The Light Crystal

You will not believe me even when I tell you, so it is fairly safe to tell you. And it will be a comfort to tell someone. I really have a big business in hand, a very big business. But there are troubles just now. The fact is... I make diamonds.
—Stranger, "The Diamond Maker," by H.G. Wells

Ever since gold first brought kings to their knees and gems induced men to kill or die, enterprising individuals have sought cheap ways to create or fake them. Making valueless things expensive is the dream of any businessman. Minting precious metals or stones is the apotheosis of that dream. Many have shared it. Among the most famous is Jabir ibn-Hayyan, the medieval Egyptian alchemist who concocted instructions for turning lead into gold. Sadly, ibn-Hayyan's theories never panned out. Worse, he himself quite possibly never existed.[1] "To tell the truth, there is no fraud or deceit in the world which yields greater gain and profit than that of counterfeiting gems," wrote Pliny the Elder, the Roman statesman and historian who died with Pompeii.

That was before General Electric crunched and cooked graphite into a crystal called diamond—real diamonds—not glassy stones set in jewelry to fool the hoi polloi. There couldn't be a bigger difference between "artificial" and "synthetic" diamonds. Artificial diamonds are costume jewelry, fakes. Synthetic, diamonds are the real thing, carbon atoms packed into the hardest known substance—only they are products of human industry. The logical next step: Make them products of human flesh.

Nature never invented a way to turn specific, deceased individuals into gem-quality diamonds. If it had, Pliny the Younger might have inherited his great-uncle's brilliance in more ways than one. In the 1970s, geologists thought that some diamonds, called eclogite, form from decayed biological (or organic) carbon that was subducted beneath the Earth's crust, and re-emerged many millions of years later as crystal. More recently, some geologists think they have buried eclogite theory under molten rock. Evidence remains ambiguous.

Four businessmen—two pairs of brothers—accomplished this feat nature hadn't thought of in 2001 when they founded a company that sells unique memorials: diamonds made from the cremated remains of clients' loved ones. It's difficult to imagine a more shocking illustration of the principle of chemical change than the transformation of a human being into a rock. LifeGem operates under radar in an unglamorous Chicago suburb, blocks from the first-ever McDonald's. "People start out bewildered and after three or four days the lights go on," says Dean vandenBiesen, a co-founder. People react to LifeGem as if they have just been smacked across the face with a whitefish. Some people immediately love the idea and want to write the vandenBiesens and Herros checks. Others react in gob-smacked horror. Love it or hate it, people are awake.

LifeGem makes a lovely introduction to the world of carbon for a number of reasons. It proves that four guys, all nonscientists, can go into the science

[1] Larry paper

business given an idea, available research, sweat and debt. Lifegem became a global novelty overnight when they announced their services to the world in August 2002. They issued one press release. The *Chicago Tribune* put it on the front page the next morning. Their media advisors told them p.r. would bring them 30 million pairs of eyeballs. Within a year, they topped 500 million.

The Dead of Night

The impetus to build the company happened overnight as well.

As kids, Dean and Rusty vandenBiesen would visit their maternal grandmother summers in Fliessem, West Germany. (They have another brother, who is not a part of LifeGem.) One night in the summer of 1971, Rusty, then four four years-old, lay scared and unable to sleep. His room was filled with images of Christ in his final agony, symbols of eternity, but to a young child, in the dark, a premature introduction to mortality. Crying, he went downstairs to join the rest of the family. “What's the matter, Russ!” asked his parents. "I'm going to die someday!" he exclaimed. Family members tried to calm him down. They assured him he would live to be 100, a nice gesture, though one that actually confirms his fears, once you think about it.

Necrophobia dogged Rusty into adulthood.

Rusty left Western Illinois University (poor grades) and found work at a hazardous-waste management company. In a rubber suit, air tanks, and gas mask he handled everything except explosives and certain narcotics, which law prohibits waste companies from collecting. "We used to process the leftover chemo IV bags from cancer patients that had been in hospitals. I remember reading the patient names on the labels and wondering if they had survived. For some reason the flies loved the chemo waste. Strange!" Rusty wrote in an e-mail. There he learned some basic chemistry, enough to work his way around carcinogens, inflammables and corrosive acids. "You name the chemical and we worked with it," he says. Wearing haz-mat suits and repackaging industrial or medical waste was not for him. He became a successful pilot, like his father, who is an Air Force veteran.

In the mid '90s, a cure to Rusty's anxiety took shape and he opened up to friends. One buddy suggested he'd like to be turned into a ruby when he dies. That sparked an idea.

