BORN BY FIRE: THE MYSTERIES OF GLASSMAKING
FOR BLUE ANT MEDIA
FINAL SCRIPT – AUGUST 5, 2019
WRITER/STORY EDITOR/RESEARCHER: CHRISTINE ALEXIOU

INTRO:

THE ART OF GLASS MAKING IS THOUSANDS OF YEARS OLD.

ON THE ONE HAND THE PROCESS IS SIMPLE...

MIX SAND WITH EXTREME HEAT...THEN ADD AIR TO CREATE UNIMAGINABLE WORKS OF ART.

BUT THROUGHOUT HISTORY, THE FORMULAS AND TECHNIQUES TO CREATE WITH GLASS WERE REGARDED AS TOP SECRET.

GLASS MAKING HAS IMPACTED ECONOMICS, ESPIONAGE AND SCIENCE.

ARTISANS HAVE CONSTANTLY PUSHED THE LIMITS OF THE PROCESS -- WHICH IS WHY TODAY GLASS CAN BE FOUND ALL AROUND US...EVEN UP IN SPACE.

THIS IS THE STORY OF GLASSMAKING FROM INCEPTION TO PRESENT DAY.

THIS IS BORN BY FIRE: THE MYSTERIES OF GLASSMAKING

ACT 1:

Hi guys, let's get started...I just want to go through what we're going to be making today...so everybody is pulling for the same goal.

NARRATOR: GLASS IS OLDER THAN CONCRETE, OLDER THAN IRON, OLDER THAN STEEL YET IT FEELS TIMELESS. FORGED IN THE PAST, IT CONTINUES TO EVOLVE.

ROB CASSETTI: And yet it's the most modern thing you think of when you think of a contemporary building. It's this incredible interface on display devices. It's the enabling technology of the Internet. It's a story that reveals itself at a technological level and an artistic level. And interestingly enough they're almost completely interwoven.

I'm just setting up the cane pole...which is a design elements

NARRATOR: GLASSMAKING HAS AN ENDURING MYSTIQUE THAT'S ENVELOPED IN THE SKILLS AND CRAFT THAT ARE INTEGRAL TO THE PROCESS.

NARRATOR: CORNING, NEW YORK IS ONE OF THE KEY CENTRES OF THE GLASS INDUSTRY AND GLASS HISTORY IN THE UNITED STATES.

ERIK MEEK: If you brought a Roman glassmaker here from 2000 years ago they'd know how to make glass in our studio today. The techniques have changed very little. We see students come through all the time and they're inspired by that history.

MALE STUDENT – When you walk through a glass studio it's hot. People are working together, they're playing loud music. When you first start working with the material you pretty much know whether it's for you or if it's not for you.

FEMALE STUDENT: It's a lot of hard work but everyone who is involved with it is so incredibly dedicated.

The best thing you can do...when you've made a fresh gather...core there

FEMALE STUDENT: Glass blowing is a lot like theater it's a lot like improv too, you have to take each other's cues and you're listening. If someone drops a beat someone can be right there to help you out.

MALE STUDENT - It's a constant change. We're reacting we're moving. It's very physical. And then of course there's fire…everything's better with fire.

NARRATOR: GLASS IS MADE BY HEATING ORDINARY SAND TO THE INCREDIBLE TEMPERATURES OF OVER 1400 DEGREES CELSIUS OR 2500 FARENHEIT UNTIL IT MELTS.

NANCY CALLAN – ARTIST - It's magical...You're working with the material that goes from liquid to solid. Back to kind of liquid again and then back into solid. And you can keep reworking it and until you get the effect that you want. And it's kind of like you can stop time.

NARRATOR: AS THE MOLTEN SAND COOLS, IT UNDERGOES A COMPLETE TRANSFORMATION INTO...GLASS. THE ONLY MATERIAL IN THE WORLD THAT ACTS LIKE A SOLID YET KEEPS THE STRUCTURE OF A LIQUID.

MIKE SOUSA - SCIENTIFIC GLASS BLOWER - Everybody else has nailed a piece of wood, screwed in a piece of metal, manipulated almost every material you can think of. But glass is kind of a rarity for people to handle.

ERIK MEEK: It’s really important as a glassmaker today to really focus on technique and to focus on those traditions and to make the next generation of glassmakers know the proper way to approach the material.

TOC: TYRE, LEBANON

NARRATOR: GLASSMAKERS’ MANIPULATION OF FIRE EVOLVED OVER HUNDREDS OF YEARS BUT VERY LITTLE IS KNOWN ABOUT THE FIRST ATTEMPTS TO MAKE GLASS.

ONE POPULAR MYTH TAKES US BACK THOUSANDS OF YEARS. ACCORDING TO THE ROMAN HISTORIAN PLINY THE ELDER - PHOENICIAN SAILORS DISCOVERED THE MIRACLE MATERIAL BY ACCIDENT.

NARRATOR: DR ALI KALIN IS AN ARCHAEOLOGIST WITH LEBANON'S MINISTRY OF CULTURE. HE’STUDIED THE EXTENSIVE RUINS OF ANCIENT TYRE - A MAJOR PHOENICIAN SEAPORT THAT BECAME PART OF THE ROMAN EMPIRE.

