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Narrative and Curriculum
2015

Mission: To educate and inspire personal growth through the medium of glass art.

Statement: DMG School Project combines art, history, geology, chemistry, math, critical and creative thinking to motivate students to adopt an inclusive, symbiotic perspective toward learning and life experiences.

<u>Introduction and Qualification</u>:

DMG School Project is a unique program developed to ***create a spark*** through the kinetic modality of art, and to motivate learning in other academic fields. While multiple researchers have shown the overwhelming influence of arts education, and the NASSE / AEP 2006 joint publication *Critical Evidence: How the Arts Benefit Student Achievement, "* identified art education as a core curriculum along with math, reading and science.", funding for the arts has not kept up with other fields of study. The DMG School Project seeks to provide an alternative solution for this discrepancy.

The program provides teachers and students with the opportunity to create glass art while utilizing real world applications of history, geology, chemistry, math, critical thinking, and problem solving. The positive social experience, and exercise of creative imagination, also results in the children achieving a sense of accomplishment and elevated self esteem.

Supporting the concept initiatives of the DMG School Project's principles, the National Assembly of State Arts Agencies (NASAA), and Arts Education Partnership (AEP) reported, "Based on (research) findings, the compendium has identified six major types of benefits associated with study of the arts and student achievement: (1) Reading and Language skills; (2) Mathematics skills; (3) Thinking skills; (4) Social skills; (5) Motivation to learn; (6) Positive school environment".

The US Department of Justice; Arts Education Partnership, CAAE concluded, "Arts education has a measureable impact on at-risk youth in deterring delinquent behavior and truancy problems while increasing overall academic performance…" also, "arts education… increases test scores across every subject area, lowers dropout rates and helps close the achievement gap regardless of socio-economic status. "

Furthermore, a collaborative study by Stanford University and Cambridge Foundation For The Advancement of Teaching: 1998, concluded "young people who participate in art are: 4 times more likely to be recognized for academic achievement; 3 times more likely to be elected to class office within their school; 4 times more likely to participate in a math and science fair; 3 times more likely to win an award for school attendance; participate in youth groups nearly 4 times as frequently; read for pleasure nearly twice as often; perform community service more than 4 times as often".

Clearly the research is conclusive as to the benefits of art education and the need for art in the lives of students. The College Board, a nationally recognized leader in assessing national education standards, particularly through the SAT and ACT tests, as well as a global resource for educational trends, is urging an increased inclusion of arts as core curriculum for K-16 education. The 2010 NTFAE recommended and the College Board adopted the goals of "collaboration with policy makers and educators to promote arts for underserved students; 1) place arts at the core of education; 2) encourage student creativity; 3) integrate arts across the curriculum; 4) establish a global arts perspective; 5) support professional artists; 6) affect policy; 7) build partnerships."

Partnerships are a solution that not only the NTFAE recommended but also the United Nations task force. In 2009, a UNESCO project in conjunction with Australia Council of The Arts and International Federation of Arts Councils and Cultural Agencies (IFACCA), published *The WOW Factor: Global research compendium on the impact of the arts in education.* The international researchers reported, "Quality art education tends to be characterized by a strong partnership between the schools and outside arts and community organizations. In other words it is teachers, artists and communities, which together share the responsibility for the delivery of the programmes." This is the position that DMG School Project is poised to fill. Years of success under the leadership of nationally renowned glass artist Duncan McClellan, and partnerships with government, non-profit and private sector organizations, gives DMG School Project the ability to create the opportunity for ***the spark*** that will ignite education and social change for our youth.

Course Description:

- Students are introduced to a **history** of western civilization from the perspective of the many roles that glass has served from the Stone Age to modern times. Instruction includes, but is not limited to; glass as a rare and valued commodity; glass representing social and political status; glass in the use and promotion of religious ritual; glass as an economic development tool; glass' evolution as relative to the industrial revolution; and glass as a form of artistic expression.
- Instruction will also include the study of **geology, geography**, and scientific experimentation relative to the advancement of the utilitarian development of glass. Students will be introduced to concepts of **chemistry** and compounding that affect the production, quality, and color of glass.
- Students will be instructed in **mathematical** formulas used during the production of glass blowing as well as the **economics** of present day production costs and fair market pricing.
- Instructors will discuss the symbiotic relationship that exists between all of the fields of study, and students will be asked to analyze the facts using **critical thinking** skills.

- The final activity will require an understanding of the material presented and the task of **creatively** translating that information into visual imagery that will be designed and etched onto a glass object.