Biology and chemistry books became Rusty's leisure reading and voluminous Inernet research regularly crashed his computer. His printer spat out research that he organized into a maroon three-ring binder covering nine areas, including venture capital, funeral-industry data, patent searches and U.S. Postal Service policies. Rusty's wife, studying medicine, wrote out the divider tabs, her handwriting much nicer than his.

If cremated remains could be transformed into a synthetic gemstone, which variety was most feasible? Rubies and sapphires are both aluminum-oxygen crystals known as corundum. Industrialists have known how to synthesize those for more than 100 years. Moissonite "diamonds" are silicon carbide. There just isn't enough silicon or aluminum in the human body (from this perspective at least). Much lampooned cubic zirconia is a crystal of molecules containing a zirconium and two oxygen atoms. Growing crystals from molecules of two elements is much more difficult than crystals composed of just one element. It adds a taxing step.

Rusty's eureka moment came on the Internet. A chemistry education Web site, Webelements.com, invites visitors to type in their body weight. A calculator reports back approximately how much of a particular element he or she is carrying around. "That was the moment," he says. WebElements assumes that humans are 23 percent carbon. Rusty, then living in a Lyle, Ill., studio apartment, called Dean and shouted over the phone, "It's a diamond!' It has to be a diamond!'

Section eight in the binder became "Carbon and Capturing Carbon."

Diamond Making

Before long, Rusty would draw himself, his brother, his brother's brother-in-law and his brother's brother's-in-law brother into a long-term, high-risk commitment. The financial exposure they took on would have turned to stone anyone other than true-believers. The goal: Make death beautiful. Rusty's maroon binder still sits in LifeGem's offices.

"It was just enough information to make us stupid enough to think we could pull this off," says Greg Herro, LifeGem's CEO.

Rusty and Dean vandenBiesen and Greg and Mike Herro spent the year after Rusty's encounter with WebElements.com conducting basic research. Hurdles in 2000 look like mountains in retrospect. Even after they were up and running, in 2004, Dean had to think about it a minute before answering if he could do it all over again, knowing how much hard work, stress, risk and debt it would take.

Making diamond was the moon-shot of industrial chemistry long before science became so capital-intensive only governments, corporations and research universities could undertake it. The moon and diamond challenges were both met with money, powerful engineering, and force of will. LifeGem and other synthetic diamond makers stand on the shoulders of scientific and industrial behemoths.

LifeGem diamonds are made with technology descended from the first "high temperature, high pressure" apparatus, which itself was modeled after the way the Earth cooks and squeezes carbon into diamond.

People tried to make diamond for at least 125 years before General Electric announced Project Superpressure to the world in mid-February 1955. The previous December, GE researchers buried diamond seed crystals under an iron foil, topped it with black carbon and subjected it to 1200 degree Celsius heat and pressures more than 1 million pounds per square inch. It worked. "My hands began to tremble... My eyes caught the flashing light from dozens of triangular faces of octahedral crystals," wrote H. Tracy Hall, a GE researcher. He became a center of controversy, after he claimed GE snubbed his disproportionate contribution to Project Superpressure's success. But that would come later. The day of GE's announcement, the company's stock rose eight percent on the announcement, to $55-1/2, and traded at three or four times regular volume. DeBeers' stock temporarily slipped about 13.5 percent, to $16, and diamonds dropped in the London market.[2]

GE's patent claimed any carbon-rich substance could become diamond. All you need is a 1,000-ton machine that replicates pressure equivalent to 240 miles below the Earth's surface. An eight year-old boy in Peabody, Mass., sent GE a lump of coal and asked that it be made into a diamond. He received one weeks later. GE scientist Robert Wentorf Jr challenged credulity in 1955 when he smeared chunky peanut butter into the press and created a stone from it. "The pity is you can't turn diamonds into peanut butter," quipped his colleague Herb Strong.[3] Wentorf was a prankster. "We're always a little jumpy in the lab. We have many explosions, of course. But we are always careful to have the stuff in heavily shielded pits, and nobody has ever been hurt," he once said. "Not long ago, we had a beauty. It sounded as though the press had fallen through the building into the cellar. The big joke among us after that was to sneak up behind a fellow who was putting chemicals together and wallop an anvil with a hammer to see him jump."[4]

GE's first stones were not gem quality. Even if they were, at 1/16th of an inch hardly were they ready for a royal scepter. Synthetic gem-quality diamonds did not arrive for another 15 years. By then, the press could make a carat a week for about $100,000 a pop (about $750,000 today). Robert Crowningshield of the Gemological Industry Association examined them in 1970, discovering tests that expose synthetic diamond from natural ones. "One gentleman involved in the cutting of the stones exclaimed that one of the cut stones is a finer color than any natural stone he has ever seen," Crowningshield wrote.[5]

The biggest differences between Earth-borne and synthetics, such as LifeGems, result from the time it takes them to cook. Natural diamonds grow neatly in eight-sided nanobricks. Their lab-made counterparts aren't built as neatly and sometimes have cubic crystal growths. Sometimes splotchy color gives it away, a sign of irregular growth. The stones look like diamonds. Chemically and physically they are diamond, but parts of the molecular lattice look disjointed. If you can spot these differences without training and equipment, you are lying.