DR ALI: There is a legend about discovering the glass itself, the production of the They say they say two Phoenician sailors at the Belus River which is today called Anorman and is next to the city of Arc in Palestine. They were with their ship, next to the river there and they wanted to fire or to cook something for themselves. The sand was too much soft and they didn’t find any kind of stones to put their cooking pottery on it, so they used these soda stones and they, So they used some stones of soda to put their pots on it and they fire it and they fired these cooking pots and after a while they discovered...the result of this firing thing, they have a very nice liquid, then it became like a solid material, transparent, translucent and that was due to the fire, to the soda and to the sand that was in the river.

NARRATOR: IT’S AN ENTERTAINING STORY BUT THE REALITY MIGHT NOT BE QUITE AS DRAMATIC...

KOEN VANDERSTUKKEN: There have been experiments to see whether it is indeed possible to have a beach fire that would be high and hot enough to melt the glass and it’s highly questionable that that would be the case. So the idea now that glass would either come from the ceramic industry or from the metal industry.

NARRATOR: BUT NO MATTER THE FACTS OF ITS ORIGIN, GLASS HAD A MAGICAL REPUTATION...

KOEN VANDERSTUKKEN: I guess it has to do with one the mystery of glass like especially in the old days people were not aware of how it was made and it was very mysterious. On the other hand there's also of course the glass makers themselves they've benefited from keeping everything magical because

of course it would help them to build up their prestige and it would be like giving more value to their product.

NARRATOR: TYRE, LOCATED IN THE SOUTH OF MODERN DAY LEBANON, BECAME RENOWED AS ONE OF ANCIENT ROME'S MAJOR GLASSMAKING CENTRES. IT PRODUCED HIGH QUALITY GLASS THAT WAS SOLD ALL OVER THE EMPIRE.

DR. ALI – This is the furnaces that produce the fine quality of glass... They used to put all their material here...After they fire the material...it became like one block....they have to destroy the tanks and the furnace...building and destroying...You can see here in these walls the remains of the glass material that had produced...

NARRATOR: DURING THE EARLY DAYS OF GLASSMAKING - ITS VALUE WAS ON PAR WITH IVORY, PRECIOUS JEWELS, AND GOLD.

ROB CASSETTI: Essentially it was a luxury commodity. This beautiful thing...the material of kings and queens.

NARRATOR: GLASSMAKING AND CARVING WAS TIME CONSUMING AND DIFFICULT AND SOON MAKERS DURING THE FIRST CENTURY B.C. BEGAN TO PUSH THE LIMITS OF THE MAGICAL MATERIAL…AND THEY INTRODUCED AIR INTO THE EQUATION.

KAROL WIGHT: The discovery that you could inflate glass, you could insert air, a bubble into this viscous material and it would expand.

NARRATOR: THE BLOW PIPE ALLOWED THE ARTISAN TO REACH INSIDE THE BLAZING HOT FURNACE AND GATHER A LAYER OF MOLTEN GLASS WITH ONE END AND BLOW INTO THE OTHER.

KAROL WIGHT: And that revolutionized glass making because suddenly instead of using laborious time consuming, expensive techniques you could inflate glass, shape it to your will.

NARRATOR: GLASS BLOWING AS A TECHNIQUE WOULD NOW MAKE GLASSWARE AVAILABLE TO THE MASSES.

NARRATOR: **AND THAT IN TURN WOULD ALTER THE PROFESSION OF GLASSMAKERS FOREVER...**

ACT 2:

NARRATOR: GLASS MAKING IS AN ANCIENT ART FORM THAT IMPACTED THE GROWTH OF CIVILIZATION AND CONTINUES TO REVOLUTIONIZE OUR PRESENT-DAY WORLD.

NARRATOR: THE PHOENCIAN CITY OF TYRE – NOW IN MODERN DAY LEBANON - WAS A MAJOR GLASSMAKING CENTRE IN THE ROMAN EMPIRE. TO THIS DAY, REMNANTS OF 2000 YEAR-OLD GLASS REMAIN.

DR. ALI - And actually they kept this the production as the secret...It was a center because of the accumulation of tradition and the skills that was here and of the existing of the raw material of the sand rich in silica that is available in the area.

NARRATOR: IT WAS VERY LIKELY IN THIS REGION THAT GLASSMAKERS INVENTED GLASSBLOWING AND CHANGED THE WORLD AS WE KNOW IT.

Dr. Ali - So this is the material that is the final production and this is the material that they send for the shops to again develop it by blowing it, or casting it or any other technique.

NARRATOR: ONCE GLASS BLOWING WAS INVENTED, THE NUMBERS OF WORKSHOPS MULTIPLIED. EVERYONE WANTED A PIECE OF THE BUSINESS.

KOEN INVU – Now all of a sudden it became a mass production...they made about a hundred million pieces a year which is a lot. And it became accessible to most people. There's indications that soldiers even were carrying glasses to drink from.