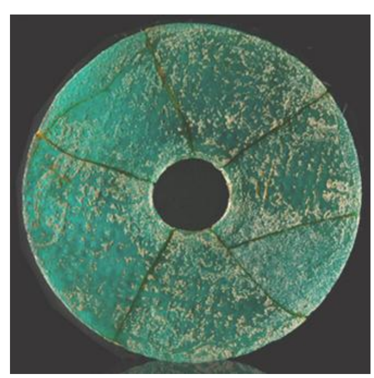
Educational goals:

Students will explore the symbiotic relationships of history, geology, chemistry, math, culture, and art as they relate to the discovery and production of glass. Through the introduction to these disciplines, students will be encouraged to view other portions of their school curriculum from a new paradigm of critical and creative thinking. At the conclusion of the workshop, students will create a visual representation of their insights that will reinforce the experience in a personal and tangible manner.

Curriculum:

History: The exact details surrounding the discovery of glass formed by sand, minerals and fire is uncertain. The most common belief is that approximately 5000 BCE in the region of present day Syria (Map B), blocks of nitrate, used to support cooking pots, melted and fused with the sand on the ground. Later, the molten liquid was formed into functional glass objects by wrapping it around a core to create vessels. As centuries passed the craft spread to Egypt, China, Greece and elsewhere. By the Early Bronze Age, 3500 BCE, Egyptians were using glass for decorative beads. These glass beads are the oldest archeological discoveries. (Map B)

Glass remained a luxury material, and the disasters that overtook Late Bronze Age civilizations seem to have brought glass-making to a halt. It picked up again in its former sites, in Syria and Cyprus, in the 9th century BCE, when the techniques for making colorless glass were discovered. The first glassmaking "manual" dates back to 650 BCE.

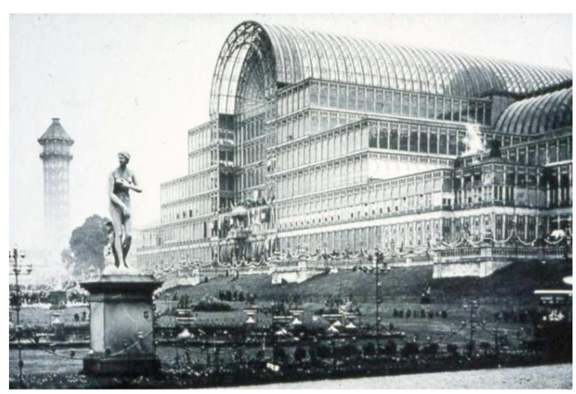


Indigenous development of glass technology in South Asia (Map C) may have begun in 1730 BCE. These shapes could be categorized into containers, decorative objects, decorative weaponry, seals, personal accessories and everyday glass objects. By the 1st century CE, glass was being used for ornaments and casing in South Asia. Contact with Mediterranean cultures introduced newer techniques, and India's* artisans mastered several techniques of glass molding, decorating and coloring by the succeeding centuries. In China the earliest archaeological evidence for glass manufacture comes from the late Zhou Dynasty (1046 BCE to 221 BCE). The glasses from this period contain high levels of barium oxide (BaO) and lead, distinguishing them from the soda-lime-silica glasses of Western Asia and Mesopotamia.*

Glass blowing appears to have developed in 100 BCE in the Syrian region of the Roman Empire(Map C). Glass craftsmen used metal tubes to blow air pockets into hot glass. They then expanded the glass into molds to form vessels of multiple shapes and sizes. This innovation distinguished Roman/ Italian glass makers as masters of the craft for centuries to come. Roman's domination of the Western world meant they also dominated the glass production and distribution.

Italy guarded its control of glass and in the Middle Ages, 5 - 15th century, Venice was the center of glass production, with over 8,000 glass artisans in the city. Laws were passed to guard the secrets of glass making until, in 1291, glass blowers and their shops were moved to the island of Murano (Map D). This was in part to protect Rome from accidental fires, and to guard the secrets of the art. Glass makers were threatened with death if their knowledge or skills were shared outside of Murano.

Eventually, glass blowing spread from other regions and became more common in daily life throughout Europe and Asia. Glass in the Anglo-Saxon period was used in the manufacture of a range of objects including vessels, beads, windows, and was even used as jewelry. In the 5th century CE with the Roman departure from Britain, there were also considerable changes in the usage of glass. From the late 7th century onwards, window glass is found more frequently. This is directly related to the introduction of Christianity and the construction of churches and monasteries. Each piece was still handmade and a luxury of the wealthier class.