The first synthetic gemstones manufactured by General Electric were magnetic—bizarre for a diamond—because the finished stones retained tiny bits of iron trapped during formation. Over time, scientists reduced that problem. LifeGem diamonds showed similar properties for the first couple of years. GE abandoned its research by 1980. Production costs were too high to make synthetic gems marketable.

A generation hence, the technology in the U.S. and abroad has advanced sufficiently for LifeGem and others to mint diamonds. Gemesis, in Sarasota, Fla., uses technology acquired in Russia to make synthetic diamonds from (nonhuman) graphite. A St. Petersburg,

[2] NYT 2/16/55
[3] Hazen 132
[4] NYT 2/13/57
[5] Shigley book

Russia, company called New Age Diamonds (or NADs, a grin-producing one-liner around LifeGem's offices.) creates diamonds from clients' locks: "Your Personal Diamond, Grown From Hair," its Web site reads. Somehow, the cultural recognition enjoyed by Frances Garrety's line, "A Diamond Is Forever," has eluded "Grown From Hair."

LifeGem picked up on the idea nonetheless. They partnered with John Reznikoff, owner of "the largest and most valuable collection of celebrity and historical hair" samples. In 2006, LifeGem announced they would make Beethoven diamonds, cooked from precious strands of the composer's unkempt do. The young company thrives on press generated by the shock value of its product.

How It Works

Not all crystals demand high heat and pressure. Middle-schoolers make salt crystals. Dissolve all the salt you want in a glass of water. Beyond a certain volume, the water won't be able to swallow any more, and the salt will snow to the bottom. If you're still really hankering to make more salt disappear, there's a way: Raise the temperature of the water. The heat makes the water molecules dance more quickly. That creates extra space for the salt to hide. When all the salt is "gone," the water cools to normal temperature holding more salt than should be possible. You've tricked it, for the moment.

Tie a small crystal to a piece of string and lay it in the cooled supersaturated water. Over the next day or two, as the water evaporates, the salt concentration rises even higher. The water can no longer hold it in. So salt molecules find the most familiar surface they can—the seed crystal—and stick to it. The more water evaporates, the more salt gets kicked out of solution and adds to the growing crystal. Rock candy—crystalline sugar—forms this way, but is harder to make at home because sugar molecules are much bigger than salt.

That's analogous to how "high-pressure, high-temperature" diamond-making works, the process developed by GE and independently bettered by scientists in Russia's Akademgorodok (Literally, "little academic city"). A tiny diamond seed sits at the bottom of the press. Carbon does not dissolve in water, but does in molten iron. Graphite or amorphous black carbon rests on top of the iron. Under the heat and pressure, individual carbon atoms leap from the graphite, into the iron solution. Lost and alone, they settle on whatever surface reminds them of home—the seed diamond.

Light Breaker

Look at a diamond the next time you have an opportunity. Stare at it. If you own one, or your wife, or mother, does, look at it under a good light. Duck into a jewelry store: The lights make the rocks seem prettier. Don't ask about a diamond's long route to the store. At best, the clerk might know its country of origin. Several years ago, the United Nations, the diamond industry, and participating nations required that stones mined and sold legally be certified upon export. The new protocols dull buyers' complicity and guilt for just long enough to write a check. "Blood diamonds," or as gem professionals sanitize them, "conflict diamonds" have become an issue of international concern over the last 10 years or so. Journalists, United

Nations investigators and experts on terrorist money-laundering have all uncovered the extent to which illegal diamonds fuel the arms trade in decimated nations like Congo and Sierra Leone and terrorists group such as al Qaeda. "We're very happy not to be a part of that," Dean says.

Stones like those pulled from the Earth constitute an infinitesimal quantity of diamonds in existence. Diamonds form instantaneously during massive meteorite impacts. Nanodiamonds float about vast dust and gas clouds in space. In 2005, researchers from the Carnegie Institution of Washington and Princeton University discovered planets orbiting faraway stars that are made largely of carbon, likely with a compressed diamond core.