NARRATOR: NEAR TYRE, IN SARAFAND, A SMALL COASTAL TOWN IN THE SOUTHERN END OF THE COUNTRY, THE LAST LIVING EXAMPLE OF THOSE ROMAN STYLE GLASS WORKSHOPS IS STILL RUNNING.

NARRATOR: THE KALIFEH FAMILY HAVE BEEN HAND-BLOWING GLASSWARE FOR WELL OVER A CENTURY.

TRANSLATION –

The craft existed since the Phoenicians. And it passed on from one person to another to our ancestors, to us.
It reached my father, my father taught me, and hopefully we'll teach this new generation because it's a very beautiful craft.

NARRATOR: IT CAN TAKE UP TO TWO DAYS TO GET THE FURNACE HOT ENOUGH TO MAKE GLASS. IT COSTS SEVERAL HUNDRED DOLLARS PER DAY TO KEEP THE FURNACE RUNNING – SO WHEN THE ORDERS COME IN THE FAMILY MEMBERS MUST WORK AROUND THE CLOCK.

Translation – *In the past we walk around the neighbourhood. Whenever we found a bottle, we break it, clean it.*

NARRATOR: THE KHALIFEH FAMILY IS INVOLVED IN THE PRODUCTION OF A LINE OF PRODUCTS MADE FROM RECYCLED GLASS, USING CAST OFF GREEN AND AMBER BOTTLES.

Translation: Now we have a truck like this one you see there. We have two factories in that put glass aside... And there are people that bring glass for us.

NARRATOR: MAHMOUD AND ALI USE TECHNIQUES PASSED DOWN FROM ANCIENT TIMES – INCLUDING RECYCLING EXISTING GLASS FOR A MORE SUPERIOR, MORE SUSTAINABLE PRODUCT.

KOEN INVU – Re-melting glass is something that has happened since as long as they've been making glass and it's even now today still like most companies will add already melted glass to their batch to their composition because it will help to speed up the process and to get a glass that is clean.

TRANSLATION:

It is a very beautiful craft to preserve, we must preserve it because it's unique.
We're the only ones that do it.
It's important because it's nowhere else in all Lebanon.
It is a beautiful craft we must teach this new upcoming generation.

Though it's very difficult, it's still a beautiful craft.
And hopefully this generation will learn it like how we did.

This one's done. Look at it.
To your taste?

NARRATOR: THE KHALIFEHS OFFER US A GLIMPSE INTO HOW POPULAR HANDMADE GLASS WAS BECOMING FOR THE ORDINARY PERSON DURING THE ROMAN EMPIRE...

KALIFEH CUSTOMER IN LEBANON – The first communion of my two children, is an occasion we give gifts bag to the people visiting people. So I have to buy something new, something nice, very special. Here it's handmade, I choose these for Holy water and essence.

NARRATOR: BUT WITH GLASSWARE BECOMING SO MUCH MORE AFFORDABLE AND AVAILABLE - THE MAGIC SHIFTED FROM THE MATERIAL TO THE MAKER.

KOEN INVU - If you could make a piece that nobody else could make because it's so complex and so beautiful then of course that would increase the value because now they had to like they couldn't rely on the value of glass anymore because that ship has sailed.

KOEN: That's why the Romans started inventing all these new techniques like...So there's all these new ways of decorating and coloring the glass that made it very interesting and new and spectacular and something that not too many people were able to do unless they found out the secret

NARRATOR: THERE IS VERY LITTLE INFORMATION OF WHO THESE EARLY GLASS MAKERS WERE – BUT THERE ARE A FEW EXCEPTIONS.

KAROL WIGHT – ...and one of them is a man named Ennion.

NARRATOR: ENNION IS KNOWN AS ONE OF THE MOST PROMINENT AND INNOVATIVE GLASSWORKERS OF ANCIENT ROME. IT'S BELIEVED THAT HE LIVED AND WORKED IN THE CITY OF SIDON IN ROMAN PHOENICIA.

KAROL WIGHT - And ingeniously when he designed the molds for his glass making, he included his name. He branded his glass.

NARRATOR: ENNION'S DESIGNER LABEL CUPS AND JUGS COULD BE FOUND ACROSS EUROPE AND THE MEDITERRANEAN. BUT IT'S POSSIBLE THAT ENNION WAS NOT THE NAME OF A PERSON BUT THAT OF A WORKSHOP OR FACTORY.

ROB CASSETTI – We don't know. But what we do know is that objects produced out of that workshop are signed Ennion – Ennion made me. And thus marketing in the glass business began.

KATE LARSEN: So after Ennion, Roman glassmakers continued to make really stunning examples of blown glass for several centuries.

NARRATOR: WHEN THE ROMAN EMPIRE FELL, IT WAS ISLAMIC GLASSMAKERS WHO KEPT THE SECRETS OF THE CRAFT ALIVE THROUGHOUT THE MIDDLE AGES.

KATE LARSEN - Glass making continued in the Mediterranean but on a smaller scale and it was much more focused on kind of daily use objects than the luxury pieces that people like Ennion and his fellows were creating.