With the rise of innovation and the Industrial Revolution the glass industry changed forever. An Englishman opened a company in Pittsburgh, Pennsylvania in 1808. His company made optical glass which contained a trace of lead. By 1820 another family member developed a system to press glass into a mould and produce inexpensive, nearly identical pieces. Mast production had begun with this Carnival Glass, and it became affordable to the masses. The use of glass as a building material was highlighted in London with the construction of The Crystal Palace in 1851.

Also in England, the mass production of glass was developed in 1887, while in America the first bottle blowing machine was invented at the end of the century through the efforts of Michael Owens and the Libbey Glass Company. These inventions marked the decline in handmade glass worldwide.

It wasn't until 1962 that a ceramics professor in collaboration with an engineer developed a small furnace that was compact and safe enough to use in an art studio setting. This invention has lead to the resurgence of glass as an art form and the creation of glass art schools.

The history of glass from a volcanic byproduct tools in the Stone Age, to adornment for the elite and wealthy, to a common inexpensive consumer product, and finally to the beautiful and inspirational art form of today, speaks of our connection to the earth, and is integrally woven in the history of humanity.

Geology:

The first archaeological evidence of volcanic glass, obsidian, was used by many Stone Age societies across the globe for the production of sharp cutting tools. Due to its limited source areas, it was extensively traded between cultures. Earliest discoveries of known usage were made from within present day Kenya and other African-Asia sites dating from 1.5 million years ago to 700,000 BC. (Map A)

During the 1st century BCE, white silica sand from the Syro-Judean area was used in the production of glass within the Roman Empire due to its high purity levels, revolutionizing the industry. With the discovery of clear glass (through the introduction of manganese dioxide), by glass blowers in Alexandria, Egypt, circa 100 CE, the Romans began to use glass for architectural purposes.

Following is a partial list of compounds used in glass, the colors they create, the scientific symbol and the raw material from which they are derived. Additional information is included that demonstrates the natural/ raw form of the metals and minerals.

Minerals Used	Color of Glass	Chemical Symbol	Mineral Source
Cadmium Sulfide	Yellow	CdS	Greenokite or Hawleyite
Gold Chloride	Red	AuCl	Gold and Chlorine gas
Cobalt Oxide	Blue	CoO	Cobalt, by product of Copper and Nickel mining

Manganese Dioxide	Purple	MnO_2	Pyrolusite
Nickel Oxide	Violet	NiO	Nickel from meteorite, Busenite
Sulfur	Yellow-Amber	S	Sulfur from volcanoes
Chromic Oxide	Emerald Green	CrO_3	Chromium
Uranium Oxide	Fluorescent Yellow, Green	UO	Uraninite, Coffinite, Brannerite, Davidite, Thucholite
Iron Oxide	Greens and Browns	FeO	Iron Ore (Rust)
Selenium Oxide	Reds	SeO	Selinium or byproduct of copper mining
Carbon Oxides	Amber Brown	CO	Coal
Antimony Oxides	White	Sb	Sulfide Mineral Stibnite
Copper Compounds	Blue, Green, Red	Cu	Copper ore
Tin Compounds	White	Sn	Cassiterite
Lead Compounds	Yellow	Pb	Lead Ore
Manganese Dioxide	A" decoloring" agent	MnO_2	Manganese is found in combination with iron
Sodium Nitrate	A "decoloring" agent	$NaNO_3$	Nitratine, Nitratite or Soda Niter

Some of these compounds may be familiar to students as current news and ecological impact discussions subjects.

** Raw state of minerals and metals used as glass colorants

Greenokite or Hawleyite Yellow - Cadmium Sulfide - CdS

Gold Red- Gold Chloride - AuCl

Cobalt (byproduct of Copper and Nickel mining) Blue - Cobalt Oxide - CoO

Pyrolusite Purple - Manganese Dioxide - MnO_2

Nickel from meteorite, Busenite Violet - Nickel Oxide - NiO

Sulfur from volcanoes Yellow/ Amber – Sulfur - S

Chromium Emerald Green - Chromic Oxide - CrO_3

Uraninite, Coffinite, Brannerite, Davidite, Thucholite   Fluorescent Yellow, Green -Uranium Oxide-UO

Iron Ore (Rust)   Greens and Browns - Iron Oxide - FeO

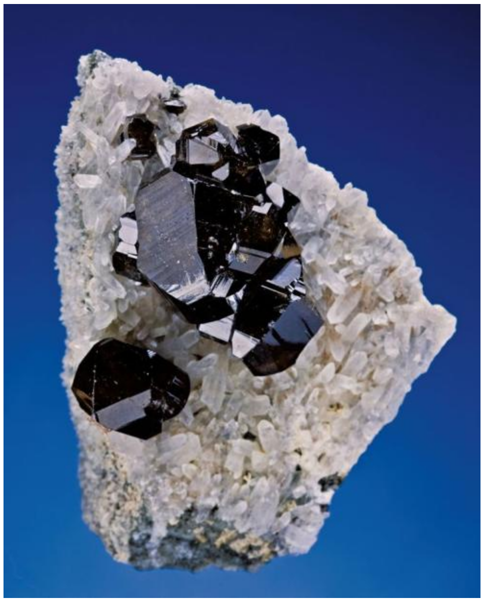
Selinium, or as a byproduct of copper mining   Reds - Selenium Oxide - SeO

