Mad Scien

Whether he's searching for a malaria cure, a cloaking device, or the perfect french fry, Nathan Myhrvold pursues his goals with magnificent obsession.

BY MARK McCLUSKY | PHOTOGRAPHS BY ART STREIBER

PLUS 7 OTHER RENEGADE RESEARCHERS


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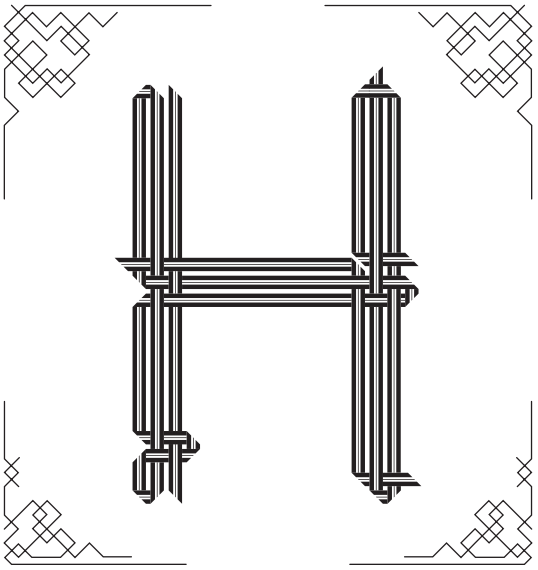
The perfect french fry—golden brown, surpassingly crispy on the outside, with a light and fluffy interior that tastes intensely of potato—is not easy to cook.



Here's how most people do it at home: Cut some potatoes into fry shapes—classic 3/8-inch batons—and toss them into 375-degree oil until they're golden brown. This is a mediocre fry. The center will be raw.

Here's how most restaurants do it: Dunk the potatoes in oil twice, once at 325 degrees for about four minutes until they're cooked through and then again at 375 degrees to brown them. This is a pretty great fry.

But let's get serious. The chef Heston Blumenthal—owner of the Fat Duck restaurant in Bray, England, holder of three Michelin stars—created what he calls triple-cooked chips. (He's English.) The raw batons are simmered in water until they almost fall apart and then placed on a wire rack inside a vacuum machine that pulls out the moisture. The batons then get the traditional double fry. You need an hour and a $2,000 vacuum chamber, but these are the best fries in the world. Or rather, they used to be.

The new contender was created by Nathan Myhrvold, the former CTO of Microsoft. Myhrvold cuts his potatoes into batons and rinses them to get rid of surface starch. Then he vacuum-seals them in a plastic bag, in one even layer, with water. He heats the bag to 212 degrees for 15 minutes, steaming the batons. Then he hits the bag with ultrasound to cavitate the water—45 minutes on each side. He reheats the bag in an oven to 212 degrees for five minutes, puts the hot fries on a rack in a vacuum chamber, and then blanches them in 338-degree oil for three minutes. When they're cool, Myhrvold deep-fries the potatoes in oil at 375 degrees until they're crisp, about three more minutes, and then drains them on paper towels. Total preparation time: two hours.

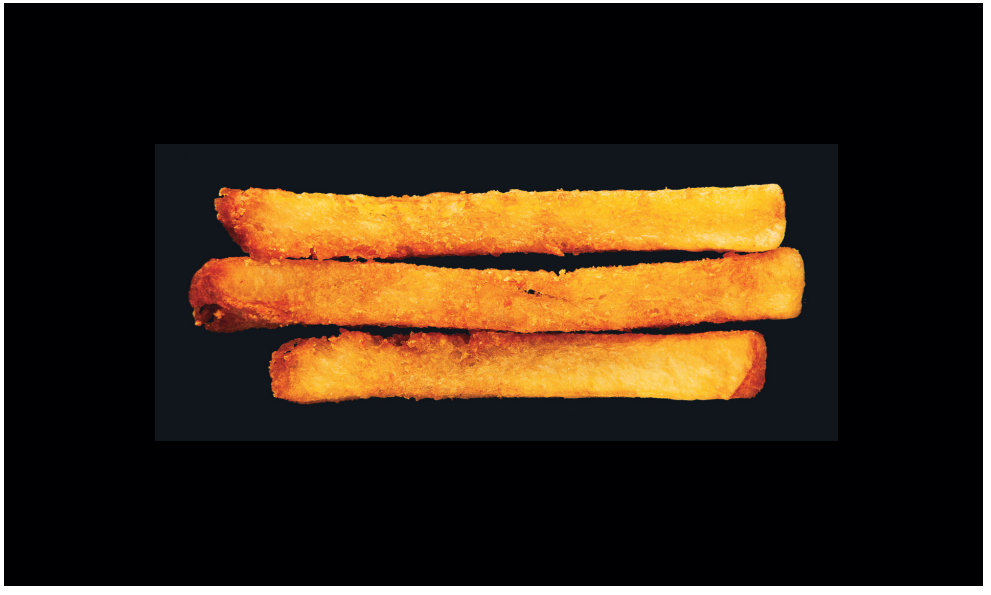
The result is amazing. The outside nearly shatters when you bite into it, yielding to a creamy center that's perfectly smooth. The key is the cavitation caused by the ultrasonic bath—it creates thousands of tiny fissures on the potato's surface, all of which become crunchy when it's fried. When Plato saw the shadow of a french fry on the wall of his cave, the guy standing behind him was snacking on these.

