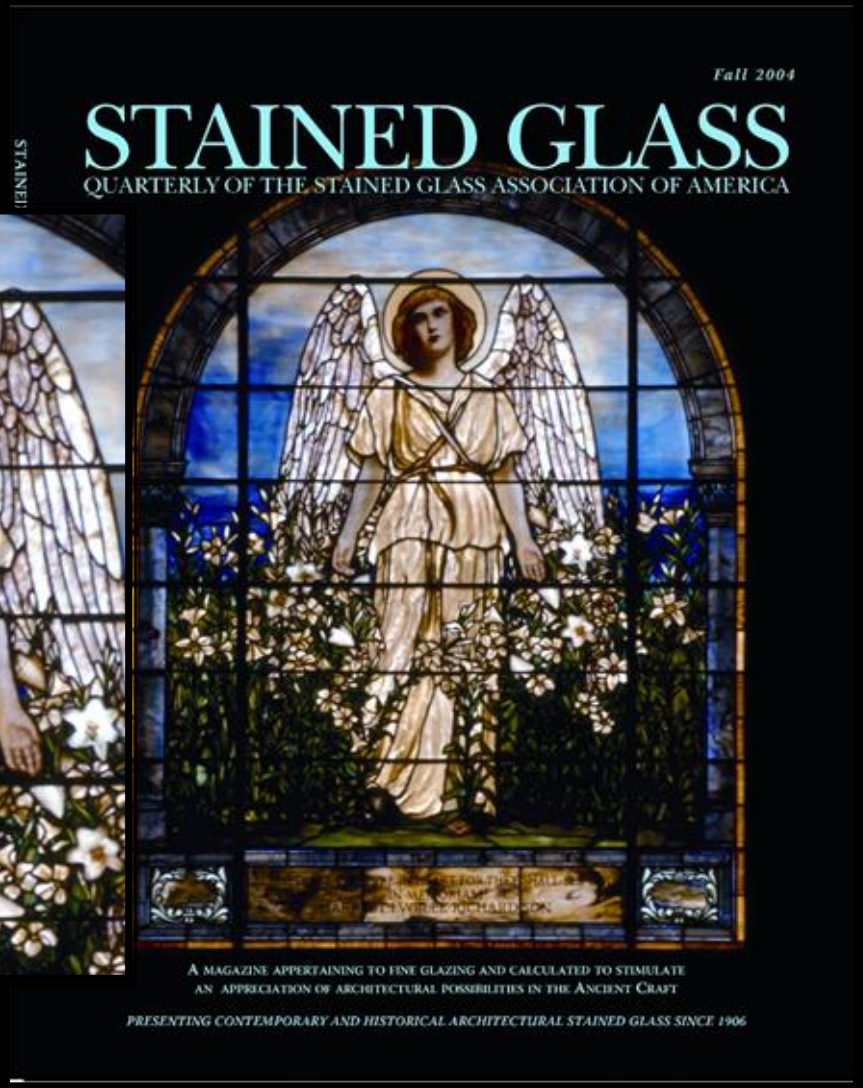

STAINED GLASS MAINTENANCE AND REPAIR

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- Replace broken and missing stained glass panes.
- Repair cracked panes.
- Reattach loose reinforcing systems.
- Recement stained glass window.
- Flatten and shore up bulged areas in a stained glass window when lead came is in good condition.
- Touch up deteriorated sections of glass painting in place with cold paint.