NARRATOR: IN THE 11TH CENTURY, GLASSMAKING RETURNED TO MAINLAND EUROPE BY WAY OF VENICE.

KATE LARSEN - Venice was the link between Islam and the rest of the Mediterranean and mainland Europe. They had diplomatic connections, economic connections with places like Cairo and Damascus that were important centres of glass production in the Islamic world.

NARRATOR: BUT GLASS BLOWING WAS ABOUT TO CHANGE FOREVER WHEN THE MASTERS OF MURANO, A TINY ISLAND OFF THE COAST OF VENICE, ITALY GOT A HOLD OF THE SKILL.

NARRATOR: THE FORMULAS AND PROCEDURES INVENTED IN MURANO WOULD ALTER THE FUTURE OF SCIENCE, ART AND TECHNOLOGY.

NARRATOR: THE GLASSMAKERS AND THEIR SUPERIOR SKILLS WERE HEAVILY GUARDED AS INDUSTRIAL TRADE SECRETS BY THE VENETIAN GOVERNMENT.

KOEN INVU: Because like keeping a secret, knowledge is power and is also economical power. So it was important to them to protect that.

NARRATOR: AND FOR THOSE GLASSMAKERS WHO DARED LEAVE THE ISLAND AND SPREAD THOSE SECRETS, THE PENALTY...WAS DEATH.

ACT 3:

NARRATOR: WE INTERACT WITH GLASS ON A DAILY BASIS YET WE OFTEN TAKE IT FOR GRANTED.

BUT SCRATCH THE SURFACE AND WE FIND IT'S A REVOLUTIONARY MATERIAL

WHEN GLASSMAKERS INVENTED GLASSBLOWING IN FIRST CENTURY A.D. IT MARKED A MAJOR TURNING POINT IMPACTING ECONOMIES AND THE FABRIC OF DAILY LIFE FOR CENTURIES TO COME.

Kate Larsen - Blown glass really takes advantage of this increased prominence of glass in the early Roman world. It takes advantage of trade systems that Rome has established across the Mediterranean and it makes it possible for not just blown glass but all kinds of glass to really become popularized.

Kate Larsen - You get a wider variety of forms - you can make plates, you can make bowls, you can make glasses

NARRATOR: THE SOPHISTICATED PRODUCTS CREATED AT THE WORKSHOPS IN THE MEDITTEREAN REACHED PLACES LIKE ROME, SOUTHERN FRANCE AND EVEN ENGLAND. AND SO DID THE TECHNIQUES – PASSING FROM MASTER TO APPRENTICE.

NARRATOR: WHEN THE ROMAN EMPIRE FELL, AND THE GERMANS INVADED – THE KNOWLEDGE OF GLASS MAKING IN MAINLAND EUROPE STARTED TO DISAPPEAR.

NARRATOR: BY THE RENAISSANCE, A RESURGENCE IN SOPHISTICATED BLOWN GLASS ITEMS WAS BEING STOKED IN VENICE.

KOEN INVU: Venice who was one of the major trading centers in the Mediterranean area and did a lot of trade with the East....glass was brought back. And so the traditions that got lost were reintroduced into Venice and Venice became like this major center of glass in the world

NARRATOR: VENETIAN GLASS ARTISANS FOUNDED A GUILD AND BY 1292, THERE WAS SUCH A HIGH CONCENTRATION OF WORKSHOPS THROUGHOUT THE CITY THAT IT BECAME DANGEROUS.

Rob Cassetti, Senior Director of Creative Strategy, Corning Museum of Glass - Glass making can cause fires. So let's put it on an island where Venice is safe from the potential of fire and on the island Murano, glass and glassmaking was refined and explored at a level that was nothing short of remarkable.

NARRATOR: THE ISLAND BECAME FAMOUS FOR ITS INNOVATIONS IN GLASS MAKING.

Koen Vanderstukken – The secrets was not just about techniques but it was about the glass they invented.

NARRATOR: GLASS AT THE TIME WAS CONTAMINATED BY IRON AND HAD A GREENISH COLOUR. IT WAS A CHEMIST ON MURANO WHO INVETED CRISTALLO BY USING CRUSHED QUARTZ AND ADDING THE SECRET INGREDIENT OF MANGANESE DIOXIDE TO THE FORMULA.

KOEN: And so the result was a glass that was more clear and more brilliant than most of the glasses that they knew until then. So they could make things that were very, very complicated like nobody else was making at the time.

NARRATOR: THESE SAME TECHNIQUES HAVE BEEN PASSED DOWN TO THIS DAY. MAESTRO DAVIDE SALVADORE – AN 11TH GENERATION GLASS BLOWER WAS BORN AND RAISED ON THE ISLAND OF MURANO.

DAVIDE SALVADORE - My family work with the glass from 11 generation – since 1650. All my family work in glass. My mother was a very very nice artist. I think the real family artist. And I work with her...for many years. She made beads for her. She give me the sketch and I made it for her.

NARRATOR: ONE OF THE STRENGTHS OF MURANO THAT REMAINS IS ACCESS TO THE BEST RAW MATERIALS.