Coal   Amber Brown - Carbon Oxides - CO

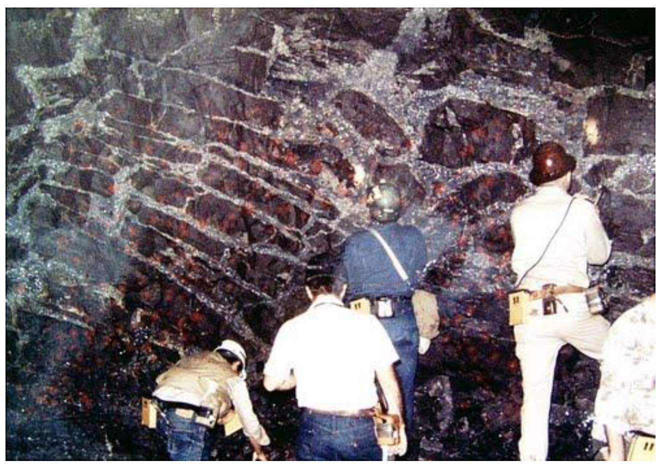

Sulfide Mineral Stibnite   White- Antimony Oxides - SbO

Copper ore   Blue, Green, Red - Copper Compounds - Cu

Cassiterite White - Tin Compounds - Sn

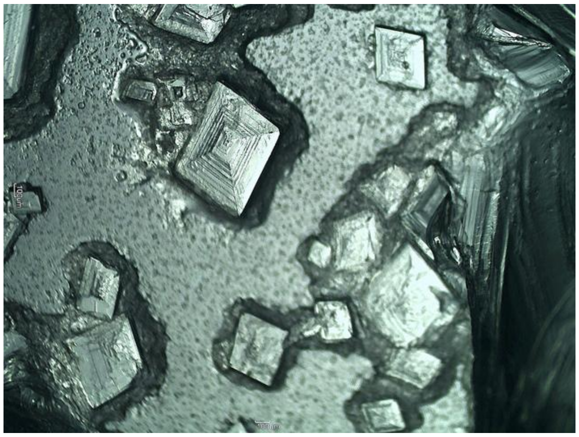


Lead Ore Yellow - Lead Compounds -Pb



Manganese(found in combination with iron) A" decoloring" agent- Manganese Dioxide-MnO_2

Nitratine, Nitratite, or Soda Niter A “decoloring” agent - Sodium Nitrate - $NaNO_3$



Chemistry:

Silica or silicon dioxide, sand, is the main ingredient in glass. While the discovery of glass was probably accidental, to make a suitable glass batch, recipes have been developed over the centuries to produce various qualities for different glass making methods. Like recipes for baking, flour may be the main ingredient, but the other additives are what make the difference between brownies or a cake.

The base for glassblowing is approximately 72% silica. In America the purest silica is mined in Pennsylvania, West Virginia and the Mississippi Valley. Fluxes are added to reduce the melting temperature of the sand from 3110* to 2450* and give it a workable consistency.

Soda ash (Na_2O) , 14.9% soda will lower the melting point of silica, but that also makes the solution water-soluble. The other ingredient needed to stabilize the mixture is lime (CaO calcium oxide) in the form of limestone, dolomite, or whiting. The alkali component of Syrian and Egyptian glass was soda ash, sodium carbonate, which can be extracted from the ashes of many plants including saltwort a seashore plants.

A sample recipe may look like:

Silica SiO_2	72%
Soda NaO_2	14.9%
Lime CaO	7.9%
Subtotal	94.8 %

The additional 5.2% of trace ingredients that make the mixture more stable, workable, durable and colorful are determined by the colorants and chemical reaction between the elements. Each ingredient in the batch has a chemical reaction with all of the other ingredients, the temperature, and the humidity in the air. Too much or too little will change the intended color, cause the glass to not set up fast enough, set up too fast, crack when cooling or sometimes to explode.

Commonly used compounds include:

Alumina (Al_2O_3) is added (1.8 % of the total recipe) to increase chemical durability of the glass. Alumina is derived from the natural source of corundum which is the mineral in mica, rubies and sapphires.