REPLACING BROKEN GLASS PANES

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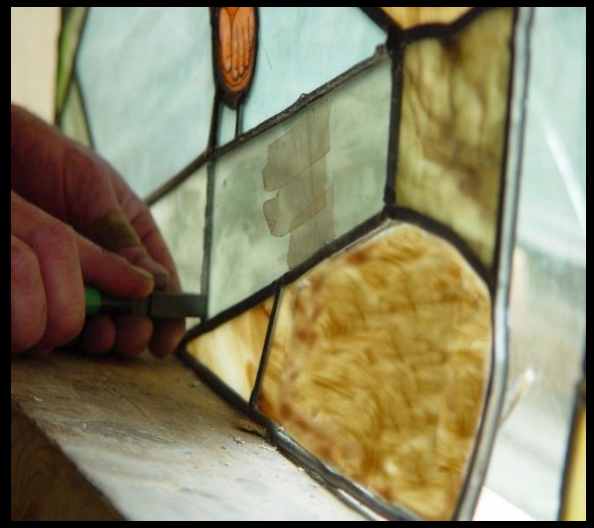
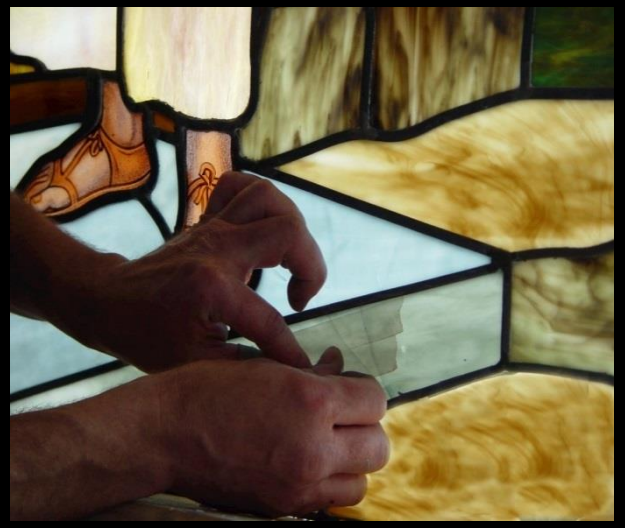
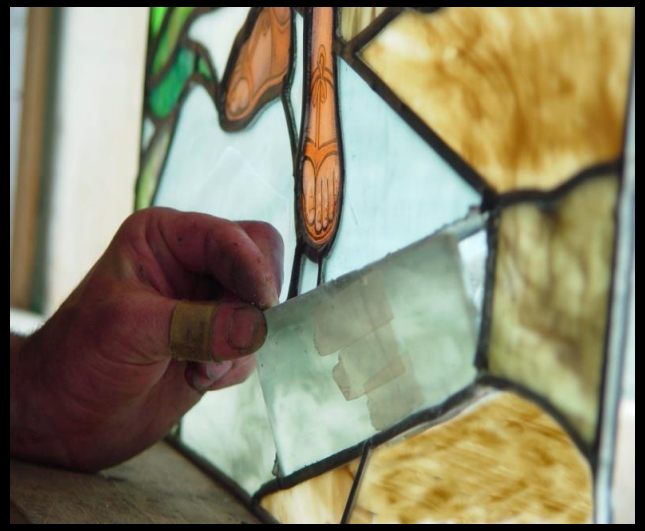
Replacing Broken Glass Panes and Memorial Plates:

- When you have a broken pane that is damaged beyond repair, it must be removed from the lead and a suitable replacement put in its place.
- Place conservation tape over the cracked area of the broken pane. Use enough that it will make the broken piece stable, and hold it together once removed.
- Cut the solder joints over the half of the lead that is holding the broken pane in place.
- If the lead is the flat lead type, fold the lead back exposing the edges of the broken pane.
- If the lead is the round lead type, the lead may need trimmed away to expose the edges.
- Carefully remove the glazing cement from around the edges of the broken pane to loosen it.
- If the piece does not easily come out, use a pick with an angled end to gently pull the broken pane out. You may have to work it loose at the corners due to solder in the corners.





REPLACING BROKEN GLASS PANES CONTINUED

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- Find a suitable replacement piece of glass that matches color, texture, and density.
- Lay the broken pane on top of the new piece of glass, trace its shape and size onto the new piece to be cut. Make sure the direction of any features like texture and color features are facing the same direction as the broken pane.
- Cut the new piece of glass. Compare the cut piece to the broken pane to make sure sizing adjustments don't need to made. Little burrs of glass could make it challenging to put the new pane in place if not addressed.
- Place the new pane in the location of the old pane. Make sure the texture and / or glass painting of the glass faces the same side as the other panes in the panel remaining consistent with the other panes of glass in the window.
- Fold the lead back down if flat lead, or replace any lead that had to be cut away with lead of the same type and size.
- Solder the cut lead joints or new lead in place where removed. You will first have to clean the areas that will be soldered, and apply acid free flux.
- Apply new glazing putty or window cement. This is done by pushing it between the lead flange and the glass. Make sure it is dark enough that it matches the existing glazing compounds in the rest of the window. If not dark enough you will have to darken it using lamp black.
- Clean the excess glazing compound or window cement from the glass, also clean the areas that were soldered to remove excess flux. Be sure to us a PH neutral cleaner if a cleaning agent is used.