CHRISTIANO EFFETRE, MURANO GLASSWORKS - These materials is only for the basis. And after we put inside all the material for the colour.

Now the raw material is ready... we bring to the furnace.

CHRISTIANO - People work in glass. Not the machine. Not the book. This is important.

NARRATOR: MURANO BECAME KNOWN AS A GLASS ISLAND AND THE PRODUCTS PRODUCED BY THE MASTERS - INCLUDING MIRRORS AND CHANDELIERS - WERE HIGHLY DESIRED ALL OVER THE WORLD.

CHRISTIANO – You look at the different companies. You look at the improvements. This is experience is very important. This is the real power. It's not the new sand. It's the experience of the people work many many years in glass.

NARRATOR: THE VENETIAN GOVERNMENT WAS SO PROTECTIVE OF THEIR MONOPOLY IN THE GLASS INDUSTRY THAT GLASSMAKERS WERE BANNED FROM TRAVELLING ABROAD TO PRACTICE THEIR CRAFT IN OTHER CITIES.

Koen Vanderstukken: There was a lot of pressure from the Venetian government to stay at Murano – they could go on holiday but to keep the secrets in Murano.

NARRATOR: DESPITE THE THREATS, A FEW MURANO GLASS MAKERS WERE ENTICED TO PARIS BY LOUIS XIV TO PRODUCE MIRRORS FOR HIS PALACE IN VERSAILLES. BUT THEY DIDN'T GET AWAY UNSCATHED.

Koen Vanderstukken: Some of them apparently were poisoned by Venetian spies who didn't agree with the fact that they would give up the secrets.

NARRATOR: CENTURIES LATER, MURANO GLASSMAKERS CAN LEAVE THE ISLAND WHENEVER THEY WANT BUT MANY STAY AND CONTINUE THE LEGACY AND THEIR FAMILY TRADITIONS.

DAVIDE – The story continue. When I was young, I talk with my grandfather. With my father. About what? About the glass. And now is the same story. I talk with my son about the glass.

DAVIDE - You can't imagine the satisfaction I have with work with my son...I walk 2 centimeter on the floor for that. But don't say that to my son.

DAVIDE – My technique, I use the filigrana, the murrina technique and the incalmo technique.

VIZ – Davide and team make the filigrana vase

DAVIDE - The filigrana is to put rods...

DAVIDE – The incalmo technique is to put parts together to make one piece.

NARRATOR: IN THE VENETIAN DIALECT, INCALMO MEANS 'TO GRAFT'. IT TAKES TWO DISTINCT PARTS AND JOINS THEM BY HEAT. ONLY THE MOST SKILLED GLASSBLOWER CAN PULL IT OFF AND DO IT WELL.

KOEN INVU: Glass blowing is like incredibly difficult. It looks very easy and everything is fluid but that's how it has to be. You have to follow the flow of the glass in order to be able to control it. it takes years and years and years to become a master to the point where your muscle memory is taking over and you don't even think about it anymore. You become one with the medium you know what it's going to do you know how it's gonna react and you can anticipate at any given moment during the process and adjust to that and make sure that you're still under control and the glass doesn't control you.

DAVIDE – When I finish the piece, my heart is in my throat...da-da-da-dah...Every time can happen something bad because sometimes the glass don't like me. I am satisfied when I touch the piece with my hand.

DAVIDE – Now the piece is cold...and I take off the bounty...with this action...with vibration – I can break the piece. I am very afraid about that.

DAVIDE – Perfect buddy!

NARRATOR: BUT THE ADVANCEMENTS OF THE VENETIAN GLASS INDUSTRY WENT BEYOND THE PRACTICAL AND THE DECORATIVE.

Mike Sousa – Scientific Glass Blower - When we look at the birth of science it's launched with glass.

ACT 4:

NARRATOR: **GLASS IS ALL AROUND US. TODAY, THIS MATERIAL ONCE CONSIDERED MAGICAL IS ROUTINELY PRODUCED AROUND THE WORLD IN INDUSTRIAL AND ART STUDIO SETTINGS.**

Mike Sousa – We're blessed to have glass....Science begins with glass blowing.

Mike Sousa - We get windows. We get the prism. We get Newton we get Galileo. We get all of these great discoveries through glass. We know what germs look like because we can look at things close. We know what our universe looks like because we can look at things far away all because of glass. We discovered the electron because of glass...

Mike Sousa – We discovered all new sciences because of glass…all in the last 400, 500 years.

NARRATOR: **ONE 19TH CENTURY INVENTION THAT PROVED TO BE A HUGE GAME CHANGER WOULD NOT HAVE HAPPENED WITHOUT GLASS AND GLASSMAKERS.**

Mike Sousa - You can do just miraculous things with it we can't do with any other material. Because unlike any other material glass blowing is additive - you can inflate it. You can't do that with metals. Can't do that with wood.

NARRATOR: WHEN AMERICAN INVENTOR THOMAS EDISON PATENTED THE FIRST COMMERCIALLY VIABLE INCANDESCENT LAMP IN 1879, THE BULBS WERE MADE BY HAND ONE PIECE AT A TIME.