The recipe is one of 1,600 in Myhrvold's new cookbook, *Modernist Cuisine*. It's a big book—2,400 pages big. Six volumes big. Big like the original slipcase failed Amazon.com's shipping tests and had to be replaced with acrylic. Big like it weighs nearly 50 pounds and costs $625.

This is the way Myhrvold operates. After leaving Microsoft with all the money in the world, he started a company called, immodestly, Intellectual Ventures and turned his attention to busting some of the biggest problems in science and technology. And he dove into a few hobbies. Now most of us, if we were to get interested in cooking, might start to putter around the kitchen at home or do a little reading. Maybe we'd take a class. Because cooking is primarily a craft, dominated by artisans—or artists, if that's how you view what a chef does. Every once in a while, a chemist drops in to take a look or heads for the world of industrial-scale food.

But Myhrvold—a theoretical physicist and computer scientist—has the lifestyle flexibility of a multimillionaire and the mental discipline of a world-class researcher. To

PHOTOGRAPH BY MODERNIST CUISINE, LLC



MORE MAD SCIENCE
OTHER RENEGADE RESEARCHERS

OWEN HOLLAND
ROBOT MAN

Owen Holland's robot is not cute. With its single, squidlike eye, bone-white thermoplastic skeleton, and coils of exposed mechanical viscera, the thing looks like the top half of a zombie Cylon. Asimo would run from it; a Roomba would hide under the sofa. But while his bot may not be making trade show appearances anytime soon, Holland believes it will be able to do something much more impressive: think.

When it comes to artificial intelligence and robotics, *think* is a slippery term. "In what is essentially an engineering discipline, talking about machine consciousness isn't going to get you very far," the psychologist turned roboticist says from his lab at the University of Sussex. "But I'm at the end of my career, and I don't give a toss." His Embodied Cognition in a Compliantly Engineered Robot (get it? "ecce robot"?) aims to shed light on cognition with an "anthropomimetic" physical structure that matches ours, down to vertebrae, muscles, and tendons. ECCErobot's floppy body "has no intrinsic stiffness," Holland says. "If we turn the power off, it would collapse in a heap just like you would." And that's the idea—figure out how to control that system and you've probably learned what the brain has to do to control the human body.

To that end, this year Holland plans to upgrade ECCErobot with tension sensors to give it proprioception—the ability to tell where its body parts are—and a Kinect to give it depth perception. The point is to allow better interaction with the environment, which, according to Holland, is what underpins cognition.

So, time to welcome our new robot overlords? Not so fast. ECCErobot might eventually be able to wheel into a room, see a ball rolling atop a table, and pick it up. "And that's only if our control systems don't crash and burn," Holland says. Still, if ECCErobot does work, its body will be so similar to ours that cognitive comparisons will be inevitable—and logical. Let's just hope ECCErobot's descendants get some external upgrades—the thing looks like a frakking toaster. —*John Pavlus*

him, cooking is about fundamental interactions in the material world: How heat enters food. How you mix two separate materials most effectively. How water molecules interact in a solution. You see a pork chop and some mashed potatoes; he sees a mesh of proteins that coagulate at a specific temperature next to an emulsion of starch and fat. "Chefs think about what it's like to make food," Myhrvold says. "Being a scientist in the kitchen is about asking why something works, and how it works." To him, a kitchen is really just a laboratory that everyone has in their house. And when you have that attitude with that brain and those resources, well, you might not be the best cook in the world, but you just might put together the best cookbook.