REINFORCING BAR AKA REBAR

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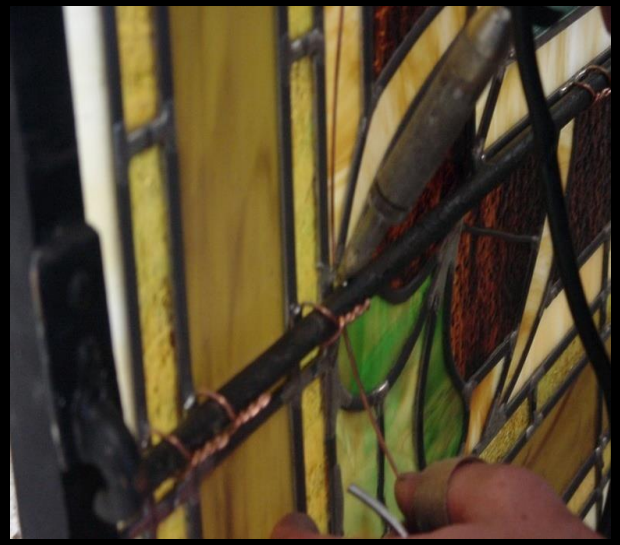
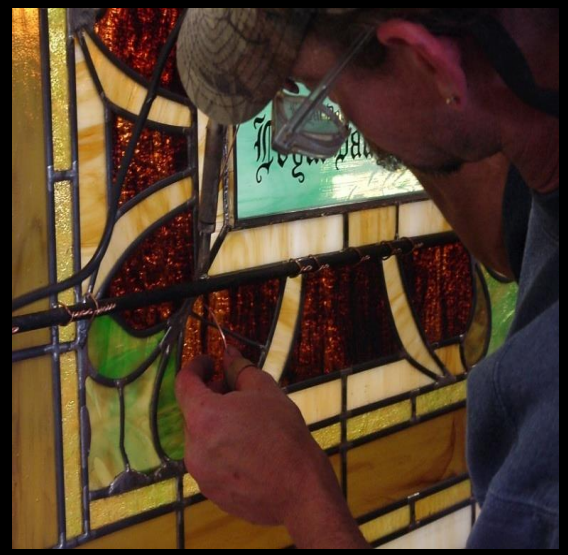
Replace or Reattach Reinforcing Bar AKA Rebar:

- Locate loose rebar and broken tie wires.
- Clean the lead, solder joints, and rebar in the locations rebar's need reattached.
- Apply acid free flux to the locations on the lead, solder joints, and rebar that will have solder applied.
- When attaching or reattaching a round rebar: attach a new copper tie wire by soldering it to the lead, or existing solder joint.
- Hold the round bar in place. Bend the tie wire around the round rebar until both ends cross at the center of the opposite side of the rebar than where attached to the stained glass window. Then twist the tie wire around itself.
- Clip off excess wire (the twisted tie wire should be ½ to 5/8 of an inch long). Then bend the wire so it sits flat against the rebar.
- If attaching or reattaching a flat rebar: hold the rebar in place and solder directly to the lead and existing solder joints.
- Clean the areas where flux was put on the lead, solder joints, tie wires, and rebar's with a PH neutral cleaner.





CLEANING AND MAINTENANCE OF STAINED GLASS WINDOWS

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TESS BOVARD AND CARRIE THOMAS TAKE PHOTOGRAPHS OF EACH STAINED GLASS PANEL OF THE DAMAGED WINDOWS IN THE RESTORATION PROJECT. DOCUMENTING THE DAMAGED WINDOWS CURRENT PHYSICAL STATE AND APPEARANCE.

Cleaning Stained Glass Windows

- Use pH neutral cleaners such as Triton X or Orvis horse shampoo, and dilute with distilled water.
- Never use cleaners with vinegar (which attacks glass paint) or ammonia (which over the long term it will corrode the lead) in the ingredients.
- Distilled water is also acceptable.

