Tulane University

Student Glass Handbook

Contents

A few words on this new student handbook:

This new handbook was designed with all the glass students in mind, not just beginners. Included in this manual, in addition to basic safety and equipment procedures, are some helpful handouts on many of the processes used at Tulane. The concept behind this text is to provide students with a helpful guide throughout their time at Tulane as well as their futures in glass.

Gene Koss
July 28, 2017

This is Tulane Glass
The Tulane/Newcomb Glass Art Program is dedicated to the use of glass as an artistic sculptural medium. The program here is in many ways a struggle against tradition. Since its invention some four thousand years ago, glass has always been used for functional or decorative purposes. At Tulane, students are encouraged to pursue glass well beyond these boundaries, be it through purely abstract work or even performance. Glass is an ideal sculptural medium because it can take on so many diametric forms. Glass is a static liquid—molten like honey when gathered from the furnace but timeless and solid when cooled. Glass can be clear, clean and smooth or opaque, raw and rough. It can be void of color or made dizzyingly vibrant. The glass artist also incorporates another powerful element into the work—light. Through illumination, a work in glass acquires new meaning and dimensions.

As important as expression, creativity and improvisation are at Tulane, without proper technique, students will find it quite difficult to execute their ideas. Students are taught fundamentals of solid working, blowing and casting and with practice students grow and explore their individual projects. Students are encouraged to push the material as far as they possibly can. If nothing ever falls on the floor, if nothing ever breaks, if nothing ever goes wrong, then the work is not being pushed hard enough. Mistakes are the best way for students to grow and experimentation and practice are key. Glass can be terribly frustrating for beginners, as well as the most advanced artists. Those who know this material make everything look easy. This is the hardest reality for beginning students to grasp: this stuff is hard. It is hot, physically demanding work. It can be too much at times but for those who fall in love with the material; it will become a life long love affair.

Tulane University sports one of the best collegiate studios in the country. There are three furnaces, four student work stations and glory holes, a garage, ten annealing ovens, pipe warmer and a complete set of tools and pipes for every bench. Specialty equipment includes extensive hot cast tools, a large car kiln and an enormous thirty-six inch glory hole. The cold shop has lapidary wheels for beginner, intermediate and advanced students. There are also two lathes, two up-right belt sanders, a wet drill press, a diamond saw, and small rotary tools. A large encapsulated sand blaster is also available for use. Mixed media sculpture is promoted so a large metal shop is available for intermediate and advanced students.

The Tulane/Newcomb Glass program was always extensive. Tulane was one of the earliest Universities to develop a glass program. Established in the late 1960s by Ron Bolling and then by Greer Ferris, the department died out for several years until Gene Koss revived it in 1977, along with a grant from Margaret Pace-Wilson. The first studio was under a lean-to where the ceramics salt and raku kilns now reside. The equipment was all salvage and scrap. These were lean years. In 1982, construction began on the present shop with another grant from Margaret Pace-Wilson. During the 1990s, with the help of numerous private donations, the studio expanded again into what it is today. Improvements continue with every new group of students. This studio is a living, growing entity. It feeds off the energy that Gene Koss and his students bring into it.

Hot Shop Rules

1. Studio hours: Monday -Friday, 6 am - 12 am. No Beginners after 9 pm. No Undergrads allowed on Saturday and Sunday.
2. **No one works alone in the studio**.
3. Beginners work in the Hot Shop only when Advanced or Intermediate are present.
4. Keep Visitors off the shop floor. Only students enrolled in a glass class are allowed.
5. When working, watch out for people behind you.
6. No one is allowed in the studio while intoxicated.
7. No drugs or alcohol allowed in the studio.
8. No making drug paraphernalia.
9. Always wear proper attire.
10. Anyone fifteen minutes late loses his or her lab slot.
11. Notify your partner if you are going to miss a slot.
12. Only use equipment that you have been taught to use by an instructor.
13. CLEAN, CLEAN, CLEAN.
14. Clean around the bench, glory hole and marver. Everything in the studio moves out of the way to clean.
15. Return all the tools and pipes to their proper places.
16. Clean tops of marvers.
17. Students are responsible for any damage to equipment.
18. Keep hot glass off the floor and any flammable surfaces.
19. Never leave a Glory Hole unattended.
20. Do not tamper with furnace or annealer settings.
21. Keep the Domestic glass and the System 96 separate.
22. Don't quench the pipes unless they are needed immediately. The temperature change causes extra stress in the metal.
23. Once again, CLEAN UP. Sweep, hose and squeegee after working. Leave your work area better than you found it.

Some other studio information and protocols:
EMERGENCY NUMBERS:
Public safety 865 5911
TEMS 865 5911
Important studio numbers are kept on the chalkboard in the hot shop.
A first aid kit is kept under the chalkboard.
A fire extinguisher is kept by the stairs to the metal area and in the hall by ceramics.

Expect everything in the studio to be hot (kilns, tools, bench rails, pipes, etc.)

Common sense is the most important tool available.
If there are any questions, ask someone in charge, either an instructor or a T.A.
Take good, detailed notes during class.
If anything goes wrong, no matter how minor, notify a glass studio staff person.

Take care of your body. Drink water. Stay cool. The studio is a hot place.

EVERYONE WASHES GLASS.

Do not handle other students' work.

Teamwork is essential, so watch out for your partner and those around you.
Proper Attire

1. Always wear safety glasses.
2. Wear only natural fiber e.g. cotton, wool, denim. Synthetics will melt and fuse with skin.
3. No shorts. Long pants and sleeves are required. Wear either a long sleeved shirt or cut-off socks for arm protection.
4. No open toed shoes. Wear sturdy shoes or boots made of leather or canvas. Again, synthetics will melt.
5. Tie back long hair.
6. Do not wear jewelry while working.
7. Do not wear gloves while working on the pipe.

Use only Kevlar gloves to put work away; leather gloves do not provide enough protection.

Opening and Closing Duties

The Tulane/Newcomb Art Glass Studio is a community. As student progress throughout the program they acquire more responsibilities and the studio needs the students to keep everything running smoothly. Students who are signed up for the first and last slots have opening and closing duties that must be done. If openers do not do their job, the studio will not be up to speed for the rest of the day. Closers have to make sure the studio will be set for the next day. Without either of these the studio would be in shambles in a day.

Opening Duties

1. Unlock and roll up the doors to the loading dock.
2. Turn all the lights on. The switch to the hot shop is by the fire exit door.
3. Turn on the exhaust fan by the double doors to ceramics. Push the “hand” button.
4. Light the pipe warmer and any glory holes being used before completing the list.
5. Rake all the tanks.
6. Be sure to keep an eye on the glory holes - they can go out.

7. Make sure there are annealers up for the day (beginner, casting, blowing.) If not, start on the call list.
8. Flush water barrels and block buckets.
9. Get to work.

Closing Duties

1. Turn off glory holes, pipe warmer, garage and torches.
2. Return all pipes and tools to proper places.
3. Empty all barrels, trashcans and buckets.
4. CLEAN, CLEAN, CLEAN.
5. Sweep beneath all equipment.
6. Empty the knock-off barrels. Pitch any colored or junk glass; recycle clean gabber and domestic.
7. Generally tidy up the studio, metal area, locker room, cold shop, and layout area.
8. Turn off the exhaust fan by double doors to ceramics.