If *Modernist Cuisine* lives up to Myhrvold's hopes when it's published this March, it'll be the definitive book about the science of cooking—the *Principia* of the kitchen. It's dense and beautiful and inspired, and even though Myhrvold assembled a team of 50 chefs, writers, photographers, designers, scientists, and editors to create it, the final product is in fact an eerily accurate recapitulation of how Nathan Myhrvold thinks.

Which is to say, the man thinks big about nearly everything. And he wants his french fries to be perfect.

MODERNIST CUISINE started with a problem.

In 2003, Myhrvold was building his dream house on the shore of Lake Washington outside Seattle, stocking it with esoteric kitchen equipment. One of the toys was a temperature-controlled water bath used for a technique known as sous vide, vacuum-sealing food in plastic bags and cooking it for a long time at relatively low temperatures. Done correctly, it lets a chef precisely control the temperature of the food, so the final product comes out perfect every time.

Myhrvold had come across the technique while studying cooking in France, but he needed information on how long to cook various foods and at what temperature.

And that was the problem. There *wasn't* any information.

For Myhrvold, that's not acceptable. He's a creature of knowledge; talking to him is like taking a graduate seminar. Actually, it's like taking every graduate seminar at once. He bounces from topic to topic as if someone were clicking the remote control through 500 channels of really high-end BBC documentaries. Here's a lunchtime conversation, only slightly edited:

"Alaska has had more than 10 times the number of botulism cases of New York state. But its population is a few percent of New York state. It's because they eat a lot of crap up there ... The most thermally diffusive thing that heat travels fastest in is diamond, by a big margin ... Suppose you have a broiler with a bunch of separate rods. Turns out there's an optimal distance away from them to have the most even heat. And it's 44 percent of the distance between them, plus 5 millimeters ... The big innovation in the 20th century wasn't in high-end food, it was in industrial food ... Our Carolina barbecue sauces are very thin. We made them authentic thickness. But then we have a note that says 0.2 percent xanthan gum will give you something that clings to your meat and makes your shirt less dirty. Ba dum ba dum ba dum."

That's how Myhrvold cuts off a lot of his own sentences, with what sounds like a kettledrum sound effect for a cartoon somersault. It's not an ellipsis; it's more like his brain has accelerated past the rest of the information. The proof is left as an exercise for the student.

After finding only a couple of articles and one book (in Spanish) about sous vide, Myhrvold posted a message on the high-end culinary discussion forum eGullet asking for sources, recipes, anything. "I sort of naively thought that sous vide was well understood," Myhrvold says. "You heard about people using it, so I figured they clearly must understand it. Well, I discovered that they didn't."

He was no stranger to kitchens. Growing up in Santa Monica, California, with his mother, a model and schoolteacher, Myhrvold started cooking at an early

A cutaway of an actual barbecue grilling meat from *Modernist Cuisine*. It shows the hot spots and radiant heat that lead to the perfect burger.

age, checking out cookbooks from the library and preparing elaborate Thanksgiving meals when he was 9. While at Microsoft, he moonlighted in the kitchen of a leading French restaurant in Seattle for nearly two years.

But he's primarily a scientist. Myhrvold has a master's degree in geophysics and space physics and another one in mathematical economics. He got his PhD in theoretical and mathematical physics from Princeton at 23 and did a postdoctoral fellowship with Stephen Hawking at Cambridge. He started a software company that Microsoft bought in 1986, founded Microsoft Research in 1991, and left the company as its CTO and chief strategist in 1999. He has hundreds of patents issued or pending. Oh, and he's also a photographer, a patron of paleontology research, and a world-champion barbecue chef. Seriously.

So Myhrvold the cook and Myhrvold the scientist went to work. Chicken and salmon and beef all got sous vided, with temperature probes inserted so Myhrvold could track how the heat moved through the food. He wrote a program using Mathematica to model the heat transfer through various shapes and sizes of food without actually having to cook. "I got kind of carried away," he says.

Almost a year and a half after asking his question on eGullet, Myhrvold answered it himself, posting the results of his experiments—charts that showed how long and at what temperature to cook a certain piece of food to get to a desired final temperature. Instantly, the thread became the definitive reference to sous vide.