Diamonds split white light into its component colors. Imagine trying to lead a phalanx of sport utility vehicles through a mountain forest. Each has a different color and chassis width. Every driver makes it through, but he is on his own. The fearsome symmetry of the phalanx is shattered. That's what happens to light in diamond. Light is a stream of particles called photons. White light breaks down to its component colors that are remembered by school children as Roy G. Biv (red, orange, yellow, green, blue, indigo, violet). Every color in the spectrum has its own tread width, or wavelength, measured in hundreds of nanometers.

Roy G. Biv makes up a slim portion of a wide spectrum called electromagnetic radiation. Visible light sits in the middle of that range, organized by their energy wavelengths. Wavelengths larger than visible light include radio, microwaves and infrared light. Ultraviolet light, x-rays and gamma rays carry shorter, more powerful radiation.

All of these forms of radiation, including white light, travel at 186,000 miles per second in a vacuum. Outside a vacuum, light hits speed bumps. In a diamond, light has the trouble of an impala bounding through a pond of molasses. Its speed plummets to 80,000 miles per second when photons cross the threshold between air and diamond. Carbon atoms are packed so tightly that color wavelengths trip over different atoms. They fall out their military formation. Photons bounce around the many facets looking for a way out. We see the colors of the spectrum skipping one into another, bouncing off the walls, seeking egress. Each color finds its own exit, whenever it can.

Crystals are just big molecules, ones large enough to see. Their defining trait is a repeating atomic structure. If you could pick any dozen atoms out of a diamond, they would have the same arrangement. That's why a fine, if limiting answer, to the question, "What is diamond made of?", is "more diamond." Graphite is made of more graphite. Quartz is made of quartz. That's true all the way down to the single molecule.

How do they know that?
Scientific speculation about diamonds' composition dates at least to Sir Isaac Newton. He proposed in the 17th century that diamond must be related to substances that catch fire and burn away. Perhaps diamond is an "unctous body coagulated," he wrote, meaning a petrified oil.

Nothing expresses a man's love for the scientific enterprise quite like the willful destruction of diamond. Antoine Lavoisier invented modern chemistry, a distinction that makes his biography and work among the most studied and celebrated in all of science. His "Elementary Treatise on Chemistry" (1789) lays out the fundamental principles of scientific interrogation. The "scientific method" is a phrase with wide meanings that have evolved over 400 years. Literally, it is a step-by-step instruction guide to scientists: observe, predict, test and reflect. On a grander scale, it is a life lived in inquiry.

Lavoisier had plenty of money and spent most of it on expensive lab equipment. In 1772, he sealed about 150 milligrams of diamond in a container. A carefully placed magnifying glass channeled the sun's heat on to the glass, raising its. The diamond vaporized. Carbon atoms flew off its surface picked a pair of oxygen atoms to make carbon dioxide Analysis revealed the container to have more air than Lavoisier started out with. The evaporated diamond mated off with oxygen in the air to become carbon dioxide, the same gas we exhale and power plants emit. Lavoisier did not call it that, because he would not coin the word "oxygen" until 1774. In a follow-up experiment, he placed 150 mg of charcoal in a box. It vaporized into the same gas, in the same quantity. Diamond and charcoal were made out of the same substance, he concluded. Fearing his colleagues might find such a discovery ridiculous—it is still counterintuitive—he didn't broadcast his results.[6] No tale of Lavoisier is complete without mention of his unfortunate end. French revolutionaries beheaded him during the reign of terror, in part over their outrage that he consulted for a company that somehow contaminated tobacco with water.[7] Madame Lavoisier, who married Antoine in 1771 at the age of 14, remained a central organizing figure in the chemistry community after her husband's death.

Two decades later, a British chemist named Smithson Tenant published results from an experiment similar to Lavoisier's. Tenant thought the combustion of charcoal and diamond meant something deeper than Lavoisier apparently did. He thought the matter deserved greater investigation and in 1797 wrote of diamond, "It consists entirely of charcoal, differing from the usual state of that substance by its crystallized form."

The subsequent 20 years brought radical change to chemistry. Tenant's "charcoal" became known as "carbon" as chemistry entered adolescence in the 19th century. Tenant met an abrupt end when an old bridge gave out under his horse, leaving the scientist trampled in a ditch. A year previous, another giant of British science, Humphry Davy, confirmed Tennant's conclusions about diamond. "Diamond, when once ignited in oxygen, continues to burn until it is consumed." Davy died before his time, too, though less abruptly. A common feeling was that years of inhaling lab—including his discovery of laughing gas—took its toll.