CLEANING AND MAINTENANCE CONTINUED TIFFANY STAINED GLASS WINDOWS

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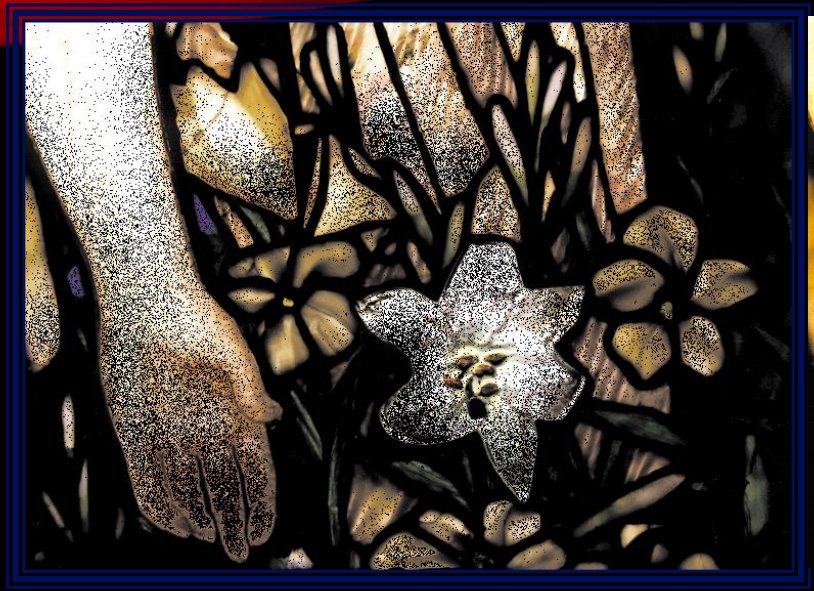
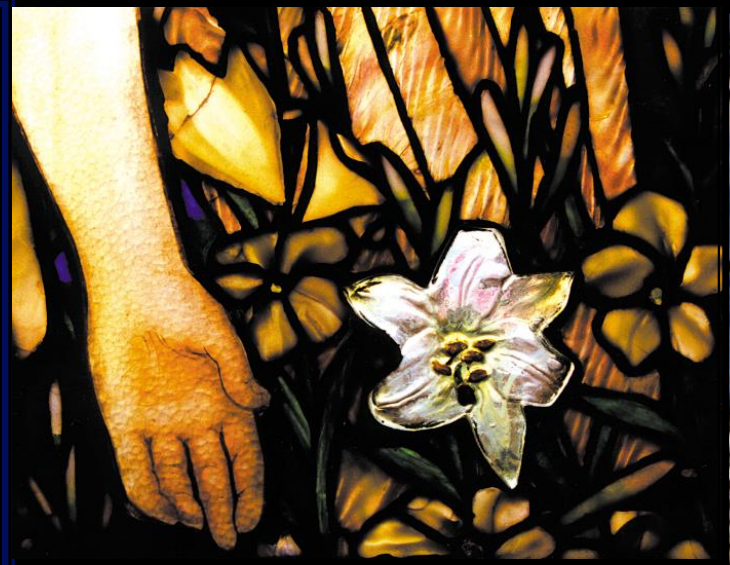
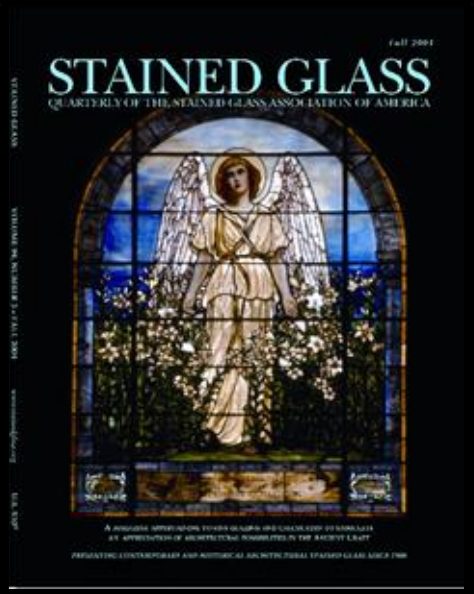


Before



After



St. Luke's, UMC, Dubuque, IA.

- Stained Glass windows that are plated with 2 or more layers of glass such as Tiffany stained glass windows which have up to 7 layers of glass plating require extra care.
- The plates must be disassembled, so that cleaning can take place between the plates.
- Before and during the disassembly thorough documentation must occur to ensure the window will be properly reassembled. This will allow for the windows historic integrity to remain intact.
- After the disassembly, and cleaning, they must then be reassembled.

FRAME AND PANEL STRUCTURE AND REPAIR

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- Reputty where putt on T-bars or window frame is loose or missing.
- Keep frames rust free and painted.
- Replace or restore rotted wood.
- Replace loose or missing glazing cement.
- Keep reinforcing bars attached to the stained glass window.

Improperly Designed Protective Covering

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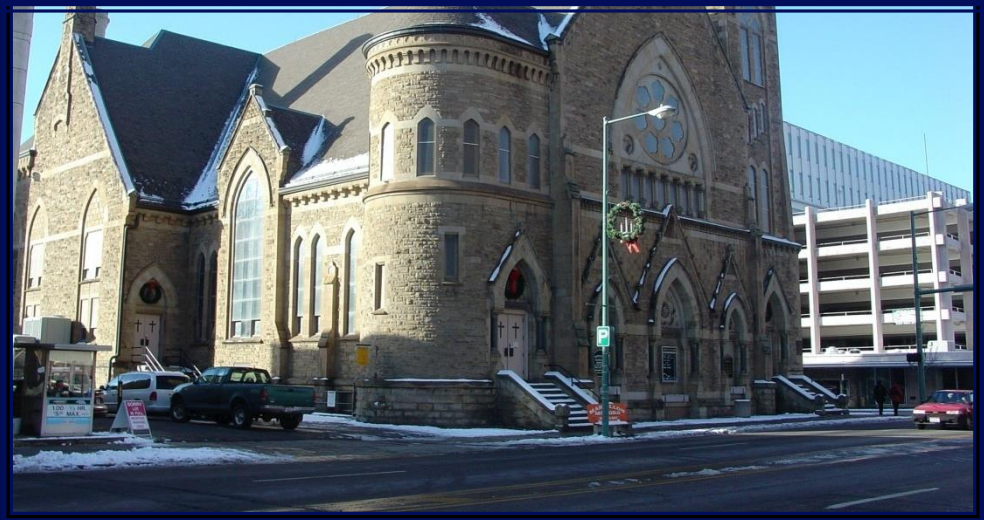
According to a 1996 study for the National Preservation Center in Natchitoches, Louisiana: More damage has probably been done to stained glass windows from improperly designed exterior glazing and protective covering systems than from fires, vandalism and storm damage combined. Poorly designed protective covering systems also detract from the architectural integrity and beauty of the building.