Marv Bolt: So this first bulb is made around 1901, 1902

NARRATOR: A SKILLED GLASS BLOWER COULD PRODUCE SEVERAL HUNDRED BULBS A DAY.

MARV BOLT: starting in about the eighteen eighties. And for 20 years there was really no improvement in how you could make these glass bulbs.

NARRATOR: PRIOR TO 1903, BOTTLES AND LIGHTBULBS WERE ALL DONE BY HAND BY GLASS BLOWERS. BUT AUTOMATION WOULD TREATEN THEIR EXISTENCE. AND IT WAS DONE AT THE HAND OF ONE OF THEIR VERY OWN...

NARRATOR: MICHAEL OWENS WAS A JOURNEYMAN GLASSBLOWER AT THE AGE OF 15. HE BECAME A SUPERVISOR AT A GLASSMAKING PLANT IN TOLEDO, OHIO AND THIS IS WHERE HIS IDEA FOR A GLASSBLOWING MACHINE BEGAN.

Rob Cassetti, Senior Director of Creative Strategy, Corning Museum of Glass – When you watch a glassblower today, they make the bottom first and then finish the top and the rim. Michael Owens turned the process upside down.

Rob Cassetti - Where you want precision is the neck. You want that crown cap to fit, you want the wine cork to fit precisely every single time. Make that first, make it accurately and then let the rest generally fall where it may. So Owens put it all together. He built this monstrosity of a machine called the Owens bottle machine. And essentially owned the world.

NARRATOR: WITH REFINEMENTS, THE OWENS BOTTLE MACHINE WAS ABLE TO PRODUCE GLASS BOTTLES AT A RATE OF 240 PER MINUTE. THAT'S AS MANY BOTTLES AS A TEAM OF GLASSBLOWERS COULD DO IN A DAY.

NARRATOR: IN THE 1920S, ANOTHER FORMER GLASSBLOWER NAMED WILLIAM WOODS AND HIS COLLEAGUE ENGINEER DAVID GRAY INVENT THE HIGH-SPEED RIBBON MACHINE TO MANUFACTURE LIGHTBULBS.

Rob Cassetti - A ribbon machine can produce more light bulbs in a minute than a machine gun can fire bullets.

NARRATOR: THE VOCATION OF HAND BLOWING GLASS WAS DYING, BUT THE SECRETS OF GLASS WERE MESMERIZING A NEW GROUP THAT WOULD TAKE THE POSSIBILITIES OF GLASS AND GO BEYOND FUNCTION, BEYOND DECORATION AND CREATE A WHOLE NEW ART FORM.

NARRATOR: BUT FIRST THEY NEEDED TO GET THEIR HANDS ON THE GLASS AND TOOLS FOR THEMSELVES.

Rob Cassetti - One of the tenants of design and really artistic practice is to understand deeply the material you're working with.

NARRATOR: PRIOR TO THE LATE 1950S AND EARLY 1960S, ARTISTS WHO WANTED TO WORK IN GLASS COULDN'T DO IT EASILY UNLESS THEY HAD ACCESS TO A GLASS FACTORY. IN NORTH AMERICAN, IT WAS A SON OF A SCIENTIST WHO LAUNCHED THE STUDIO GLASS MOVEMENT.

Rob Cassetti - Harvey Littleton was the son of a scientist but he was an artist. He'd been in and out of factories. Why can't artists have access to those factories. Why can't we go make that glass?

NARRATOR: LITTLETON WORKED WITH A GLASS CHEMIST AND RESEARCHER NAMED DOMINICK LABINO AND TOGETHER THEY BUILT A SMALL FURNACE THEY COULD EXPERIMENT WITH.

KOEN – Before the 60s glass art actually didn't exist. Like everything that was made was either functional or decorative but it wasn't use for sculpture the way you would find pieces in metal, or in stone or wood or any other medium.

NANCY CALLAN - One of the reasons why I love working with glass is because it seems so magical...

NARRATOR: IN ANCIENT TIMES, GLASS BLOWING WAS DOMINATED BY MEN BUT BY THE MID-17TH CENTURY, WOMEN HAD ENTERED THE FIELD – FIRST AS GLASS BEADMAKERS AND THEN AS FLAMEWORKERS AND ENGRAVERS AND ULTIMATELY ARTISTS.

NANCY CALLAN - It's also dangerous. You know you can get burned. You can lose a piece. There is always the opportunity for things to go south or for

something to break. So it's really challenging and you have to be on your game the whole time.

NARRATOR: JUST LIKE GLASSMAKING IN THE HEYDAY OF MURANO, GLASS ARTISTS WORK IN TEAMS – BUT THEY'RE PUTTING A WHOLE NEW SPIN ON AN ANCIENT TRADITION.

NANCY CALLAN - ...there's not very many art forms that I can think of that you really have that team aspect. It's kind of like if you've ever seen a great jazz band...Everybody's has their job and that's how they make beautiful music. And it's like that with glass blowing.