Charging Duties

Charging is done every night after the studio has shut down so that the tanks are full of glass for the next working day. The glass must be charged slowly so as to not damage the furnace or cause seedy (bubbly) glass the next day. Tulane uses cullet or broken glass to charge into the tanks. Done properly this is less damaging to the furnaces than batching, where raw ingredients of glass are added directly to the melt and a chemical reaction occurs. Improper charging can at best result in poor quality glass and at worst fracture a tank liner or crash a furnace. If one were to simply fill the furnace with cold glass, the thermal shock would rupture the liner. Therefore, charging must be done in small increments. Another major concern, since Tulane uses several different types of glass, is compatibility; **DO NOT CHARGE THE WRONG KIND OF GLASS INTO A FURNACE**. This will ruin an entire melt and everything that is made from that glass will break. Not all clear glass is alike. If you are unsure which glass goes in which furnace, ASK. The actual process is rather simple and low-tech—cullet is shoveled from a barrel into a metal trough and then dumped into the furnace.

1. The Beginning and System 96 tanks (#3, #1) are smaller and take less glass per charge than the Casting tank (#2). Shovel five scoops of glass into the trough, open the furnace door and dump in the glass. The casting tank requires seven to nine scoops.
2. Suit up. The furnace door will be wide open and if you are not properly protected, you may get burned or even damage the furnace. You should be wearing: safety glasses, gloves, a jacket and a face shield.
3. Try to get an even coat over the surface of the glass with a dome of the remainder in the middle. Avoid glass on the walls of the tank and most definitely do not hit the burner. This is very fragile and very expensive.
4. A single charge will most likely not fill the tank so subsequent charges will be needed. It typically takes about an hour for a charge to melt. Once the hour has past, rake the tank twice. This will help squeeze the seeds out of the glass and produce a finer, cleaner glass the next day.
5. Repeat the process until the glass is two inches from sill of the tank.

The chargers should check to make sure all the closing duties have been completed, and perform any of these duties which were left undone; the people who work the last blow slot of the night and are responsible for these. Once the chargers are finished, their only responsibility should be to clean up the glass they spilled on the ground, hose and squeegee the studio and close doors. This means

chargers should arrive slightly before they are scheduled to work and make sure the studio is closed properly. If the shop is a mess in the morning, all parties will be held responsible, including chargers. After the studio is closed up, go home. It is late, you are tired and your service has been appreciated.

Hot Shop Tools and Equipment

Tulane has three furnaces that run twenty-four hours a day, seven days a week. They only shut down over winter and summer breaks. Every night intermediate and advanced students charge cullet (small broken bits of glass) into each tank. There is a blowing tank, a casting tank and a beginning tank. Each is designed for a specific use.

Of Tulane's five glory holes, four are for general studio use. The glory hole is used to reheat glass in between manipulations. As glass cools, it must be reheated continuously or it will shatter. On each glory hold are doors that can be opened to accommodate larger work.

Glory Hole

Furnace (above and right)

The garage is for use by advanced students for the assembly of multi-component work. Multiple parts can be made, put in the garage and then assembled later.

Glass will not gather onto a cold pipe. Blowpipes and puntis are kept in the pipe warmer until use so that the very tip is hot enough for the glass to properly adhere.

When used properly a marver can be the most versatile tool in the hot shop. Marvers are portable steel tables used to shape and cool the glass. Marvers must be cleaned with alcohol before and after use or dirt can contaminate the glass and must also be covered when finished or the steel may rust. There should be a marver with every bench.

Traditionally glass is made on a blowpipe or punti. Blowpipes are used to create a volume within the glass either for a vessel or a sculptural form. Puntis are solid rods used either for bits or solid working. It is important not to overload or overheat pipes or puntis or they will bend—straight pipes work better. Even though they are made of steel, these can be damaged easily.

Diamond shears are used for grabbing pipes or cutting bits. The ends are rounded for grabbing pipes; never use the sharpened diamond-shaped part of the blade to grab anything.

Straight trim shears should be used for cutting small gathers or bits. Also use these shears to trim vessels and shape bits. Use larger casting shears to cut through large gathers. These sheers should also be used by casters to strip ladles and trim pours.

Some words on cutting glass:
Glass cuts better when it is hot. Cold glass will not cut and will only dull the blades. Cut quickly; it is hot in there and fiddling about will only burn your hand.
The blades do not actually “cut” the glass. It separates the two halves by chilling the cut line and making small breaks along the line. The faster the cut, the smaller the breaks, the cleaner the cut.

Do not bite off more than you can cut. Only take as much glass as you can cut cleanly.

Jacks are incredibly versatile. Some masters create magnificent works using only the jacks. Basic uses are creating necklines for knock-offs, opening vessels and shaping gathers and bubbles.

Tweezers are used for manipulating hot gathers, forming bits and streaming water on the jack line.

The tagliol is a metal paddle used for cooling and flattening hot glass. Casters also use them to flip and manipulate casts.

Wooden paddles are helpful because the wood does not chill the glass; this is especially handy with thin glass. They can be used wet or dry depending on the situation. Paddles are also used to shield the gaffer when needed.

Toys, tools and texture.
Just about any metal object can be used as a tool for glass. Steel works best but thick pieces of aluminum and bronze or other copper alloys can be used too. Be careful as both aluminum and copper alloys will fuse to the glass if it gets hot. Knives, files and awls work well. Many glass workers make their own texturing tools. Be inventive and find ones that work best for you.

Torches are used to heat specific areas or keep delicate parts hot that would melt in a glory hole.

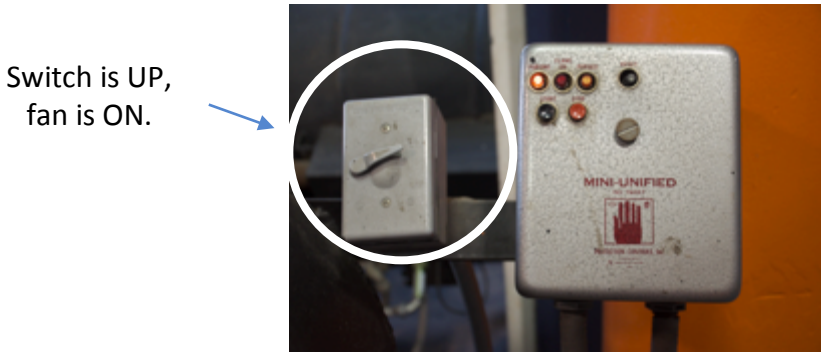
Gas Equipment

Lighting the glory hole

1. Open the doors of the glory hole.

Switch is DOWN, fan is OFF.

2. Turn on the fan by pushing the switch UP on the left. A light will turn on and say **purging**. Once the purged light comes on,



3. **Make sure no one is standing in front of the glory hole.**
4. Once the purged light comes on, press and hold the start button for at least 1 second or until the glory hole lights. When the glory hole lights, the Flame On button will turn on.

5. Close the doors of the glory hole after 30 seconds with a steel door tool.
6. Keep an eye on the glory hole until it is fully up to temperature. If the flame goes out, go back to step one.
7. To turn off the hole, press and hold the stop button for 1-2 sec, purging light will come on. When the light changes to purged, then turn the fan off.