WHY PROTECTIVE COVERING?

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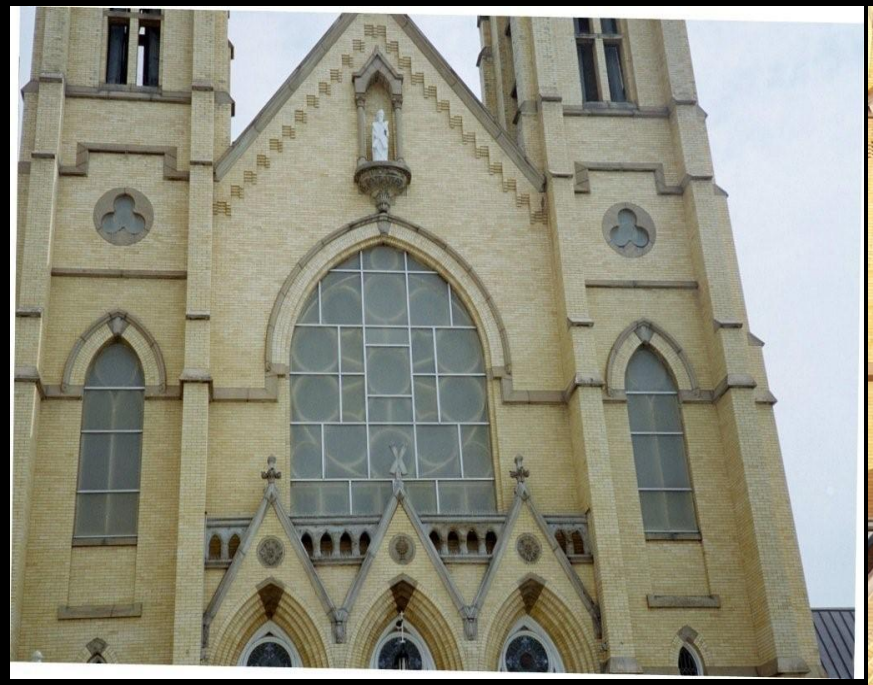
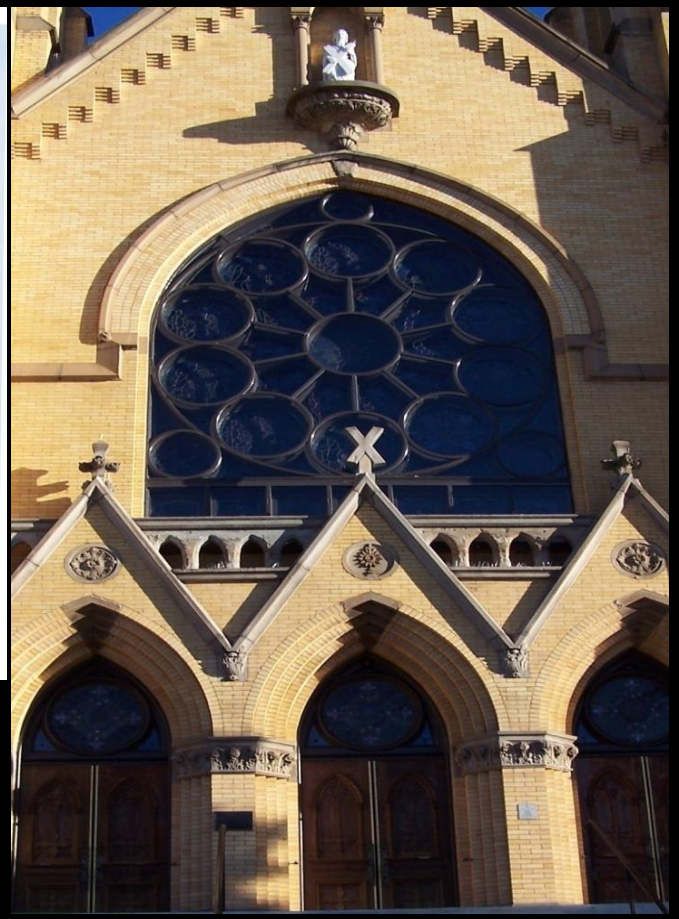
- People are not used to water from condensation and leakage in their buildings today. There is no going back to single-glazed systems for most clients.
- Properly designed protective covering systems protect stained glass windows from vandalism and storm damage.
- A definitive engineering study on protective covering, was released June 30, 1996 from The National Preservation Center, Natchitoches, Louisiana, shows stained glass protective covering systems need 1 square inch of venting top and bottom for every 16 square feet of stained glass.