Where's the Carbon?

Dean nearly burned down his house one weekend in October 2000 roasting spare

[6] Brock

[7] Brock 123

ribs into charcoal. Propane torches souped up his grill the way steroids build sluggers. A high-end air filter suspended from the garage ceiling inhaled the porcine ash. The smoke billowed from his garage, alarmed his neighbors and patient wife, Kimberly. He burned out everything but the pitch. On Sunday night Dean de-gunked the filter of fat blobs and grease. Sixty grams of black goo remained. He removed it, sealed it in a sandwich bag, and guarded it as if it were gold. It was worth significantly more. Carbon has greater value in diamond than in pork.

Dean sent his porcine gunk to Advanced Carbon Technologies, in Topton, Penn. Six weeks later he received 20 grams of graphite that met military standards for purity. A friend carried the material to Russia, where former Soviet scientists had invented a way to make diamond less expensively than GE's generation-old attempts. Four months later, four canary-yellow diamonds returned from the East, in the pocket of the go-between. Two years of relentless, bank-account busting work culminated in Rusty completing his lifelong search to find beauty in death.

To throw off possible competitors, the vandenBiesens and Herros wanted an intimidating name that sounded like a large company. The International Research and Recovery Corporation, conducting business under the name LifeGem, incorporated on Sept. 27, 2001. "That's four guys and a napkin right there," Dean says.

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"I came up with that idea in 1994," says Robert Hazen, a staff scientist at the Carnegie Institution of Washington. Hazen has a lot of ideas, more than he has time to pursue. A prolific author of popular science books, he's also a university professor at George Mason in Fairfax, Va. He gave the cremation-diamond idea to a graduate student who showed great initial interest. That excitement withered before the enormity of the enterprise, and the student stuck to his academic career path in geology.

Hazen and the vandenBiesens aren't alone. John Hatleberg creates authorized replicas of the world's most famous diamonds. Hatleberg learned stone-cutting as a preteen, the sole middle-schooler in a community workshop of retirees. Eventually he formally trained in gemology, and his breakthrough came in 1988 when a client invited him to recreate the Hope Diamond out of a gemstone he's contractually prohibited from revealing (safely rule out diamond). Institutions and owners of historically significant diamonds might want a replica for several reasons, as a visual description for an insurer or to ship across the world to potential buyers of the original. Since then, Hatleberg has cut replicas of 27 major diamonds, which he estimates together could be worth many millions of dollars.

A year after he recreated the Hope, he had an epiphany. "We have a 500-year-old history associating diamonds and love, and a 2,000 year history associating roses and love," he says. "Put those two together." Hatleberg's apartment overlooks East 83rd Street, about 150 yards from New York's Metropolitan Museum of Art. We are standing at a window. I can see the Met. *Ginkgo biloba* trees line the north side of 83rd Street. The windowsill is deep and filled with remarkable artifacts he has collected over the years. He picks up a gaudy-looking ring studded with green and white stones. "I call these 'sex diamonds,'" he says of the white ones. They are diamonds contaminated with hydrogen atoms, which makes them glow in the dark. "When I was 28 I showed my girlfriend. She was so wowed, she said, 'You can do whatever you want to me for as long as that keeps glowing.'"

Hatleberg removes a white envelope that contains four canary diamonds cooked from roses and seeds. I push them around my palm, thinking that these days you can have canary diamonds in the way you can have snakeskin boots. One of the stones leaps to the floor, missing the radiator's abyssal darkness by inches. "I've done that before," Hatleberg says, completely unfazed. "We had to remove the whole radiator to find it."

U.S. patent application, No. 20040071623, is a charming document written not only to protect Hatleberg's intellectual property—"synthetic diamonds prepared from roses"—but as a Romantic treatise on the history of roses, diamonds and love. It is guerilla literature masquerading as bureaucratic filing. A brief excerpt, legalese paragraph numbers included:

> [0030] Roses convey love, sensuousness, life, youth and happiness. The rose's complicity also conveys their fleeting quality. Perhaps the most poignant aspect of the rose is ephemerality. Ernest Dowson succinctly describes this:
>
> [0031] They aren't long the days of wine and roses!
> [0032] Out of a misty dream,
> [0033] our path emerges for a while,
> [0034] then closes.
> [0035] The essence of "rose" so permeates culture that Gertrude Stein was able to meaningfully pen "Rose is a rose is a rose is a rose".