By the time someone online suggested that he write a book based on the information, Myhrvold had already moved on to looking at food safety concerns raised by the low temperatures used in sous vide. He was even helping chefs convince food inspectors that the technique was safe. "From there I sort of decided, hey, why not do the whole thing?" Myhrvold says. "It made sense at the time."

PHOTOGRAPH BY MODERNIST CUISINE, LLC

BRIAN McCONNELL

SPACE COWBOY

MORE MAD SCIENCE

Sending humans to another planet—according to conventional wisdom—would be uncomfortable, expensive, dangerous, and (at present) technologically unfeasible. But telecom entrepreneur Brian McConnell thinks he has a solution: Just add water. ¶ Writing in the *Journal of the British Interplanetary Society*, McConnell, an engineer and space enthusiast, says his water-powered "spacecoach" could get astronauts to the Martian moon Phobos for less than $1 billion, using existing technology. The cheapest estimates for manned missions to Mars run in the range of $30 billion—roughly twice NASA's yearly budget—a literally astronomical price tag compared with a robot or orbiter. But in space travel, weight equals cost, and to keep astronauts alive and get them home you have to send along a lot of drinking water, which is really heavy. And so is chemical rocket fuel to power a craft through the vastness of space. "It's a very expensive undertaking," McConnell says. "It has a very hard time getting off paper." ¶ McConnell's plan solves the fuel problem. In space, ships don't need instantaneous power to accelerate. They can pick up speed over a long time, which means they can use the economical electrothermal propulsion regularly employed for maneuvering in Earth orbit. These engines superheat gas with microwaves and push it through a nozzle to create thrust. The fuel? Water, which pays for its weight by keeping a garden alive, slaking the thirst of astronauts, providing a shield against the radiation of deep space, and eventually getting used for thrust. (Enough to last the whole trip would be stored frozen in the hull.) A smaller rocket gets the spacecoach to orbit, and the water drive takes over from there. It's all relatively simple off-the-shelf technology. ¶ Sure, for all its streamlined elegance, McConnell's design is optimistic, to say the least. But undaunted, he plans to launch an X Prize–like competition, funded by Laminar Research, to improve the technology and raise awareness. Because with space travel, the hardest part of the journey is the first step (except for all the other parts). *—Mario Aguilar*

MYHRVOLD'S TEAM AND ITS TOOLS

IMMERSION CIRCULATORS AND WATER BATHS ULTRASONIC BATH COMBI-OVEN CENTRIFUGE

To create his megacookbook *Modernist Cuisine*, Nathan Myhrvold assembled a team of chef-researchers and built the most high tech kitchen ever created—they called it the Cooking Lab. The chefs included (from left) Sam Fahey-Burke, coauthor Chris Young, coauthor Maxime Bilet, Grant Crilly, and Anjana Shanker. (Chef Johnny Zhu is not pictured.) Stocked with traditional equipment and an astonishing array of gear more suited for a laboratory, the Cooking Lab became the site of unprecedented research into the physics of cuisine. Some of the highlights of Myhrvold's collection include: (1) immersion circulators and water baths for sous vide cooking, the technique that set Myhrvold on his cookbook quest. The ultrasonic bath (2), more commonly used to clean jewelry and lab equipment, became a key tool in the creation of the lab's french fries. (They also use it to brew tea.) The combi-oven (3), one of the most powerful tools in the kitchen, can function like a regular oven—providing finely adjustable dry heat—but temperature and humidity can be independently controlled, giving chefs the ability not only to bake and roast but also steam and cook sous vide in the oven. Instead of straining or filtering materials, the Cooking Lab team uses a centrifuge (4) to separate and extract

ROTARY EVAPORATOR AUTOCLAVE FREEZE-DRYER

unique ingredients like pea butter, the small amount of fat in peas. A rotary evaporator (5) distills small amounts of essential oils; unlike a regular still, it keeps the distillate at a low enough temperature to retain the volatile components that ordinarily disappear. Everything from prawn powder to carrot chunks comes out of the freeze-dryer (6), a clever way of concentrating flavor without heating food. And while Myhrvold and his team love pressure cookers, they don't rely only on stove-top versions. They use an autoclave (7), more often deployed to sterilize medical equipment, as the world's most expensive way of creating stock and soups. —*M.M.*

ILLUSTRATIONS BY Max Rose

MARLA SPIVAK

BEE QUEEN

MORE MAD SCIENCE

If you can't beat the diseases and pests that are killing bees, build a better bee. That's the notion behind the work of Marla Spivak, an entomologist at the University of Minnesota. She bred a strain of pollinating bee that fights varroa, a parasite linked to widespread bee deaths. With colony losses fluctuating around 30 to 40 percent every year, scientists and commercial interests are desperate for anything that'll help these pollinators thrive.