St. Matthias RCC, Cascade, IA.



Before

St. Andrews RCC. Roanoke, VA. After new vented Precision Flow® protective covering was installed by Bovard Studio Inc.



After

***Note: This does not take the area of louvers, or screens on venting into consideration. Louver and screen area needs to be taken into consideration when engineering a proper ventilation system into protective covering to ensure proper ventilation.**
***In addition, Bovard studio was noted in the study for venting protective covering before it was even recommended.**

PROTECTIVE COVERING DESIGNED FOR STAINED GLASS WINDOWS

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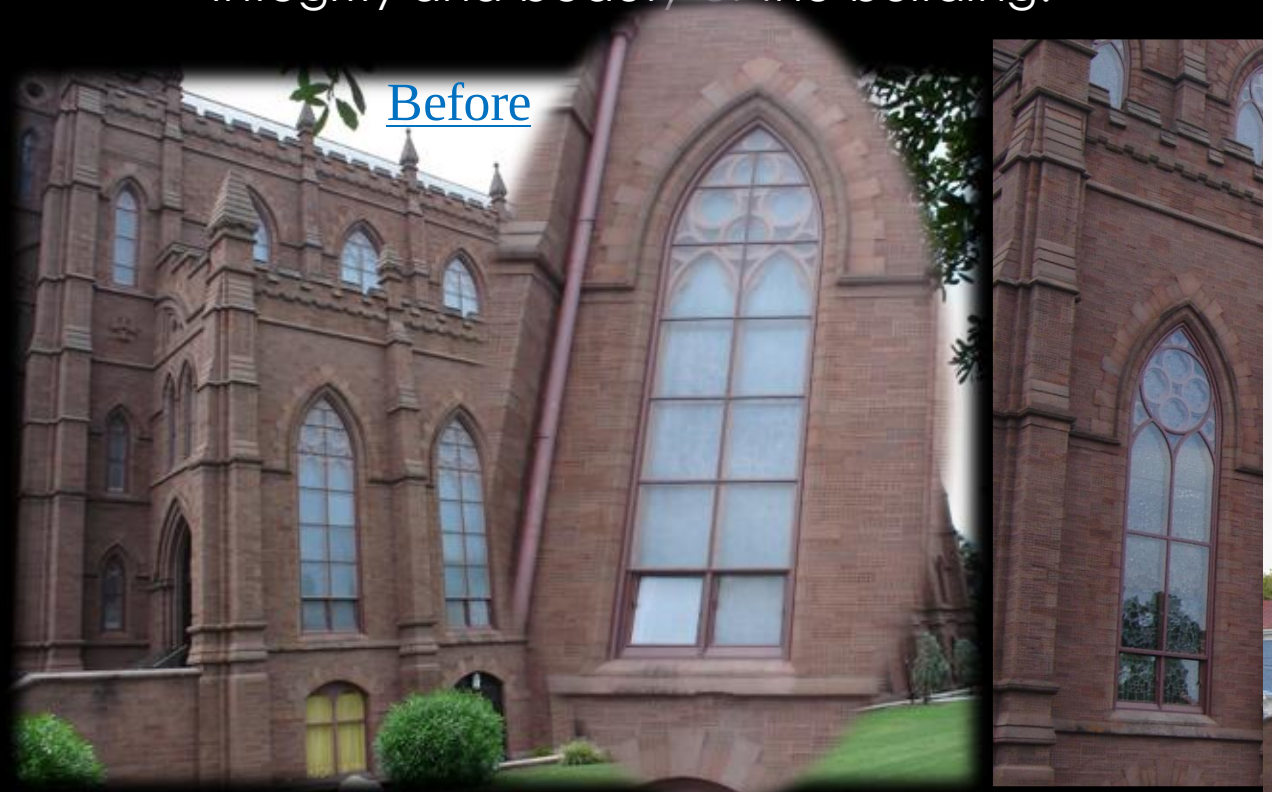
- It is important to design the protective covering with proper venting for conservation of the stained glass window and to compliment the window frame to preserve the architectural integrity and beauty of the building.



Before, and after photos of The Cathedral of St. John the Baptist RCC; The Mother Church of The Roman Catholic Diocese of Charleston, located in Charleston, South Carolina. Bovard Studio Inc. restored the stained glass, and installed new Precision Flow® vented protective covering that was bent to match the shape and flow of the historic wood frames.