Lighting the pipe warmer

1. Place a lit propane torch above the burner holes in the middle of the pipe warmer.
2. Turn the gas leaver from 3 O'clock to 2 O'clock.
3. When lit, adjust the flame until it just touches the bricks above.
4. To turn off - just kill the gas.

Lighting the garage

1. Place a lit propane torch below the burner, outside the garage.
2. Ease on the gas until a small flame appears.
3. Remove the torch and ease on the gas until the flame reaches the other side of the chamber.
4. Keep an eye on pyrometer until the temperature reaches 1000 degrees. Adjust the gas accordingly.
5. To turn off - just kill the gas.

Hand torches

1. There are two sets of hand torches: intermediate and advanced.
2. Turn on main gas at tanks all the way.
3. Adjust regulators. Screw in the intermediate torches fully. Set the advanced torches to 40 psi.
4. Turn on main gas on intermediate torches. Adjust and light pilots on both torches until a small flame appears.
5. To turn off kill gas at main on tank. Bleed the hoses and regulators. Ease off regulators and turn off valves on torches. Roll hoses loosely.

Annealer Etiquette

Annealers are ovens designed to safely and slowly bring hot glass down to room temperature.

1. Load only into your annealer. The annealer should have an “up” arrow and will designate who is supposed to load into it, i.e. beginner, cast, blow or an individual.

2. NEVER open an annealer with an X on it or a “down” arrow. This will destroy everything in it.

3. Make sure there is space in the annealer before you start working. If there is not, ask one of the staff members where to load.

4. Load each shelf tightly. Load back to front and left to right.

5. Do not load pieces on top of one another. They may fuse if loaded too hot.

6. Load quickly and precisely. Do not leave the annealer doors open for more than a few seconds. If a piece needs to be adjusted wait a minute for the temperature to return to normal and then go back inside. Remember, the more a piece is handled, the more likely it is to break.

7. Never tamper with the computer control panels.

8. Any work that is improperly loaded may be removed.

Remember that sometimes stuff happens. Just because a piece of glass made it into the annealer is no guarantee it will come out. This could be because of an annealer malfunction, or a hot piece touched a colder one, there was some incompatibility in the glass, but most likely it was artist error. The glass could have went in too cold, was set down too hard, or just poorly made. The bottom line is do not count on a piece until it is in your hand and maybe not even then.

Before You Start

"Know what you are going to do before you do it." This is a phrase that will be said almost as often as "heat it up" or "keep it turning." While improvisation is encouraged, it is crucial to have at least a basic plan before starting. Communication is key to glass working. An easy way to let your partners know what you have planned it to draw it out on the floor with chalk. Draw your plan out step by step so everyone knows what to expect. Have everything set up before you start; be it your bench, any casting equipment or other special needs. Make sure all the tools at the bench convenient to reach. Make a habit of putting the tools in the same place every time so that you will not have look for them. Arrange your work area logically, keeping the glass blower's triangle in mind.

The Glass Worker's Triangle

Glass workers essentially work in a triangle between the bench, the furnace and the glory hole. There may be a dozen other places the gaffer and assistants will go during the course of piece depending on its complexity, but most of the time will be spent moving back and forth from the furnace to the bench and to the glory hole. Keeping this in mind is essential in a communal studio. The furnace may have to be shared between several groups but each bench has its own glory hole and most gaffers find it terribly distracting to have other people working out of their hole. It is also dangerous having that many people in close quarters with hot glass. Always be aware of who is around, not just the assistants. Plan movements ten steps ahead and keep an eye on both the end of the pipe as well as the surroundings. Keep the area inside the triangle free of obstructions, people, or otherwise. A glass worker needs room to groove.

Basic Glass Working

Most work will begin by gathering glass onto a pipe or a punti. Open the door just far enough to get your gather out (having a partner run the door works best for beginners) and rest the pipe on the sill of the furnace. Dip the tip of the pipe one and a half inches into the glass at a forty-five degree angle and make at least two full rotations. Push forward and move in a slight crescent. While rotating lift the gather out of the glass and pull back. Continue turning until the stringer burns off and then lift the pipe out of the furnace. Keep turning. Be quick and smooth. Do not spend too long in the furnace or else the gather will just melt off and the pipe will heat up. Take successive gathers as needed.

Marvering the glass is a quick way to make many shapes. Remember to move smoothly and support the weight of the pipe or there will be a flat side on the piece. Marvering at different angles will move the glass in different ways and produce different shapes. Steel chills the glass. This can be used to the blower's advantage to cool sections of a bubble.

Glass can also be shaped with a wet newspaper or wooden block. These must be kept wet and will deteriorate quickly if not. Both of these tools are used to form the glass into rounded shapes usually for blowing.

Use the jacks to create a neckline for breaking off the piece. At the bench hold the jacks like a dagger perpendicular to the pipe. Gently apply the jacks to the piece as close to the end of the pipe as possible. Do not make a jack line on the pipe or the piece will never come off. The jacks must remain square or the line will swirl up the glass. Make the jack line early while the furnace heat is still in the piece. If you wait until the end the glass will be too cold and everything will melt when you try to get it hot enough. Turn the pipe at a consistent pace and use the entire bench—short choppy rotations will throw the glass off center.

Glass must be reheated frequently so it can be tooled and to keep it from cracking. Learning to read the temperature of the glass is something that just takes time and experience. If the glass gets too cold it can crack in the hole; if it is too hot it can melt out of control. Keep the glass as hot as you can handle it. Get used to moving to and from the bench frequently. Remember that thin areas will heat up and cool faster than thick areas.

As you are working the pipe will heat up. Cool it down by pouring water over the middle section. There are two water buckets with pitchers by number one and three glory holes. Be careful not to splash the glass.

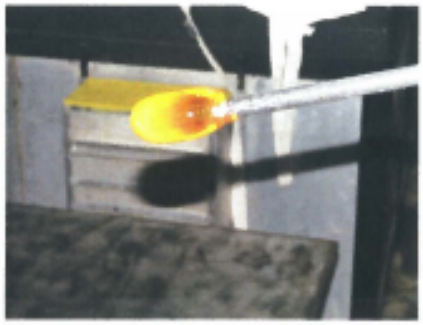
The transfer is one of the hardest maneuvers to master but is essential in many situations. Transferring a piece allows the gaffer to work on all sides. The process itself is simple; however making it work can take a maestro's touch. A punti is made (there are many types,) attached to the piece and then transferred from one pipe to another. If the timing is off slightly or either part is too cold the transfer will fail.

Glass cannot stay on the pipe forever. Once finished the glass must be idled down in the glory hole, the neckline cooled and knocked off to be put in an annealer. Again it sounds easy but if the glass is too hot it will not break off or can even slump in the annealer; if any part is too cold it will break in the wrong place or can explode in the annealer.

Generally, glass is clear. Color is available in powder, frit or chunks of color bar. Most artists purchase color but it can be batched in a furnace. Color can be added in bits, overlays, inlays or even stirred in to casts.

Basic Bits

Just manipulating hot gathers will get boring for both the gaffer and the viewer. Many artists create amazing works by attaching shaped bits of glass to the central form. Bits come in as many shapes, sizes and names as the gaffer can imagine ranging from hot gathers dragged across a piece specially shaped flat, square of cone shaped bits. These are examples of just a few so be inventive and craft some new ones.