Feldspar (KNaO Al_2O_3 SiO_2) (0.4% of the total recipe) is another compound that adds alkalis in the compositions of calcium oxide, potassium oxide, and sodium oxide which also act as flux to lower the melting temperature of silica-soda-lime base.

Lithia (Li_2O), (1% of the total recipe) is a powerful flux that softens the glass, decreases viscosity and lowers the melting temperature. Lithium melts at 180*and is the only metal that can float.

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Barium Oxide ($BaCO_3$), (0.5% of the total recipe) lowers the melting temperature, decreases the tendency toward the formation of crystals within the glass, and produces a higher refractive index (how much light is bent when it enters the glass). Barium is toxic. Because of its high chemical reactivity barium is never found in nature as a free element.

Zinc Oxide (ZnO), (1% of the total recipe) is added to increase the brilliance of the glass. It works well with colors, extends the working time and reduces the formation of crystals (devitrification).

When the glass batch is heated to the melting point of 2450* it becomes full of air bubbles. These can cause problems when working with the glass so a fining agent is added to bind with the bubbles and dissolve or cause them to rise to the surface.

Arsenic (As_2O_3), and **Antimony** (Sb_2O_3) , (0.2% of the total recipe) are the two most common.

A small quantity is needed however they must be handled with great caution because they are both highly toxic.

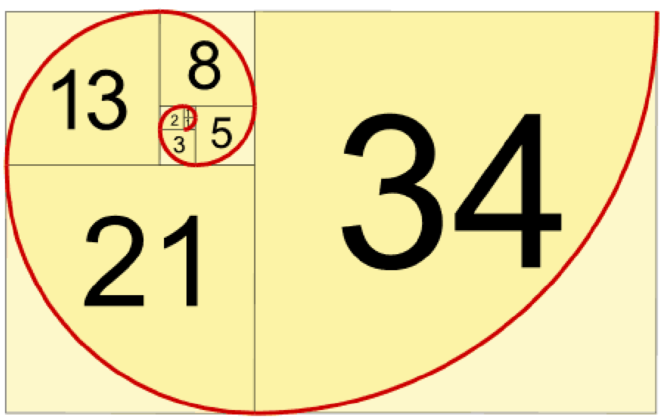
Most sources of silica have some mineral or organic impurities in them that cause the melted glass to have a tint of color. To remove all color, **Manganese dioxide** (MnO_2) is added to the mix.

This produces a clear glass which was very highly valued for centuries. With the development of clarity by glass blowers in Alexandria, Egypt, circa 100 CE, the Romans began to use glass for architectural purposes.

In China during the Han period (206 BC to 220 AD) the use of glass diversified. The glass from this period contains high levels of barium oxide (BaO) and lead, distinguishing them from the soda-lime-silica glasses of Western Asia and Mesopotamia. Each region developed formulas based on the available geology. Through discovery and experimentation each culture created its signature glass formulas and glass forms.

Math:

Mathematics is essential to glass making. When creating the molten glass precise math calculations are required to translating the percentages of each ingredient needed into specific quantities. Other mathematical formulas relative to density, mass, volume, circumference, and radius are essential. Equally important is an understanding of the Fibonacci Sequence



as this helps calculate the rate of cooling of the glass after an item is created. Cooling too quickly or too slowly will destroy the final form.

Economics:

The basic ingredients of glass are plentiful in the earth's crust and therefore not expensive. However, the additives, oxides, and sulfides can be quite rare, expensive to produce, dangerous to handle, and increase the cost of glass items substantially. Few glassworkers make their own colorants as it takes time, money, space, an extensive knowledge of glass chemistry and involves serious health risks.

Most glassmakers purchase pre-manufactured colorant to add to the clear glass mixtures they make in their own furnaces. These colorants came in a wide variety of transparent and opaque colors. The colors come in rods, frits (small chunks) or powder form.

Ultimately the price of glass art is dictated by the cost to produce it. Economics and business management rules apply to glass production as much as any other free enterprise undertaking. The raw materials, specific additives, cost of the furnace, fuel, tools, building, utilities, taxes, salaries, marketing, phone, computer, bank charges, accountant & legal fees, government licensing, and a profit must all be included in the consumer pricing of each glass object. Math accuracy plays an important role in the successful creation of glass, and the success of a livelihood built on glass art.

Critical Thinking:

Students will be assigned the task of analyzing the relationships of the data presented in the lesson. The relationships between historical, political, geographical, chemical, mathematical, and financial aspects of glass will highlight inter-dependency as well as influence of each subject. Discussion prompters may be developed by individual teachers as they deem relative to the educational level and focus of their individual classrooms.