Bovard Studio's Patented Precision Flow® Vented New Thermal Barrier Aluminum, and New Vented Wood Frames

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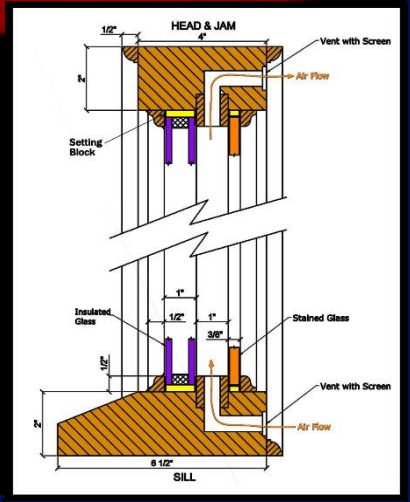

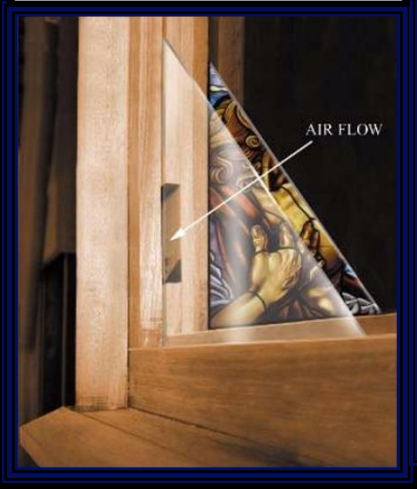

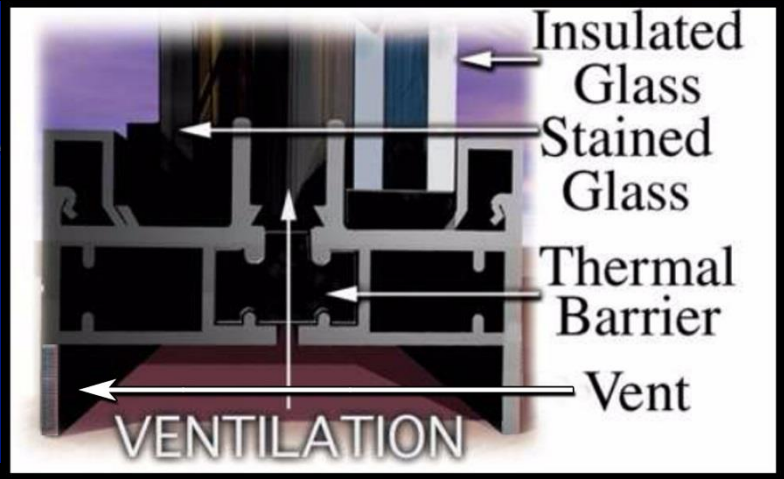

Above: Our Precision Flow® aluminum thermal barrier framing system designed to hold stained glass windows and insulated glass.

Above: Air flow with a bug screen and rain guard; Precision Flow® ventilation systems in our new wood frames.

U.S. Patent: #7,607,267 B2

WOOD FRAME REPLACEMENT

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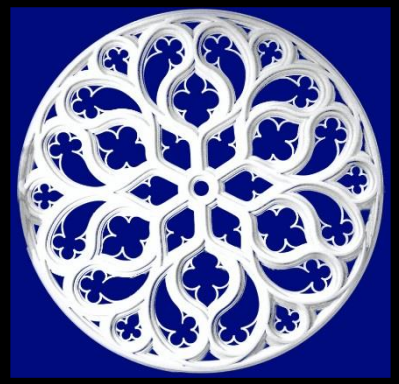
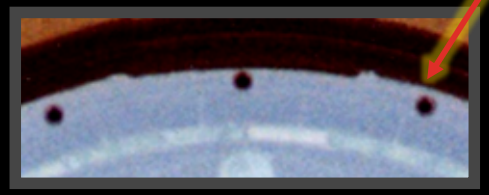


- New and replacement frames should be made from genuine Honduras mahogany, the heart wood of eastern white pine or equivalent 100 year rot resistant woods.

VENT PLUGS OR AFTER MARKET VENTING

BOVARD STUDIO
STAINED GLASS



- Vent plug with bug screen and rain guard added.
- You add ventilation to your existing protective glazing system.
- Replace lose sealant as required.
- Clean glass or plastic with appropriate cleaners.
- Retain weep system at base of protective covering.
- Vent plug.

SAFETY!
LEAD EXPOSURE TO WORKERS AND THE CLIENT'S ENVIRONMENT

BOVARD STUDIO
STAINED GLASS

- Caution : A main ingredient in traditional glazing cement is lead oxide

LEFT: One of Bovard Studio's glaziers is shown cementing a panel from St. Luke's Tiffany "Job" stained glass window.