The application takes shots at DeBeers and General Electric. Rose Diamonds, he says, will be an alternative for people who find LifeGem creepy, "possibly due to the sacred nature of the material used to make the diamond," he says in his patent filing. The U.S. Patent and Trademark Office has not yet awarded patents to LifeGem, Hatleberg or other pending organic carbon-to-gem applications.

Rose diamonds, once he gets his business off the ground, won't be made under high-heat and pressure, as LifeGem's are. A younger technology, called chemical vapor deposition (CVD) can grow diamonds more quickly, cheaply and at room temperature. LifeGem does not believe CVD makes viable gemstones, and will stick to its proven high-temperature, high-pressure technology.

At the 100th anniversary party for the Carnegie Institution of Washington's Geophysical Laboratory, Russell Hemley led a few guests on a tour of the diamond labs. We entered a small room, stacked wall to wall, floor to ceiling with gray, boxy electronic equipment, tanks of pressurized gas and a network of tubes that seemed to have no vestige of a beginning, no prospect of an end. It is a chemical vapor deposition lab. Rus motioned us one at a time toward a tall apparatus. "Look in the mirror," he said. It reflected the machine's interior chamber, where a bright, green-white ball of ionized molecules softly hovered. A pipe delivered to it methane gas that is quickly shorn of its hydrogen atoms. The carbon atom deposits on a surface. Incrementally, the layer grows into a stone you can see. I see the stone but am not thinking about it. The plasma ball, where carbon and hydrogen split apart and release energy, nearly knocked the wind out of me it was so stunning.

Jabbir ibn-Hayyan's alchemical dream was never viable. These days it is no longer even interesting. As Hatleberg says of his Rose Diamonds, "It has a sense of the alchemical to it. It's like turning lead into gold. But if you can turn rose into diamond, why bother?"

Off and Running

LifeGem has opened offices in the United Kingdon, Belgium, Norway and Japan. They opened in Japan in 2006 and already expects to gross $1 million there. In Japan, a mountainous island nation with limited real estate, cremation is standard. In many funeral homes, friends and relatives can sit by and watch the deceased consumed in flame. Total 2005 revenues for LifeGem may top $5 million—with 30% profit margins. As of April 2006 Lifegem has the capacity to make up to 100 diamonds a month, in three plants, in the U.S., and two in Europe. They spent 2005 powering through a back log of orders, with little time for relaxing, or pulling in new customers. "No Cubs games," Dean says with the sharp diction of suburban Chicagoans. "There was no monkey business."

They've found themselves in side businesses they couldn't have anticipated. Some potential customers are reluctant to commit to LifeGem because they have already purchased burial plots. Dean offers to buy and resell them if they buy a LifeGem instead. "We could become the largest owner of burial plots in the country," Dean jokes. Sort of.

Along the way, LifeGem cured Rusty of his lifelong angst and taught him the universality of his fears. "I had the same problem we all have," he says, mortality. Entering the lives of LifeGem clients brought a humbling perspective. "You start to be real thankful for what you've got and get more interested in other people."

Raw materials

LifeGem's name collapses the "animal, mineral or vegetable" troika of childhood guessing games into one Uber-substance. Pre-modern chemists believed an *elan vital* animated life and was absent in rocks, water and the like.

We are stuff. It's humbling, really. You can take our stuff make us into other kind of stuff. That's the fundamental principle behind life on Earth and transformation in the Universe. There are things called atoms, gazillions of them, and they continuously rearrange themselves letting muscles, waterfalls and volcanoes do their work.

We don't like to think of ourselves as carbonaceous bags of watery stuff. "Man was matter," Joseph Heller wrote in the climax of *Catch-22*, "that was Snowden's secret. Drop him out a window and he'll fall. Set fire to him and he'll burn. Bury him and he'll rot, like other kinds of garbage. The spirit gone, man is garbage. That was Snowden's secret. Ripeness was all."[8] That's not very pleasant, nor is it accurate. The spirit gone, man is microbe carrion. That's a far cry from garbage. Coal slurry is garbage. Plastic containers are garbage. His spirit gone, man is nutritious. New Guineans balk at Westerners who bury their dead "without doing them the honor of eating them," writes Jared Diamond in *Collapse*.[9] Taboos against corpses are not universal. LifeGem asks, If you are going to take what Heller indelicately calls garbage and burn it, why not create something that sparkles?