Spivak's breakthrough was literally cool. She used liquid nitrogen to kill a handful of baby bees inside their wax-sealed hexagonal cells. And then she waited. In some colonies, bees would never uncap the cells and clean them out. But in particularly neat-freak colonies, the corpses were gone in 24 hours or less. That's the trait she selected for, eventually coming up with a line she dubbed Minnesota hygienic. In colonies of Minnesota hygienic bees that get invaded by varroa—an eight-legged mite that drinks bee blood and lays its eggs inside cells—the bees uncap and clean out the cells containing infected, sick pupae before baby mites grow and reproduce—a contraceptive counterpunch.

Commercial beekeepers were reluctant to select for the trait themselves, though. Then, during a presentation, Spivak had "an aha! moment at the same time as a well, duh moment," she says. She had to work with breeders in the field. So she left her lab to work in California—hub of the commercial beekeeping industry—for three years.

These days, breeders are using her freeze-kill method to rear hygienic strains. And Spivak, a MacArthur "genius grant" winner, has dispatched a former grad student to identify 2,000 potential breeder colonies. The goals: separate the robust from the sickly, and breed from hives with the highest level of hygienic behavior and the lowest level of disease. Spivak today concentrates on an antimicrobial resin called propolis that wild bees shellac onto the inside of their hives as a sort of collective immune system—maybe pointing the way to an even better bee. —*Kirsten Traynor*

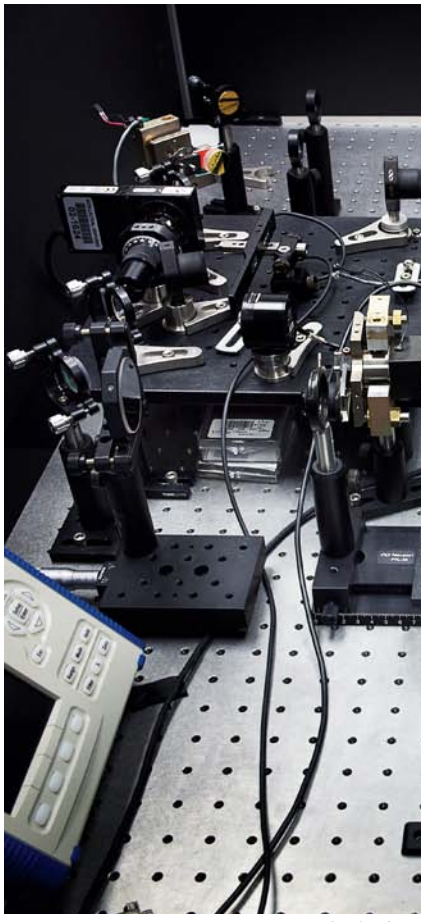
THE INTELLECTUAL VENTURES LAB, hard by a tennis practice facility and an auto-repair shop on the outskirts of Bellevue, Washington, isn't just easy to miss—it's almost as though it was scientifically designed to look as nondescript as possible. Inside the former Harley-Davidson garage, though, is 27,500 square feet of thinking space—as much a physical manifestation of Myhrvold's polymath mind as the cookbook is a literary and photographic one. Just inside the front door are the wet chemistry lab, the physics lab, the repair shop, and the laser testing rooms. A space farther back and to the right is crammed with computer-controlled milling machines that carve objects from metal or plastic with millimeter precision and a giant water-jet cutting table. It's hundreds of thousands of bucks worth of gear—a factory for fabricating anything a scientist might need.

Inside, dozens of PhDs work on a bevy of projects. One group is trying to perfect an idea that scientists have been hammering on since the 1950s—a traveling-wave nuclear reactor. It could, in theory, run for 50 to 100 years without needing to be refueled, primarily on uranium 238, which is a cheap, non-weaponizable byproduct of the uranium-enrichment process. The TerraPower project, as it's called, should yield a prototype reactor by 2020.