ACT 5:

NARRATOR: DURING THE EARLY 20TH CENTURY, THE RISE OF MACHINES AND AUTOMATION WOULD PUSH GLASSMAKERS OUT OF THE FACTORY. BUT IN THE EARLY 1960S – THE ANCIENT TRADITIONS OF GLASSMAKING WOULD EXPERIENCE A REBIRTH - LAUNCHING A WHOLE NEW ART FORM.

KOEN – And In the history of 4500 years of glass making... For the first time it was used as a medium to make sculpture, to make art.

KOEN - so many artists from so many different ways of life, all started to get interested in glass...and started making pieces in glass and were able to sell them as well.

NARRATOR: TODAY, GLASS ART IS FEATURED IN INSTALLATIONS AND GALLERIES WORLDWIDE.

NARRATOR: IN THE EARLY DAYS OF THE STUDIO GLASS MOVEMENT IN NORTH AMERICAN, ARTISTS WERE STILL EXPERIMENTING.

Nancy Callan – When I first started blowing glass, I realized how technically challenging blowing glass was. I mean the first time you try to get the glass out of the furnace it's just all over the place.

NARRATOR: INNOVATIVE ARTISTS WERE EAGER TO EXPRESS NEW IDEAS AND PERSPECTIVES THROUGH GLASS BUT THEY NEEDED A BASIS IN TECHNIQUE TO TAKE THE MEDIUM TO WHERE THEY IMAGINED IT.

KOEN - When they started making glass, they didn't have the same kind of skill and tradition. So they went to Murano and other places in Europe to learn directly from the masters and see how they were doing it. And at one point masters likely not know Lino Tagliapietra who is from Murano even went to the States to start teaching workshops and classes.

NARRATOR: WITH THE INJECTION OF TECHNIQUES FROM THE VENETIAN MASTERS, GLASS ART EVOLVED FROM EXPERIMENTAL TO EXPRESSIVE.

ERIK: One of my mentors...approach to the material...You want your thumb here...

ERIK: If you're making something thick and massive...thinner...on point and little bit more...

Soft glass...give it...go ahead...perimeter...

NANCY CALLAN: I think that somebody can be a great, great technician a great glass blower but you have to have both. You have to have the creativity and the vision to be to be able to have a career as a glass artist.

Right now I'm making a collar...that goes on top

NARRATOR: GLASS ART ABSORBED MORE THAN JUST TECHNIQUES FROM THE MASTERS OF MURANO, THEY TOOK ON THE TEAM APPROACH BUT WITH TWIST.

NARRATOR: INSTEAD OF WORKING TOWARDS THE COMPLETION OF A TECHNICALLY PERFECT DECORATIVE PIECE, GLASS ARTISTS WORK WITH THEIR TEAM TO REALIZE THEIR ARTISTIC VISION.

NANCY CALLAN - everybody on the team has a job. It's kind of like if you've ever seen a great jazz band. You know that there is one person in charge but Everybody's has their job and that's how they make beautiful music. There is no way I could make the things that I make at this scale with this much intricacy without an amazing team to work with.

NANCY CALLAN - When I'm doing demonstrations oftentimes I'll have students come and help. And it's usually the guy students that come which is great but I also want to get the women involved too. So that's one thing that I'm really conscious of.

NANCY CALLAN - It's not just the team that has the rhythm. It's the glass that has the rhythm.

NARRATOR: BUT WHETHER TECHNICIAN OR ARTIST, THEIR PASSION TO THE CRAFT IS STOKED BY THE SAME FIRE.

NANCY CALLAN - You can't read about how to blow glass you know you have to do it. And you have to constantly do it.

NANCY CALLAN - I want the traditions to carry on because these are centuries old techniques that we don't want to lose.

ERIK: So People have been blowing glass for thousands of years and this is the way they learn they pass it on to people.

FEMALE STUDENT - There's only a few people that have the privilege to be able to play with glass and to be a part of that tradition is phenomenal. That's a lot of fun

ERIK - You know you worked really hard to learn techniques and you learn from people who are influential in your life and you think of them would never use their techniques. And it really is very fulfilling to know that you're influencing a young artist in the same way that you're showing them that something that they maybe had never seen before and that maybe they'll incorporate in their own work. And that's very fulfilling.

What do you guys think....Applause

NARRATOR: THOSE TRADITIONS AND TECHNIQUES OF GLASS BLOWING HAVE ALWAYS LAUNCHED GLASS INTO NEW AND SURPRISING FRONTIERS.

MIKE SOUZA - There's just seems to be this paradox - science and glass? But when you think about it - if you took 20 of the most significant scientific discoveries, ever. Fifteen of them use glass as a main material.

KOEN INVU –- Glass definitely has changed our perception the way we look at the universe would have been quite different if we never had a telescope, the way we look at diseases, we would never have known without a microscope. The same thing happens with cameras and lenses photography, how photography changed our vision on the world and our ideas about what is real and what is not real.

NARRATOR: OVER 2000 YEARS AGO, HUMANS HARNESSED THE POWER OF SCIENCE – MIXING THE FORMULA TO MAKE GLASS – SOMETHING THEY SAW OCCURRING NATURALLY ON EARTH. IN THIS CENTURY, SCIENCE IS TAKING GLASS INTO OUTER SPACE.