Carbonless materials generally do not burn. Werner Herz was a chemistry professor at Florida State University in the middle of the 20th century. In a 1962 textbook supplement I bought for less than a dollar on the Internet he writes, "One of the features which distinguishes organic compounds from most inorganic ones is combustibility. When brought near a flame, the organic compounds ignite and burn completely. What happens to the elements of which they are composed? The products of combustion are carbon dioxide, water, and, in some cases, oxides of nitrogen."[10]

Heat makes atoms fidgety in their molecular straightjackets. Really, what Chonps atoms in heat want is to mate with oxygen atoms. Bonds of carbon and hydrogen are stable, but no more than a Hollywood marriage. They're useful for a while. If you invite carbon-hydrogen couples into a room full of oxygen, add heat, suddenly you're left with carbon dioxide and water.

Dean chose spare ribs for his garage experiment because they have a high fat content. Most of the body's carbon is stored in fat. Fire carries away hydrogen, nitrogen and oxygen, leaving incombustible carbon, clumped together in thick, black, irregular structures that sort of resemble molecular chicken wire.

Human bodies are carbon compounds. How do they burn? That's the question Dean was left with, having torched his spare ribs into charcoal. Out of the Weber grill and into the fire.

LifeGem visited funeral homes and studied how much carbon remained after cremation. Practices differ from state to state and country to country. Heat and time dictate the final color and granularity of remains. If a body burns slowly with a lot of oxygen present, the cremation will produce more carbon dioxide, leaving less black ash behind. If there is less oxygen or the cremation occurs too rapidly, the carbon content of the ash rises. Some ashes come out angel white, others distinguished gray.

Cremation is a growing practice in the United States. It has long been the standard means of disposal in Japan and England, where 90 percent of funerals are cremations. At the end of the 19th century, more than 1,000 cremations a year were performed in the U.S. That number rose tenfold by 1913. During the years of the Great War, cremations leapt to 65,000 a year, peaking near 300,000 after World War Two. The annual rate dipped to about 60,000 in the 1950s, but

[8] Heller 1996 ed. pp450
[9] Diamond p 151
[10] Herz 4

began a steady ascent since then, to the current number of about 700,000 a year.

Public reactions to LifeGem in many ways parallel reactions to the first U.S. cremation, which took place on Dec. 6, 1876, in Washington, Penn. Baron Joseph Henry Louis Charles de Palm left no explicit rationale for his wish to be committed to ash. Before his demise he dismissed burial, claiming enigmatically that a female acquaintance he'd once known was buried alive.

The Theosophical Society, a blender of religious and scientific ideas from East to West, built a "media spectacle" out of the cremation a century before that phrase even gained currency. Journalists loved it or hated it. They reacted to cremation as if they were simultaneously slapped in the face with a whitefish. Adding to the perceived ghastliness of cremation was the state of de Palm's corpse on its big day. He died more than seven months before, and arrived poorly embalmed "The cremation was widely covered in American newspapers, which from the movement's inception rightly recognized this new way of death as scandalously good copy," writes Stephen Prothero in *Purified by Fire: A History of Cremation in America*.

Committing the body to flame has become a science since then. Sixteen hundred degree heat disintegrates a coffin pretty quickly. The wood ignites like kindling. The panels swell and contract before giving way to the body beneath. Flame consumes the hair and skin, revealing musculature. Trapped gases cause the abdomen to expand, until the muscle shrinks and splits, offering the gases exit. Abdominal muscles contracting in the heat can cause the body to move--even sit up, an eerie surprise to the uninitiated. Leg and arm muscles might similarly tense and flail. The skull, arms and legs reveal bone before parts of the body covered in muscle and gut. Ribs emerge through flame and ash. Bones in hands and feet let go their appendages but remain bonded together by slow-to-burn ligaments. Inner organs fade away, the lungs are consumed more slowly than others. The brain, dense and heavy, burns more slowly than other soft tissue. Bones emit a soft orange glow until they too finally submit. The funeral director removes remaining bone fragments, metals and other foreign materials. The bone is pulverized.

An average person can yield from 50 to 100 carats.[11]

LifeGem started out using a special contraption to collect carbon during the cremation, a heavy gauge steel box, shoebox size, with walls ¼-inch thick. Halfway through the procedure, the funeral professional slid some remains into the box, to prevent oxygen from kidnapping carbon atoms and stealing away as carbon dioxide. LifeGem's first diamonds were collected this way. Their first human diamond was created from a 27 year-old cancer victim named Valerie Sefton, whose family ordered five stones. By the next year, LifeGem moved away from using the collection box. "The act of interrupting a cremation to collect carbon proved dangerous to the operator and was not well accepted by the funeral profession, so we had to change our focus," Dean says. Advanced Carbon Technologies helped them

[11] Description compiled from Kubasak 1997, Evans 1963 and DvB interview.s

develop a way to purify the ashes that remain after the normal process. An eight-ounce cup of remains run through a 2000-degree Celsius vacuum-induction furnace produces several grams of graphitic carbon.