Then there's the Salter Sink, which is supposed to lessen the impact of hurricanes by funneling warm water from the ocean's surface into the colder water below. And there's the solution that the company has proposed to slow global warming: Pump sulfur dioxide into the stratosphere to mirror the cooling effect caused by large volcanic eruptions. Al Gore told the authors of *SuperFreakonomics* that the plan was "nuts," but that's of little consequence to Myhrvold; several Nobel laureates agree with him that the sulfur scheme might work.

Scientists at Intellectual Ventures have invented a new x-ray scanner that produces clearer images, surfaces that sterilize themselves, a portable freezer that keeps vaccines active without electricity, and even metamaterials that could reverse light, creating a cloaking device. But perhaps the flashiest creation from the lab is a bug zapper called the photonic fence, which Myhrvold unveiled at the TED Conference in 2010. It's a result of the company's ongoing work to eliminate malaria in response to a challenge from Myhrvold's old boss, Bill Gates. At a brainstorming session in 2008, someone suggested that lasers could kill mosquitoes before they could spread the disease—a kind of insect-world Star Wars laser-defense system.

The team pulled together parts from consumer electronics and eBay to develop a prototype—one that could even determine if a mosquito was male or female (only the females bite humans). The females would be blasted out of the sky; the males would be left alone. It's a massively clever bit of engineering and coding—and the parts are cheap and getting cheaper. Like the other gadgets, it's so crazy that it just might work.



The nonculinary research tools at Intellectual Ventures include a mosquito-breeding pen to raise bugs for malaria research (top left), a laser setup for killing those mosquitoes (right), and a refrigerated dewar that can store vaccines for long durations without power (bottom left).

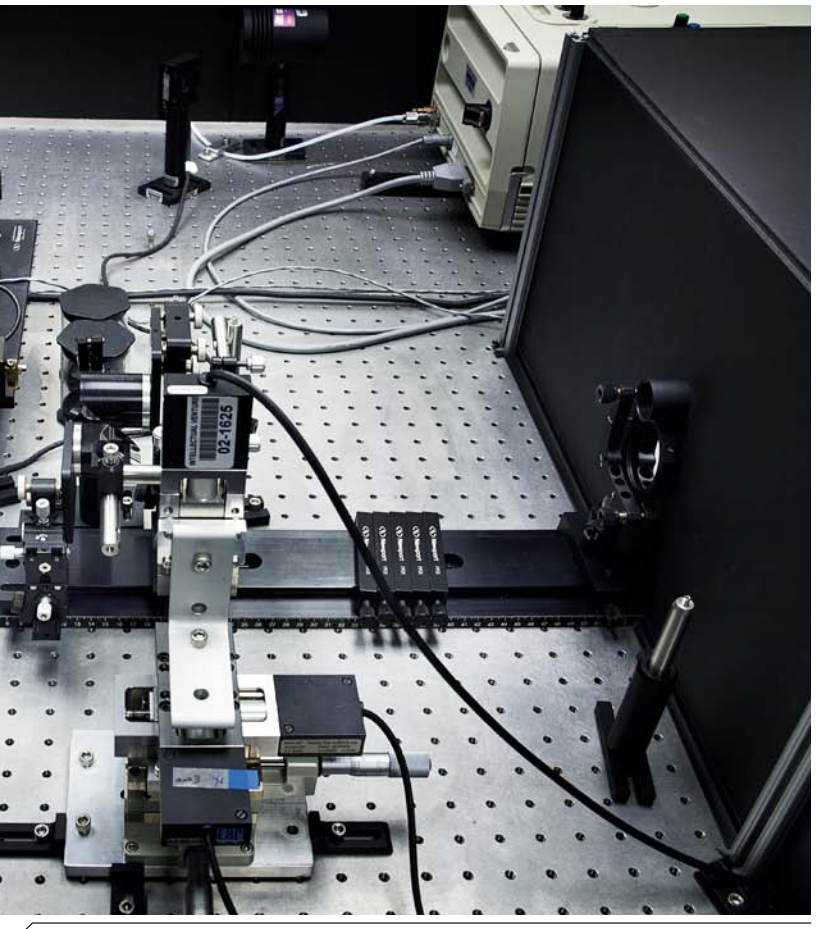
Malaria is the focus of a lot of effort at the lab. Across the street in the annex (a former interior-design showroom that still has some cabinet display models on the walls) is the company's supercomputer, built from 1,000 Xeon core processors, which mathematician Philip Eckhoff is using to model the spread and potential eradication of the disease.