Basic Blowing—A Tumbler

There are masters who have been blowing glass for half a century (if they live that long) and glass still holds secrets to them. This will be one of the most difficult techniques to learn in a glass career and while there are other processes that may take precedence, everyone should be able to make a simple, consistent tumbler. Generally these methods, especially the early steps, can be applied to most vessels with variation in form and size.

1. **1st GATHER**—Heat a standard blowpipe until the very end (1/2 in) is red hot. The hot end helps the bubble blow out close to the pipe. Take a single medium gather allowing it to round up. Hold the pipe at a slight angle down ot the glass falls off the pipe while walking to the marver.

2. **MARVERING**—Start low and fluidly marver all the glass of the end of the pipe. Come up to the level and push forward slightly to round up the end of the gather. This needs to be done quickly or it will be very difficult to get a starter bubble.

3. **"CAP AND BLOW"**—Raise the pipe and blow into the pipe. While blowing, cap air in the pipe by moving your thumb over the hold while still puffing. Puff hard. With the hole still covered, move the pipe so you can watch for the bubble to form. Keep the pipe turning and the air in the pipe will heat up and rise forming a bubble in the glass. Do not let the walls of the bubble get too thin or else the next gather may collapse it. Marver the starter bubble into a nice cylinder and wait for the bubble to cool enough to gather again. A, B and C should all be done with the furnace heat in the first gather.

4. **2nd GATHER**—Once the bubble is cool enough that it will not collapse but still hot enough that it will not shatter, gather again. This process can be repeated as many times as necessary, just remember to inflate the bubble so it does not collapse after each gather.

5. **SHAPING**—Do not go straight to the marver after the second and subsequent gathers. This will push the bubble out of shape and scar the glass. Instead, go to the bench and let the glass settle down and get a skin on it. Use a newspaper to form the glass into a bullet shape.

6. **BLOWING IT OUT**—From here the vessel can go in many directions but the basic idea is to cool the thin areas so the thicker areas blow out. Use the paper, a tagliol, the back of a pair of jacks or for heavy cooling the marver. The hope is to get a vessel with a uniform thickness. Now, before the bubble gets too large, be sure to get a neckline in or the bubble will never come off. Generally it is convenient to start one soon after shaping but be careful not to jack too tight and close off the bubble. While the rest of the bubble is being blown out the neckline will need to be continually reestablished. This also has the benefit of cooling the jack line so the neck and shoulder thins out.

7. **ANATOMY**—Vessel parts are described using human parts. The bottom is the foot followed by the belly/body, shoulder, neck, and lip. The parts must be developed in a certain order. The foot and bottom half of the belly must be shaped while still on the pipe. For a tumbler, the walls of the belly need to be made into a cylinder and the foot flattened. Do not rely on the marver. Use the jacks horizontally to round out the cylinder while someone paddle the bottom so the tumbler gets a flat bottom and nice 90-degree walls. Once done, it is time to transfer and finish out the shoulder and lip.

8. See the section of transferring.

9. **TRIMMING THE LIP**—Ideally the lip is thin and neat. More often than not this will not be the case. Flash the whole piece and then heat just the lip until it is nice and soft. With tweezers pull out the lip until it thins and flares out a little. This may take several heats. Heat one more time and with trim shears cut in from the bottom of the lip and turn the pipe away. Use quick, short cutting strokes and be sure to finish the cut in one heat or the trimming will fall back on the piece during reheating.

10. **OPENING**—Now that the vessel has been transferred heating becomes crucial. Do not over heat the punti; short flashes only or the piece will fuse and break out the bottom. Also the piece will get all wonky if it is over heated. Flash the whole piece and the concentrate on just the shoulder and lip. Hold the piece at a very slight angle down and do not turn fast or the cup will quickly turn into a plate. Once the lip is nice and hot open it with the jacks. Start deeper than the lip (the bend where the shoulder meets the belly) and gradually spread the jacks and move up the tumbler. This may take more than one heat. Be sure not to open the lip too soon or it will out and the tumbler will no longer have straight walls. Have someone paddle the lip with a wooden paddle while opening to make it straight and smooth.

11. See the section on the take-off.

Making sculpture from blown glass is difficult. Making good sculpture from blown glass is incredibly difficult. Somehow a vase is still a vase no matter how elaborate and creative. Do not let this dissuade anyone from trying. Experiment with starter bubble but cutting and gouging into them. These will become bubbles in the next gather. Add bits and gather them. Work on ways to use those interior spaces for some other purpose than holding water.

The Transfer

Much of the time a piece must be looked, and worked on, in two halves—the top half being largely finished before the transfer and the bottom after. The most critical step in working the glass is transferring a piece off the pipe and onto the punti. The problems occur in the necessity to later remove the punti with little scarring and as little cold working as possible.

1. The assistant gathers a small amount of glass on a punti and quickly marvers it to shape. Begin with a small gather and hold it vertically so the glass falls back on the punti. Next, marver the tip to a small blunt cone. This should be a quick process—only a few seconds. The goal is to make a punti that will hold just long enough to finish the piece. If the connection is not good enough the piece will fall off the punti; if it is too strong the piece will break when it

cracks off the pipe. The most likely time for this to occur is when the pipe is rapped to crack it free. There are numerous punties for numerous occasions. Find the best for the situation.

2. The gaffer will take the finished punti and lightly attach it in the center of the piece with tweezers. If the punti is not centered. Every move for the rest of the piece will be off-kilter. If the glass is too hot, there may be a bit of frantic turning and twisting of the punti to keep the piece centered and in place. If it is brought too cold the punti will not stick. The assistant should support the weight of the punti but cannot fight the gaffer as he or she rolls and centers up the punti.

3. If the gaffer has properly jacked the piece and attached the punti correctly, the glass should shear cleanly and easily without much shock. A few small drops of water on the jack line can facilitate this, however, too much can send checks running down the piece. A small rap with the tweezers, a tagliol or a piece of wood works well. It is important to lift the pipe off the bench so the vibrations travel all the way up the pipe. If the piece has not been properly puntied, or the neck not properly narrowed or chilled, rapping on the pipe may result in both ends of the piece breaking free and the whole falling to the floor.

4. After the transfer, the glass needs to be reheated gently and rapidly. The assistant must go directly to the glory hole. The punti/piece will be incredibly fragile and even the slightest tap on the yoke will put it on the floor. The gaffer can follow the assistant and take the punti at the hole or wait for the assistant to bring it back to the bench after a short flash.

5. When the piece is pulled from the glory hole, it is time to work on the rim and upper body of the piece. Go to it.

The Take-off

A piece of glass does no one any good if it is still on the punti. When the piece is complete, the next critical step is to remove it from the punti, preferably without taking a chunk out the bottom of the piece. If the jack line was made properly or the punti was applied properly, removing the piece is merely a matter of chilling the join and giving it a “bonk.”

1. This is less an issue with thin blown work but any solid (or thick walled beginning cups) must be idled down. Begin after the last adjustment has been made to the glass and take short frequent flashes until the entire piece of glass is the same temperature. However, this is not enough, the glass must also be cold enough that it will not slump but hot enough to provide necessary time to knock the glass off. While the gaffer is doing this, the assistant should be checking the bench for all the proper tools, checking the annealer for space and suiting up to put the work away.