Some cremations still require use of the steel box. In 2005, a newborn in Wheaton, Ill., was diagnosed was meningitis and given very little time to live. Over three months, Maddox was practically adopted by his parents' church community. The parents chose LifeGem over traditional memorial options. Dean visited the family and was present for the infant's cremation. The body was so small, only a spoonful of carbon might remain after the burning. Dean appeared at the funeral home with the collection apparatus, and met the funeral director. The woman was very matter-of-fact, which Dean says sometimes catches him off-guard. "Oh, good, you're here," she said amid a roomful of bodies. The infant's remains produced five diamonds.

When entrepreneurs sit down to write a business plan for potential investors, their goals are modest: They want to work for themselves; they see a product or service lacking in the marketplace; they want to bring an invention to market. LifeGem is trying to change the way people grieve. Its business plan implies that traditions handed down over millennia, across every major religion and probably the minor ones, too, are insufficient. They fail to memorialize human beings in a manner that truly pays respect to the deceased. "Memorials have always been tied to technology," says Kenneth Doka, a gerontology professor at the College of New Rochelle and the editor of the *Journal of Death and Dying*. "We've always used the best of our technology to memorialize and bury the dead."

Are LifeGem clients are the King Tuts of the 21st century? Perhaps. If so, far more people today can be treated like a king or queen. An Air Force logistics specialist in Afghanistan told me when his convoy came under attack one day, his subordinates asked him what he was holding so tightly on the chain around his neck. "It's my sister," he told them, and showed them the diamond ring he wore on a chain.

A New Spoke in the Carbon Cycle

Essentially what LifeGem has done is punch a hole into the Earth's long-term carbon cycle. A tiny hole. The hole isn't big enough for Mother Nature's accountant to notice that some ashes and dust are not reverting to ashes and dust. Maybe 1,000 carats worth of carbon is missing from the long-term carbon cycle, truly infinitesimal.

Robert Berner of Yale wrote a monograph in 2004 explaining a geologist's conception of the "long-term carbon cycle." The phrase "has been applied to different time scales ranging from hours in biological systems, to decades in future global warming, to millennia and hundreds of millennia in climate history," he writes. Manmade change in that carbon cycle is affecting the planet. Berner's professional interest concerns tens or hundreds of million-year cycles. "What distinguishes the long-term carbon cycle from the short-term cycle is the transfer of carbon to and from rocks."[12]

[12] Berner 2005 p5; p13

Diamonds do not interest most geologists. They satisfy the "carbon" requirement but do not "cycle" on any reasonable timescale, if at all. The Earth cooks diamond leagues underground, from carbon that has never known the inside of a bacterium or the backside of a leaf. It's lived down there, overheated, since the Earth formed. Tectonic forces push a fraction of the finished product up through volcanic formations called Kimberlite pipes. Except for any stones that have inadvertently slipped off tourists' fingers into volcanoes or vaporized in house fires, diamonds circulate economically not geologically. *Homo sapiens* has not existed long enough to participate in a long-term carbon cycle, even if they wanted to.

Some of them, it turns out, want to. From the perspective of the history of the universe, LifeGem's product doesn't interest me as much as this principle: Rusty and Dean and Greg and Mike have abbreviated the long-term carbon cycle—"the transfer of carbon to and from rocks"—by turning human carbon that the deep Earth has never used, at least not recently, into a rock that almost never reaches the surface. It's a novelty of geoanthropology. Or anthrogeochemistry. Let the grant-writers decide what to call it. The Earth has never contemplated an express train from mammaldom to diamondhood. Whatever you call LifeGem, they have opened a new, eensie pathway for carbon in the world. Resist the thought that by removing grams of carbon from the short-term carbon cycle they are helping to beat back global warming, which is caused by added billions of tons of gaseous carbon annually. The amount of fossil-fuel energy necessary to run a graphite purifier, a diamond press, and the air and ground transport to and fro puts unquantifiably more carbon dioxide in the air than if we chose another way to handle corpses, such as dismemberment and abandonment in someplace akin to ancient Tibetan charnel grounds, where vultures and bacteria feast. [13]

There's irony in LifeGem's experiment that we'll keep in mind through the pages ahead. At a time when humans are warming the climate by turning freeing carbon from mineral coal, Rusty, Dean, Greg and Mike are busy trapping carbon, spectacularly, in diamond.

[13] That's not a reason not to get a LifeGem if you want one. But it's a good reason to lobby the U.S. government for Manhattan Project-scale energy research.