Creative Thinking:

Each student will be provided with an eight inch, round, clear glass plate. Adhesive blasting resistant material and necessary tools are also provided by DMG School Project. Students explore the process of translating their experience to a visual format. Including elements of the lesson with their personal understanding and interpretation, student create imagery on the glass plate that will express their knowledge of the material presented.

Each student is asked to develop an artist statement and presentation statement relating to their creation. (Why they chose the images or shapes that they did; how the images relate to each other; what the images mean to them; what was the main message/theme they tried to convey). These will be presented to the class as part of the DMG Gallery and HotShop experience.

These personal creations will be property of the students after the DMG School Project is completed.

Time Allotment & Scheduling:

Teachers are provided with the curriculum, materials and instruction by experienced DMG School Project employees. The curriculum is presented as (a minimum) two lessons, by the teacher, in their classroom. The lessons may be modified for students from ages of 6-18. The teacher may choose to highlight a specific area of interest with added instruction as pertains to their individual area of study. During the creative process, younger children may use pre-cut shapes while the older students have the option to draw and cut their own images.

The third class of the program is conducted as a field trip to the Hot Shop and Duncan McClellan Galley. Students are given an educational tour that includes a comparison of disciplines as well as a review of the historical, scientific and economic aspects of the glass process. A glass blowing demonstration provides the visually engaging and creative excitement of leaning how heat, gravity, team work, and a variety of chemical compounds combine to produce a complex colorful object.

Finally, the students' are given the opportunity to personally sandblast their plates. While at the HotShop, students are encouraged to engage in discussion of all aspects of the lesson with artist Duncan McClellan and the glass artist on premises. Discussion points may be developed by the teacher and students prior to the fieldtrip. As students complete their sand etching portion of the tour, they will be asked to present their finished product and creative statement to the class.

Results:

This program has been well received by schools and the community serving 1500 children in 2014. DMG School Project Board of Directors, Advisors, employees, volunteers and interns believe in the benefits that this program provides to individual children and to the long-term health of our community.

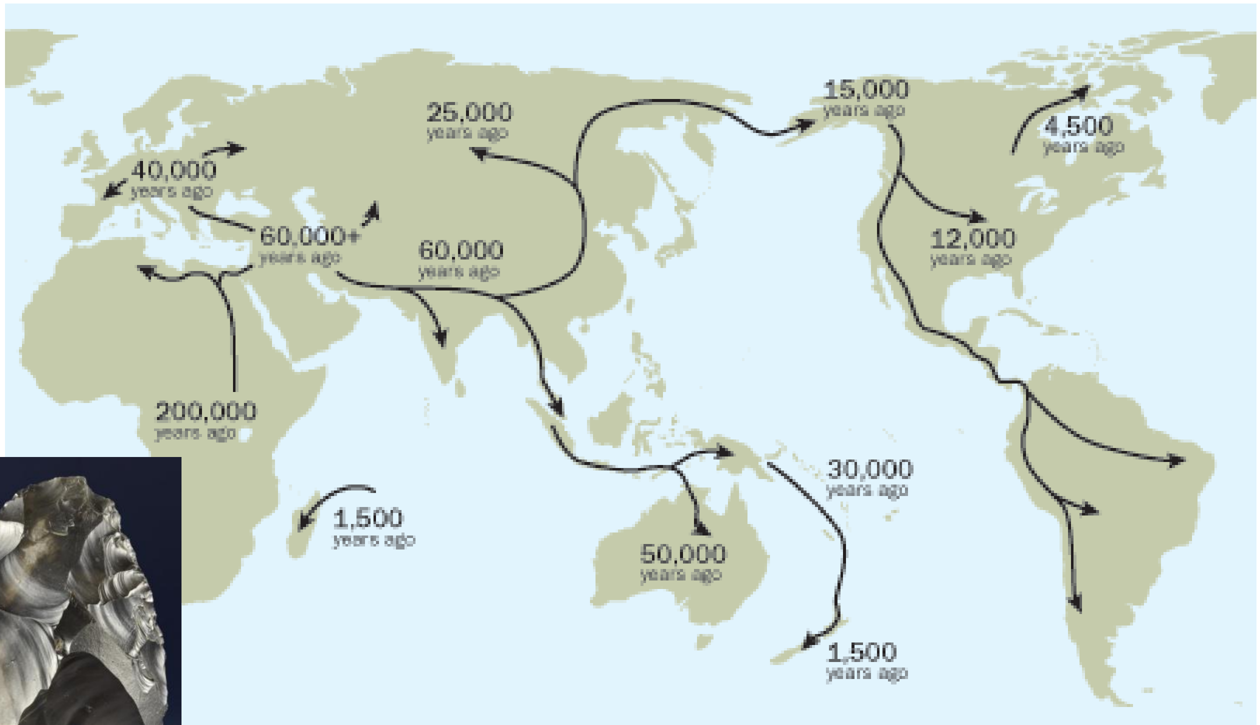
A recent review by an elementary school teacher states, 3/1/2015, "We went yesterday for an elementary school art club field trip and had a wonderful time. …They definitely had all of the kids and parents enthralled. Very cool to see and highly recommended. Lastly, the kids got to sand blow the glass plates they prepared with their art club. It was neat to see their art evolve and to see the looks on their faces. I would highly recommend a visit to Duncan's studio and hot shop. All of the art was beautiful and the staff was phenomenal. …we will definitely be back."