2. At the bench: set the pipe down gently, keep it turning and get set. Tip the back end of the pipe down and under the bench. The assistant should be ready with preheated gloves cradled under the work in case it goes early. Cold gloves can crack the glass.

3. Chill the jack line with water, a file, jacks or any cold tool. Each situation will call for a different method; for instance do not put water on a thin-bottomed vessel but just cold will not chill a fifty-pound chunk of glass. This must be done quickly as the glass is cooling rapidly and unevenly.

4. Lift the pipe up off the bench and allow the assistant to gently but firmly grasp the glass. Using either the butt end of the tweezers, a tagliol or a scrap of wood hit the pipe just hard enough to break off the glass.

5. The assistant should move quickly to the annealer. There is no need to run. Look where you are going. Place the glass lightly in the annealer and be sure to follow the annealer etiquette.

Some helpful tips:

Cool the jack line, flash and cool again for works with complex thin parts.

Use a map gas torch to heat thin areas before take-off.

Take large work off close to the annealer to avoid carrying the heavy, hot load.

Try a variety of tools and techniques to find the best.

Clamp jacks on the neckline to minimize vibrations above the break.

It never hurts to take an extra flash.

The glass can never be too idled down.

If it falls on the floor, make another one.

The Dance

Making glass is about finesse, skill and imagination. Glass has a mind of its own and will push anyone around that tries to force it to do something it does not want to do. This is the purpose of the "dance" or rather a courtship with the glass. Be loose. Be confident. Be in control. The hotter the glass, the more essential this is. An ice cube on a stick is easy to control but a hot, hairy gather or a freshly puntied cast is something else altogether. Concentrate on keeping the glass on center. At 9.8 m/s^2, gravity is the only constant in glass; heat, viscosity and skill level are all variable. Use gravity and flip the pipe from one side to the other; do not worry about making full rotations yet. Tip the piece back to fatten it. Let it fall to lengthen it. The heavy-handedness common to all beginners is because they are afraid to let the glass get hot enough to move freely or if it does they are right there with a paddle to mash it into place. Movin', Doin' it. You know. Like a glass machine. Glass is seductive. Keep that in mind.

Drop Casting

Drop casting allows several additional tools and choices in creating sculpture on the pipe. First, it enables the gaffer to add specific shapes and textures to a piece that would be difficult to hand build by filling a mold with glass and then affixing it to work in progress on a pipe. These shapes include most anything with hard defined edges, parts too time consuming to build or textures too complicated to add by hand. Secondly, drop casting permits the gaffer to build larger, faster. A greater mass can be constructed more quickly and with greater control than by gathering alone. The actual process,

however, requires better gathering skills than simple bit making. For this technique, glass must be gathered faster and hotter from the furnace. Done properly, this method can add an entirely new flavor to a work.

1. **A PROPER MOLD**—A proper mold for drop casting is either metal or graphite without under cuts and can be removed from the glass easily. For steel molds, take care to remove anything that will snag the glass, i.e. welding splatter, metal burs, improper drafting. Soft metals such as brass/bronze or aluminum can be used if thick enough and the glass is removed soon enough. These metals actually melt at a lower temperature than the glass is kept at; thin bits of these metals will melt to the glass.

2. **THE GATHER**—The larger the mold, the more glass will be needed to fill it. That said; always gather more glass than you will need. The most difficult part of this process is learning to gather hot enough to cast but not so hot that your previous gathers fall back into the furnace. Forming an adequate skin around the gather is a good way to prevent this. Begin by tapping the gather lightly on the marver while pushing forward slightly. Do not marver. This will chill out the core of the glass too much and the gather will not fall smoothly into the mold. This is a bit of trial and error to find the right temperature for you and the glass. As you take subsequent gathers, do so quicly. Take full revolutions but not so many that the core has time to heat up and fall off the pipe. Repeat this process until the gather is large enough to fill the mold.

3. **POURING THE MOLD**—Now is not the time for kamikaze glass. The gather should stay on center and totally in control. At the casting table where the mold is, make sure there is a pair of shears and a tagliol. Walk briskly to the table and hold the punti totally vertically above the mold. Allow the glass to fall into the mold. The glass may have to be stripped from the punti with the shears to fully fill the mold. Remember hot glass cuts easier and cleaner than cold glass. Reach in and cut as low to the mold as possible. Do it quickly—is will be hot.

4. **USING THE CAST**—The cast can be attached to a piece one of two ways: a “glue bit,” a small hot gather added to the either the piece or the cast before the two are joined, or the cast can be adhered hot.

Ladling

There is as much skill in ladling as there is with any technique in glass. Anyone can get glass from a furnace to a mold; to do it quickly, cleanly and with style is an art. As a caster’s ladling ability improves, the more complex a mold that can be executed. Many in the glass community see furnace casting as a brutish folly that requires little or no skill. This is just not the case. The process is simple, straightforward and there are a few tricks to learn (this probably accounts for the stereotype). The few tricks that do exist differentiate between experienced hot casters and blowers who try to ladle.

1. **LADLES, MOLDS AND TABLE**—Select the proper ladle for your process. The cup should hold enough glass to fill the mold but not have any unnecessary waste. This is less an issue with small ladles and small molds: however, a large ladle can weigh in excess of forty pounds. There is no reason to expend that much energy needlessly. Know your limits. Select the proper ladle for yourself and your mold. If a large ladle is too heavy, several smaller ladles in succession will work equally well. Orient the mold comfortably to the caster. Thinner pours should be made parallel to the ladle where the ribbon of glass is thinnest. The table, sandbox, etc. should be at a comfortable height. Ladling in the most relaxed conditions will prevent much of the strain inexperienced casters undergo.

2. **SUIT UP**—Suit up to your comfort level. Basic garb includes: heavy-duty Kevlar gloves, small leather gloves, arm sleeves, an over shirt or jacket and a face shield. A wrist brace is also useful to reduce strain of a long casting slot. Proper ladling requires that the ladler be directly in the heat of the furnace and the pour.

3. **HOLDING THE LADLE**—Proper posture will determine the level of dexterity achieved by the caster. With one Kevlar clad hand grasp the ladle as close to the cup as possible for both leverage and control. The other hand should be dressed in a leather glove so that tools can be grasped easily. Spread your legs, get sturdy and get at ease with handling the weight of the ladle. Depending on the pour, you may be pouring circles around yourself. There is one major safety concern here—do not get your gloves wet. You will get a steam burn if your ladle handle is wet. Dry it with your leather glove first to prevent the Kevlar from getting wet.

4. **GATHERING**—Gather into the rear of the ladle and pour from the front. Rear and front are determined by the ladler's rear and front. Actually scoop the glass into the cup. Simply dipping in the glass will not fill the ladle and will leave a nasty skin around most of the lip. You cannot pour over this skin so try to have as little as possible. Once te ladle is full come back to level and pull the cap to just inside the door. Allow the skin and stringers to burn back in to the tank (this should not take more than a couple seconds.) Open the door and slide your gloved hand up to the cup and lift it out of the furnace.

5. **TRIMMING**—If needed, an assistant can strip any excess drip off the ladle before it gets to the mold.

6. **POURING**—The goal here is to inject the glass into the mold as quickly and cleanly as possible. This is done to avoid pour marks form a cold or sloppy pour. This just takes practice. When the mold is full, trail back fast and allow the stream to thin. The assistant should snip low and lift any excess back into the ladle.