RIGHT: A Bovard Studio craftsperson performs the final cleaning after reinstallation of Tiffany's "Job" window at St. Luke's United Methodist Church in Dubuque, Iowa.

SAFETY FROM ENVIRONMENTAL TOXIC LEAD EXPOSURE

BOVARD STUDIO
STAINED GLASS

- The traditional glazing cement's main ingredient is lead oxide.
- Disassemble in soak tank to keep the lead oxide from becoming airborne and breathed by craftsperson.
- Used water is stored and shipped to toxic waste water treatment facility.
- Client is ultimately liable for proper disposal of lead.
- You should bypass middle man (salvage companies) to assure there is no mishandling. You can ship scrap lead came directly to a lead smelter.
- The combination of the previous points protect companies and the client from very large E.P.A. and O.S.H.A. fines for improperly disposing of lead.

GLASS PAINTING AND SAFETY

BOVARD STUDIO
STAINED GLASS

Glass painting and safety

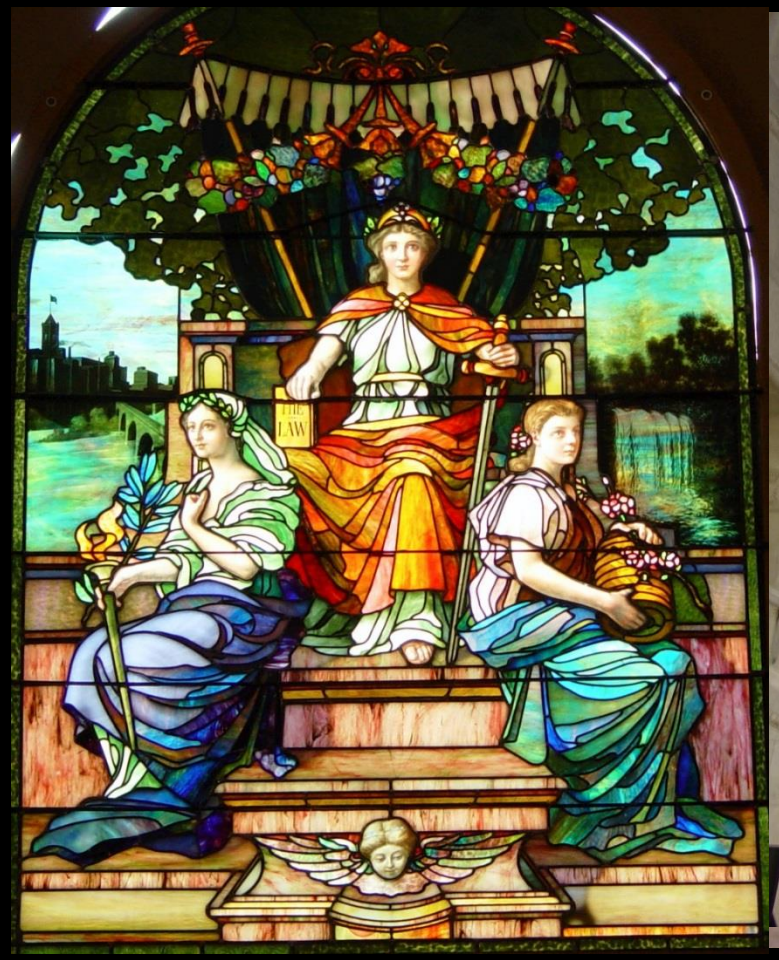
- Employees are trained in lead safety by certified trainers.
- Artists are protected from lead based paint.
- Air quality in the stained glass studio needs to be tested regularly for lead particulates.
- Routinely test employee's lead levels.
- Participate in OSHA's Voluntary Compliance Program.

THE BENEFITS OF BOVARD STUDIO

BOVARD STUDIO
STAINED GLASS

Benefits of Bovard Studio Inc.

- We have fifty talented stained glass craftspeople, artists, engineers and other staff resulting in top quality craftsmanship and product performance.
- Our staffs track record and experience in completing complex restoration projects on schedule.
- We are known for courteous, and timely service.
- Our patented vented framing and protective covering systems designed for the conservation of stained glass windows.
- We supply you with a complimentary and accurate Master Specifications Program.
- We voluntarily comply with safety and environmental safety programs to protect our employees and clients from liability.



Minneapolis, MN City Hall Stained Glass Restoration by Bovard Studio Inc.

THANK YOU FOR PARTICIPATING

BOVARD STUDIO
STAINED GLASS

Bovard Studio Offers Free Detailed Evaluations On The Condition Of Your Stained Glass Windows and Protective Glazing. We Work In Every State, Have Completed Projects In Every State, Including Alaska, Hawaii and have completed International Projects in Japan and Trinidad.

THE END

BOVARD STUDIO
STAINED GLASS

Thank you for your time.
If you have any questions or would like to schedule and appointment please contact:

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