Partners:

In addition to the Pinellas County Schools in-school programs, DMG School Project has also partnered with CURRENT (501c3) to bring our program, via a mobile unit, to homeless shelters and inner-city youth at laundromats to reach the most vulnerable children of our community. We have also partnered with Creative Clay and PARC to serve developmental challenged youth. "Arts education makes a tremendous impact on the developmental growth of every child and has been proven to help level the "learning field" across socio-economic boundaries. " (Youth ARTS Development Project, 1996, U.S. Department of Justice; Arts Education Partnership, CAAE).

Maps:

(A) Man's Migration across the globe BCE

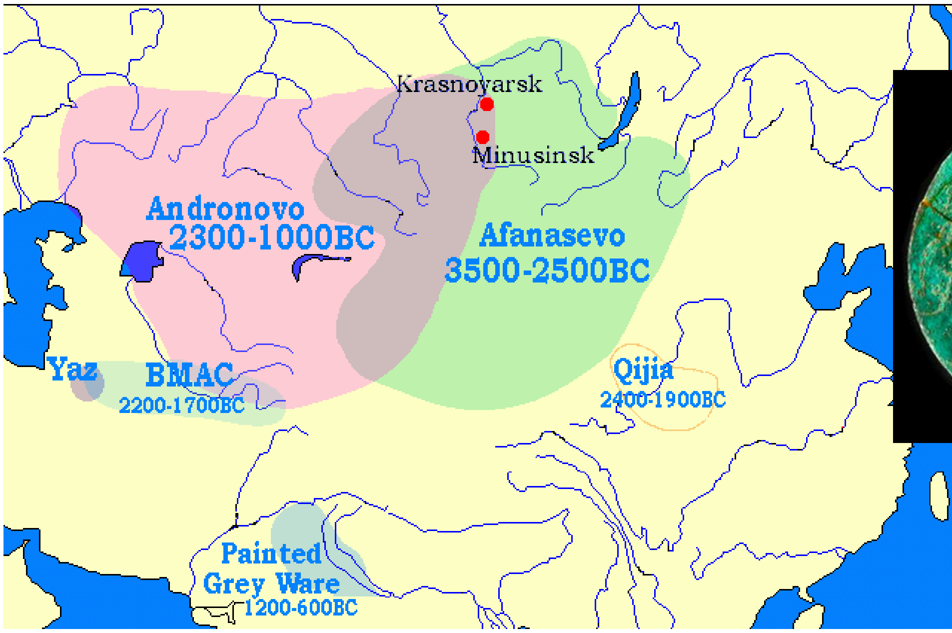


Obsidian, volcanic glass tool

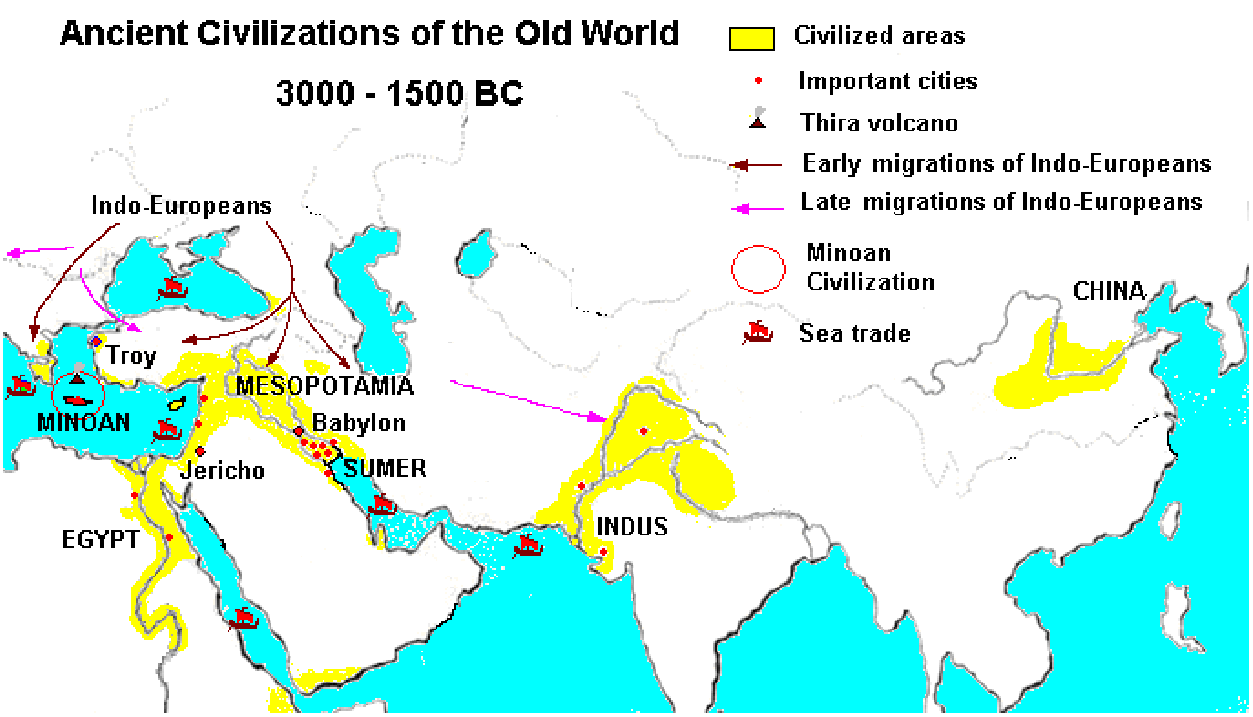
(B) Mid-Eastern Civilizations 5,000 BCE

Egyptian glass beads

(C) Asian Civilizations 3500-1000 BCE



Ancient Chinese bead



(C) Roman Empire

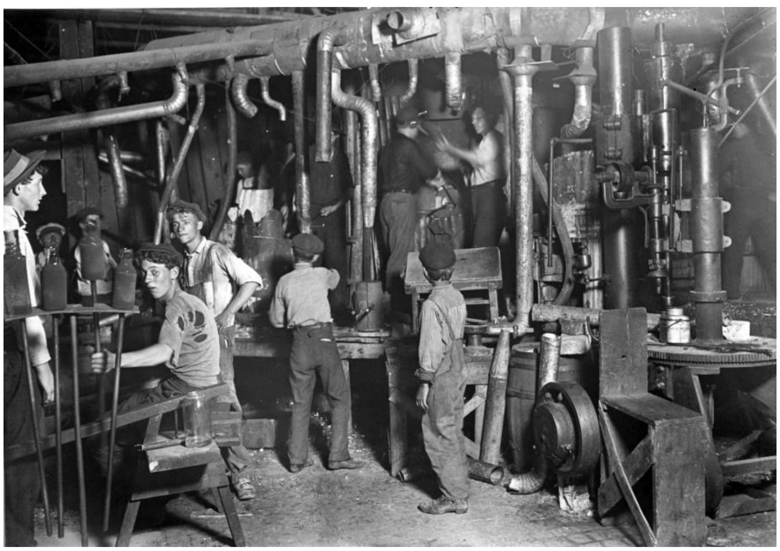
Early Roman Cup

(D) Medieval Europe

Murano Glass, Venice, Italy

St. Mary's Church

Indusrtial Revolution, glass making in America, 1880-1920



Student Tour Questionnaire

To maximize the DMG Gallery Tour and Hot Glass experience, please review this questionnaire prior to your arrival. Bring this with you to comlete your tour and demonstration.

Students:

When & where did people start using glass as a tool? ____

When & where did people start using glass as jewelry ? _____________________________ _________

What is the main ingredient in glass ? ____

What makes glass blue ? ____

What makes glass neon green ? ____

Where is the island that was the center of glass making in Medieval Europe? ______________________

Where is the Crystal Palace? ____

Why is math so important to glass making? ____

When and why did glass become an inexpensive common product? _____________________________

When did glass become a material for creating fine art? _______________________________________

Name your favorite glass art object at Duncan McClellan Gallery. ________________________________

Why is it your favorite? ____

Draw a picture of something you would like to see one of the DMG artists make with glass.

What questions do you want to ask the artists at the St. Pete HotShop?

1) ____

2) ____

3) ____

What was your favorite part of this DMG School Project experience?

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