Table Casting

Table casting, pouring glass into metal molds on a graphite or steel table, was primarily developed by Gene Koss in the late 1970's and 1980's. Casting, for most glass artists tends to consist of only sand casting. Table casting, however, allows for a totally different aesthetic than any other process. This process gives a cleaner piece of glass than any other method. Table casting lends itself to a more production-like feel, but can be used for so much more. Table casting is far more labor intensive than any other technique—unlike sand or wood molds, the table and the steel mold are sapping the heat from the glass at a much faster rate. Here timing, proper torching and accurate reading of the temperature of the glass are crucial.

1. **A PROPER MOLD**—a proper mold for table casting is either metal or graphite without under cuts and can be removed from the glass easily. For steel molds, take care to remove anything that will snag the glass, i.e. welding splatter, metal burs, improper drafting. Attach handles of some design, as these will be necessary for torching and maneuvering the mold around the table.

2. **OILING AND HEATING THE TABLE AND MOLD**—A steel mold must be coated with some sort of release. Either a store bought mold wash or a mixture of graphite and motor oil can be used. To minimize checks (cracks and stress fractures in the glass) the table and the mold must be preheated. Several small ladles on the table are a good way to heat the table.

Torching the mold briefly should be sufficient. Glass will stick to hot metal, so you do not want to burn off all the mold release or heat up the mold too much.

3. **POURING THE MOLD**—The goal here, as in any casting process is to inject the glass into the mold as quickly and cleanly as possible. This is done to avoid pour marks from a cold pour. Depending on the design of the mold, the goal is to get an evenly poured slab of glass.

4. **TORCHING THE SLAB**—Think of the torching process as you would idling a piece down in a glory hole. The whole of the slab needs to be at a stable temperature before it goes into an annealer. Remember that the table and the steel mold are going to be draining the heat from the glass quickly. The hottest point of the flame is the tip of the blue cone. Begin by torching the underside and edges of the slab. Bring the slab (still in the mold) about an inch over the table and lightly lift the edges of the slab. This is the most crucial element to master in the casting process. Most checks will occur here. Once the slab has cooled sufficiently not to slump, remove the mold and torch the slab. Flip the slab over and heavily torch the bottom. The goal is to remove the chill and the thermal shock from the table and mold. Continue to flip and torch to piece as needed until the cast is idled down and ready to put away.

5. **BOXING THE SLAB**—A table cast has two sides, the table side and the pour side. The table side will have texture and the pour side will be smooth. As you go to put your cast away, remember this and put your slab away just as it was poured. This way, your slab will not get scratched as it slides across the shelf.

Sand Casting

Sand casting, as we know it, was brought to America by Bertil Vallien. Sand casting is considered by man to a “lazy man’s” process mostly because of the “press and pour” mentality of some artists. However, sand casting is an effective and expressive process for creating sculpture. The goal here is to avoid the production-like nature of hot casting glass and emphasize individuality of expression and the design of a truly unique piece of glass. Sand casting is an excellent avenue to demonstrate the necessity for adaptation, as each cast will be different, and to break away from traditional rules of casting and take a more active role in each cast.

1. **PREPPING THE SAND**—We use slightly less than a 10% bentonite to 90% sand mixture. After the sand and bentonite clay are mixed thoroughly, water is added and the mixture is sifted. Too wet a mixture can create steam pockets and bubbles in your cast. If the sand is too dry it will not hold its shape. To check the consistency, make a small ball of sand and toss it gently in the air. If it does not disintegrate the mix is right.

2. **PRESSING THE MOLD**—Before pressing the mold, be sure to think about how the positive will facilitate the creation of a sculpture. Cast an object in glass does not make a work of art; it only makes a glass object. Consider creating unique positives (foam, wood, ceramic etc.) before using a ready made. One of the most important catches to consider when choosing a positive is that it cannot have any undercuts or anything that will prevent the object from being easily removed from the sand. Try using tools or your hands to dig a form into the sand or to create textures. Depending on the design, a flat level surface may be advantageous to the press, if not press away. A flat board and a level can help a great deal.

3. **ADDING A RESIST**—There are several types of mold releases that can be used. Most common are sugar water, carbon from an acetylene torch, graphite powder and petro bond. Graphite powder and petro-bond are the cleanest. Lay in a good, solid layer of resist but take

care not to use so much all the detail disappears. The better the resist, the cleaner the cast and the less cold work to do later.

4. **TENDING THE CAST**—As the cast is cooling it is important to frax and vent so that the cast cools uniformly. A small piece of fiberfrax or a mapp gas torch can be used to heat thin areas; use a stick or a wooden paddle to push holes into the sand near the edge of the cast so it cools faster. Some casters prefer to put the cast away with lots of sand and others prefer a bare cast. This is determined largely by the size and fragility of the cast.

Wood Casting

Wood casting is a process unique to Tulane. Gene Koss developed it in search of a more raw and unique piece of glass than a blown vessel. Wood casts produces a raw, rutty piece of glass different than any other process. The glass itself is totally unique because the mold deteriorates with every casting as the wood burns away. The molds can be carved again and again so long as the log holds up.

1. **THE WOOD**—Choosing the proper wood for the mold is essential. Hard woods work best for carving but simple pine boards can work for geometric molds. Blow molds and blocks are typically made from fruit trees but the lifetime of these molds is far too short to warrant the expense. Choose a log large enough to accommodate the cast. The walls cannot be too thin after carving or the glass will burn through. The number of castings needed will also determine the size log; the more castings needed the thicker the mold will need to be.

2. **CARVING AND HINGING**—Carving is a reductive process, meaning that more can always be removed but what is gone is always gone. Split the long into two halves and concentrate on carving one side first. Once the cavity is fully outlined, no detail is necessary yet, it can be transferred to the other side. Use several heavy hinges and attach the two halves back together. They need to match back up perfectly. There is any number of ways to transfer the outline to the other half. Colored clay, lipstick and crushed chalk outlining the cavity seems to work best. Now carve out the mirror image. Be sure there are no undercuts where the glass will lock in. Carve out a pour cup large enough to ladle into; it can be cut off later.

3. At this time add handles or lugs that can be clamped to hold the mold closed.

4. **VENTING**—The mold has to be vented or steam will cause bubbles in the glass and may prevent the mold from filling properly. Drill holes about an inch apart all over the carving.

5. **POURING**—The mold should have soaked for at least a week before pouring. Set the mold on the group and pour it hard. It will bubble and spew flames but keep pouring. Have a “pokin’ stick” ready to push the glass back into the mold.

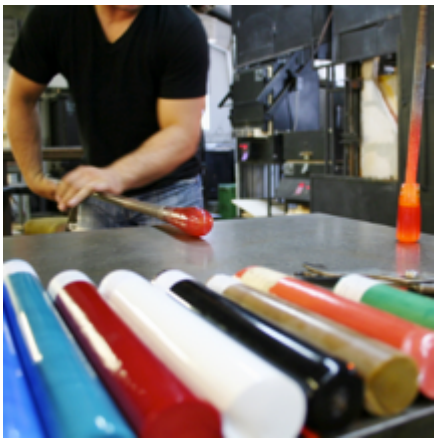
6. **CRACKING AND TORCHING**—Once the cast has settled down, loosen the clamps and crack the mold slightly. The cast will still be hot so do not let it ooze out. Once solid. Flip the mold on its side and open it. Torch one side and then close the mold, flip it and torch again. Repeat until the cast is ready to be put away.