MIKE SOUZA - Normal glasses would empty within two years. This glass will hold in helium for about twenty thousand years so it's virtually impermeable.

Rob Cassetti - Who would think that that this thing you pull out of your dishwasher every morning and put back on the shelves is this insanely high tech material. That is life changing.

MIKE SOUZA – And the amazing thing is that the techniques I used here to achieve the thickness go back centuries...You know it's just one person working with flame and glass to get this experiment that is going to be cutting edge science.

ACT 6:

NARRATOR: GLASS CAN SHRINK, SHATTER AND CRACK – BUT IT'S ALSO ONE OF THE LONGEST-LASTING MAN-MADE MATERIALS IN THE WORLD. IT HAS THE ABILITY TO SURVIVE IN THE MOST INHOSPITABLE PLACE.

MIKE SOUZA – What this is going to be is what we call a resizing operation. We're using a very rare kind of glass. It's called aluminal silicate. We're using this particular kind of glass because it'll hold in helium. Helium 3 a very, very rare isotope of helium which is already quite rare.

NARRATOR: SCIENTIFIC GLASSBLOWER MIKE SOUZA IS MAKING A MAGENETOMETER FOR THE NASA SPACE MISSION TO EXPLORE EUROPA – ONE OF THE MOONS OF JUPITER.

MIKE SOUZA - Normal glasses would empty within two years. This glass will hold in helium for about twenty thousand years so it's virtually impermeable.

NARRATOR: A MAGNETOMETER IS A TYPE OF SOPHISTICATED DIGITAL COMPASS USED FOR NAVIGATION.

MIKE SOUZA: They will take one of these magnetometers that I'll make and hang it off the end of the spacecraft. These magnetometers will help determine things like whether there's saltwater underneath all of the ice underneath there and if there is, there could be reasonable assurance that there is life within our own solar system.

NARRATOR: GLASS AND GLASSMAKERS CONTRIBUTE TO SCIENTIFIC EXPERIMENTS AND DISCOVERIES BUT SO MUCH ABOUT GLASS ITSELF IS STILL UNKNOWN – EVEN TO THE MAKERS.

KOEN: For 4500 years we've been working with glass and it has opened our minds and our visions and perspectives of the world. Even today like we see it all around us we use it every minute of the day almost. And yet we're still not able to define it. That kind of blows my mind.

Mike Souza - Is it a super cool liquid? Is it a solid? This is the biggest mystery still in material science.

KOEN – And whoever figures that out is probably the next Nobel Prize winner.

Rob Cassetti – A lunch table conversation I once witnessed among scientists who study glass. Between the three of them they held so many patents and there was such deep intellectual knowledge. They felt at the end of their careers that they were just beginning to understand what the material could do. It's that possibility of the material that makes the future of glass so interesting

this acknowledged potential. You can make a strong argument that the age we're living in now is the glass age.

MARV BOLT - Scientists and artists alike have only begun to scratch the surface of what we can do with glass and that open ended-ness to me is very exciting.

DR. ALI – This magnificent, translucent, transparent material changed the world.

DAVIDE SALVADORE - Murano people here they don't like the glass. Because it's a heavy job. They prefer to be a lawyer or a doctor...I don't know. But now thank you for the other people around the world – they understand we have a most beautiful material to work.

ERIK MEEK: It's so inspiring to see students come through and learn and grow. And then you see the work that they make and it's absolutely inspiring. It really gives you a sense that glass has unlimited potential that we have no idea what's to come in that we will see amazing things happen.

Rob Cassetti: Glass made light possible without fire. It brought television to life. Glass made mobile communications possible. And It began with glass blowers.

Karol Wight: If you think about what we wouldn't have if we didn't have glass in our lives. It would be a pretty long impactful list.

MIKE SOUZA – Computers, televisions… tubes, xray...cellphones

Karol Wight: Glass is a catalyst for human advancement because it's an enabling material.

KOEN: The way that we discover the world is still going on basically in a similar way be that instead of a microscope we're using a computer screen now.

MIKE SOUSA - I've been doing this for 50 years now and I never thought to the end of my career…that I'd be working on things like finding life on a.distant moon

NANCY CALLAN –The future is always exciting to me. It's scary but I know that like there's so much more I want to do in glass and there is so many things I want to try and innovate and create.

ERIK – The best glassblowers...are never satisfied because it's a process of continual learning and continual iteration. So you make an object and you can be satisfied with that but you always want to push it a little bit farther…you always want to explore the next piece, you want to explore the next idea.

KOEN - It's still the handmade that will feed even the industrial processes it's still understanding the medium how it works what you can do with it that is always gonna be the leading factor and how you can develop it in a more productive or bigger way.

MARV – The most fascinating thing about glassblowing for me is that it’s this delicate dance between this hands-on knowledge and the expertise that’s been developed over 2000 years and that subtlety really makes glass to me come alive.

Karol Wight: It's an incredibly important material not just for the past and what it's enabled us to do thus far. But for the properties that it has that enables us to keep thinking about the future and using glass as a material to progress as humans progress through time and space.