Basic Color

Glass color is made by adding metals and metallic oxides to the batch as it melts. Generally this is done commercially and sold to artists in bar, frit or powder. Color can be added directly to gathers,

brought as bits, overlaid, stirred into casts or even painted on. The questions of when to use color, how much to use and how to use it are entirely up to the gaffer. Keep this in mind: color only makes working glass harder, often more interesting, but always harder. Visually, color can disrupt the form of a piece and distract the viewer. Physically, colored glass has different properties than clear glass. Some colors are stiffer than others, have different coefficients of expansion or are just not compatible with other glasses. Also color is expensive and there is no reason to waste it.

Color Bar



Color bar is most often used as an overlay for a bubble. Color bar, when used properly, can provide a smooth, even layer for vessels and other blown forms. The size of the chunk of bar will dictate the intensity of the color. A good whack with a chisel and hammer is usually sufficient to cut the bar; cutting it with a diamond blade can scar the glass.

Frits and Powders

Some artists make their own frits and powders by taking large chunks of color, smashing them many times over and then sifting the remains through multiple meshes. Often, though it is easier and healthier just buy them commercially. Frist are available in several different sizes but powder is just powder. Consider layering multiple colors, drawing designs on the marver to pick up or laying it on heavy to make texture. Color gradations are easy to by layering powders thicker is some areas than others. Roll bits in color for wraps or other applications. Both frit and powder or even small bit of cane can be swirled into casts or layered on top to tint the entire cast.

Canes and Murini

Cane is nothing more than thin threads of glass. Cane can be used to draw on glass, laid into an optic mold or on a cane marver, broken into tiny bit to be used like frit or “peudo-lampworked” into a design and laid into a cast. Murini are the cross sections of cane. Depending on the size and amount of cane desired, a simple bit can be pulled into cane or for intricate murine a bit with a sculpted core might be used. Again, just be inventive and practice.

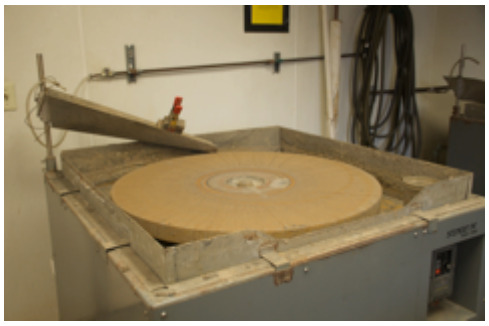
Striking and Reducing Colors

Some colors need to be heated in a special way to achieve the hue and intensity possible. These colors are said to “strike.” Generally a color will strike when it is cooled almost to cracking temperature and then reheated. This may take several attempts but keep in mind that colors can also over-strike. Reducing colors get a metallic surface when exposed to a high gas atmosphere. The reducing atmosphere, usually achieved by briefly turning off the fan to the glory hole, bring the metallic oxides in the glass to the surface. Reducing colors cannot be incased, at least not if you want to the reduction to work.

Cold Working

Grinding and polishing glass requires a steady stream of water and an abrasive compound. The purpose of the water is to keep the glass from overheating and cracking, while the compound helps to abrade the glass and achieve a polished surface. Polishing equipment ranges expensive diamond lapidary wheels that spin underneath the piece, to simple Dremel tools. Lathes, belt-sanders, power tools, and grinders have all been adapted for polishing. Generally, achieving a highly polished finish involves a series of finer and finer abrasives to wear away the glass by scratching the surface until the scratches get so small they can't be seen. Beginning and intermediate students use silicone carbide abrasives while diamond fitted tools are available advanced and graduate students. All students are shown specifically what tools are available to them. These are very expensive machines so only use that equipment that you are trained to use.

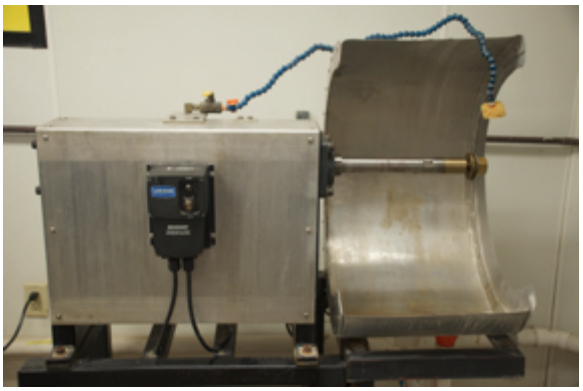
Of the three lapidary wheels, two use silicone carbide grit, the third uses diamond wheels. These wheels are used for grinding flat surfaces. Load grit into the V-Shaped trough of the grit wheels with a scraper. Make a slurry by turning the water drip on lightly and letting it flow down the trough. Too much water and all the grit will wash away, too little and the glass will just skip about on the metal surface. Grasp the glass firmly and ease it onto the wheel. The wheel will want to grab onto the glass so be careful. Move from the center of the wheel to the outer edge. Do not just rest the piece in the center of the wheel or a groove will ground into the steel and nothing will ever stand straight again. The diamond wheel uses different grit discs to achieve a polished finish. Use plenty of water, especially on the coarse disks or irreparable damage could be done to the discs and the glass. Use less water as the grits get finer or the glass can hydroplane. After four diamond discs use the leather pre-polish and the cerium pads to get a fine polish. With all wheels, turn off the water and allow them to spin dry before turning off the wheel.



There are two upright belt sanders: one with a flat plate and the other with a rounded wheel. These are used to polish rounded areas by using six sequential grit belts. Open the side door and slip the belt over the top and bottom wheels as well as the center plate/wheel. Pull the belt tight with the clamp on the upper right and turn on the machine. Adjust the tracking knob (also in the upper right) until the belt is centered. Turn the water on behind the machine—this is a wet process. Wash everything down between each belt to achieve a high polish.

The diamond saw is used to cut glass only. Plug the water pan and fill until the water is above the pump. Secure the glass on the movable tray and adjust the depth of the saw. Turn on the saw and make sure the water is flowing off the blade. Ease the glass into the blade. Cut slowly and continuously. Do not let the saw dig into the glass. It is very easy for glass to break while being cut.

The lathe is used for engraving, polishing small and interior spaces. The diamond wheels it uses are quite expensive. Allow a small consistent stream of water to fall on the wheel. Turn on the machine to a medium speed—too fast can heat up the glass and too slow will not do anything. Do not press the glass too hard on the wheel or the axle will bend.



The drill press is water fed and fitted for sintered diamond drill bits. These must be purchased by the students and are available in many sizes. Screw the bit in only hand tight—any more will damage the brass. Adjust the water to a steady stream. The larger the bit the more water will be necessary for the diamonds to cut. Place the glass securely on the platform. Apply slow, constant pressure. There will be a small dowel of glass left. Snap it off with something thin and flat, being careful not to chip the rim of the hole.

Small Dremel tools are great getting into those hard to reach places. There are numerous tips and stones available that range from diamond burs to polishing discs. Students are responsible for providing their own bits. Tulane does provide several engravers and a flex shaft Dremel. Student must wear a dust mask for all dry grinding.

The sand blaster is used to frost or carve glass. Load the glass into the chamber and close the door tightly. Turn the air valve parallel to the line. Depress the button behind the large metal compressor in the corner several times. Flip the switch on the wall to turn on the machine. The light switch for the machine is above the window. Slide into the gloves and take hold of the nozzle. Step on the foot pedal to start the flow of sand. Do not spray the window with the sand. When finished, close the air valve and drain the line by stepping on the pedal. Turn the sand blaster off and let the dust die down before removing work.

Metal Area Safety

1. Always wear eye and ear protection.
2. Wear long pants.
3. Wear only natural fibers.
4. No open-toed shoes. Leather boots are preferred.
5. Tie all hair back. No loose clothing. No jewelry.
6. Gloves should be worn when welding or handling metal. Do not wear gloves when using rotary tools.
7. No drugs or alcohol in the studio.
8. Do not operate any equipment while under the influence of drugs or alcohol.
9. Only use equipment that has been demonstrated by an instructor.
10. Clean the entire metal shop when finished. Metal dust goes everywhere so spot cleaning is insufficient.
11. ALWAYS ASK SOMEONE IF YOU ARE UNSURE OF ANYTHING OR HAVE QUESTIONS

Oxy-Acetylene Cutting

1. Cut only mild steel. Do not cut galvanized, stainless, cast iron or non-ferrous metals.
2. Always handle gas cylinders with care.
3. While standing to one side, open the main valves on the tanks. Open the acetylene three quarter turns and the oxygen fully.
4. Adjust the acetylene and oxygen regulators to a 1:6 ratio respectively. Generally a 5:30 mix adequate.
5. Open the primary oxygen valve on the torch fully. Open the acetylene valve one full turn.
6. Light the flame with a striker only.
7. Adjust the secondary oxygen valve until a neutral flame is achieved.
8. Preheat the metal until it starts to puddle. Depress handle and begin cutting.
9. When finished: close mains, bleed lines and back off regulators.

Chop Saw

1. Only cut mild steel.
2. Always clamp metal down.
3. Support full length of material.
4. Use only abrasive wheels.
5. Let blade reach maximum rpm before easing blade into the material.

Cut slowly and continually through the metal. Do not overload the machine.
6. Let blade come to a full stop before removing material.

Bench Grinder

1. Be sure all guards and shields are in place before use.
2. Ease material into the wheel. Do not let it bump and chip the wheel. Move material around so the wheel does not get grooves.

Angle Grinder

1. Clamp material to a sturdy table. Always grind in a comfortable position.
2. Position guard to deflect sparks away from user.
3. Disconnect power before replacing wheels.
4. Always use two hands to grind.
5. Grind at an angle between thirty and forty-five degrees. Do not overload machine.

Drill Press

1. Clamp material to table.
2. Adjust speed for material and drill bit size.
3. Use oil to lubricate bit as it cuts any metal.
4. Drill pilot holes for larger bits. Several pilots may be necessary.

Some Helpful Resources

Beginning Glassblowing
Edward T. Schmidt

Advanced Glassworking Techniques
Edward T. Schmidt

Glass Notes
Henry Halem

A Glassblower's Companion
Dudley F. Giberson

Glass: An Artist's Medium
Lucartha Kohler

Dictionary of Glass
Charles Bray

The Sculpture Reference
Arthur Williams

Glass Art Society
www.glassart.com

Olympic Color Rods
www.glasscolor.com

Spiral Arts
www.spiralarts.com

Steinert Industries
www.steinertindustries.com

CR Machine—Nickelite
www.crmachine.net/nickelite main

His Glassworks
www.hisglass.com

Wale Apparatus
www.waleapparatus.com

The Hub Consolidated
www.hubglass.com

Wet Dog Glass
www.wetdogglass.com

C&R Loo
www.crloo.com

Cutting Edge Products
www.cuttingedgeprdx.com

How Stuff Works
www.howstuffworks.com

White-house Books
www.whitehouse-books.com

Glossary

Air Line	Air is useful for selective cooling.
Air Marver	Technique where the glass is allowed to round up and shape itself using only gravity.
Annealer	Temperature controlled oven that allows the glass to cool down over time to relieve strain that will break glass cooled quickly.
Bench	A glass worker's bench is most commonly a steel framed chair with rails for a pipe to roll on. Generally there is a table to the side for tools and a bucket for water behind it.
Bench Blow	The process where the assistant blows into the pipe while the gaffer is working.
Bit	Any bit of glass added to a form while on the pipe.
Block	Chunks of wood, usually fruit woods, with a rounded cavity carved into it for shaping gathers.
Blow Mold	A mold of wood, plater or metal used to shape a blown form.
Blow Pipe	Hollow steel rod used to blow air into glass to create a volume.
Cane	Long, thin threads of glass used to decorate glass.
Casting	The process of pouring glass with a ladle into a mold.
Charge	Process of filling the tank with glass to be melted for use.
Cold Work	The general name for sandblasting, grinding and polishing the glass.
Color bar	Glass bars of concentrated colored glass that can be cut into smaller chunks and melted, crushed or pulled.
Color Oven	See pick-up kiln.
Cookie	A flat patty of glass dropped off a punti onto the marver.
Cork Paddle	Thick round or oval pads of cork used to softly move the glass without scarring or chilling the glass.
Crackle	Technique where a piece of glass is quickly dipped into water to crack the surface.
Cullet	Chunks of glass to be charged into the furnace.
Diamond Shear	Shears with diamond shaped indentations in the blades for cutting bits.
File	Serrated piece of metal used to score the glass for take-off.
Fire Polish	Smoothing the surface or edges of glass with heat.
Flash	A brief heat in the glory hold just long enough to keep the glass at a working temperature or to idle a piece down.
Frit	Crushed color in various sizes.
Gaffer	Generally the person in charge of a piece, not necessarily the designer.
Gather	A bit of a glass taken from the furnace as well as the process removing from the furnace.
Garage	Gas oven used to keep glass components hot for assembly later.
Glory Hole	Heated insulated drum used for reheating glass on the pipe.
Gloves	Kevlar gloves used to handle hot glass.
Jacks	Tweezer shaped tool used for necking and shaping the glass.
Kiln	See Annealer

Lehr	See Annealer
Marver	Flat steel table used for shaping glass
Moile	Any glass below the neckline on the pipe.
Newspaper	Sheets of folded newspaper moistened and used for shaping hot glass.
Paddle	Wooden boards used to shape the glass.
Pacioffis	Wooden jacks used to open vessels without scarring the glass.
Pick-up Oven	Small kiln used to preheat color or other small bits of glass for use.
Pipe Cooler	Device to cool pipes.
Pipe Warmer	Used to preheat pipes before gathering.
Powder	Finely crushed color.
Puffer	Cone shaped tool used to inflate glass after transfer.
Punti	Rod used to gather glass either for bits or solid working.
Punti Mark	Mark left by the punti after take-off.
Refractory	Any kind of heat resistant ceramic material.
Shield	Protecting the gaffer from the radiant heat of the glass while working.
Straight Shears	Straight scissors used for cutting glass.
Stripping	Draining excess glass off a gather.
Tagliol	Steel paddle use to shape glass.
Torch	Hand-held device used for spot heating of glass.
Tweezers	Pinching tool used to shape glass as well as break it off the pipe.
Yoke	A set of bearings that support the pipe and facilitate turning in the glory hole.