Almost all of these inventions have one thing in common: Intellectual Ventures doesn't want to manufacture them. The company's business is making money from ideas, not from the products that the ideas could generate.

Myhrvold says that the company is trying to create a capital market for inventions, a market for intangible intellectual property like the one that grew around software in the 1980s. But Intellectual Ventures isn't just doing its own research and brainstorming leading to patents, it is also (much more controversially) buying up thousands of patents from outside inventors, which it then licenses to technology companies like Apple, Google, and Sony.

To Myhrvold, this is an elegant, scientifically minded hack of the patent system—where people can patent not only products but ideas. To intellectual property purists, though, that sort of behavior is called patent trolling—gathering the rights to ideas and then forcing companies to pay up when those ideas actually appear in the world and are about to be turned into usable technology. And indeed, in December, Intellectual Ventures filed three lawsuits claiming that nine companies were infringing some of its patents.

But the accusation of trolling has become increasingly frustrating to Myhrvold. "If you look at the list of people who have been called patent trolls," he says, "it's everyone who's ever filed a patent suit." He points out that his company applies for patents on 500 of its own inventions every year. And anyway, he



says, the system is designed for this kind of transaction. “Some people think it’s scandalous. ‘Oh my gosh, they buy patents!’ Well, yeah. And publishers buy books from writers,” Myhrvold says. “I’ve never gotten it, except that there are people who have ideological—bordering on religious—ideas about intellectual property, most of which are in my view not very deeply thought through.”

That’s Myhrvold. On one hand, there’s the fevered imagination and brainstorming, invention and science, the quest to change the world. But on the other hand, there’s the aggressive businessman who isn’t just around to create cool stuff—he’s looking to make a ton of money, too.

WRITING ABOUT SOUS VIDE led Myhrvold to think more deeply about how heat moves through different media (which is why *Modernist Cuisine* may well be the only cookbook ever published with a long disquisition on Fourier’s law, the equation for calculating heat transfer). That led to food safety, and that led to a more general exploration of the microbiology of food. Myhrvold soon realized that his ambition for *Modernist Cuisine* had outstripped his ability to write it alone. “It’s like writing software,” he says. “If you want to do interesting software, you have to have a bunch of people do it, because the amount of software that one person can do isn’t that interesting.”

A chef would have built a kitchen; Myhrvold built the Cooking Lab. He carved out a corner of the Intellectual Ventures lab and filled it with gear—not just stoves and ovens but industrial-grade homogenizers, freeze-driers, steam-heated ovens, and vacuum distillation machines. If Thomas Edison and Martha Stewart built a house, this is what the kitchen would look like.

And then, like the primary investigator in an academic laboratory, Myhrvold

ED ADAMS AND DAN MILLER

SNOW BOMBERS

MORE MAD SCIENCE

The best way to learn about snow avalanches? Trigger some. That’s the approach employed by Ed Adams and Dan Miller, civil engineers at Montana State University who ski into the backcountry to test new avalanche-prevention methods … with explosives. Many ski patrollers already blow up snow that looks avalanchey, but they don’t always do it well. Bomb the wrong spot and a slope stays primed to slide. Avalanches on supposedly slide-controlled slopes have buried at least 26 people in the US since 2008, killing seven of them.

Adams and Miller know about the danger firsthand. Adams spent a few postgrad years ski-bumming in Utah before getting his engineering doctorate at MSU (while shredding the sick slopes of nearby Bridger Bowl). And Miller, a Montana native, pretty much grew up on skis before taking charge of supersonic ground tests for the US Air Force. After witnessing some of Adams’ early tests, which included barricading himself inside a shack and then triggering an avalanche on top of it, Miller figured he could switch gigs and help out. “It was a ‘don’t try this at home’ sort of thing, but I like to think we were being safe about it,” Adams says.

Their tests today are much less primitive. They’re trying to understand hoar, frozen dew layers that can shatter when buried under snow, triggering an avalanche. Ordinarily, ski patrollers destroy hoar with direct detonation. Miller thinks a better approach is to use shock waves to compress the entire snowpack. He uses a microphone and accelerometers to measure his test blasts. (Sometimes with a crash test dummy for vérité.)

In general, the duo has found that blast size matters less than bomb placement. Air trapped inside snow acts like a shock absorber. Mounting a charge on a bamboo pole, Adams and Miller found, gives the blast time to expand, creating a wider and deeper compaction. And canyon walls make good amplifiers. “We consider this figuring out the fundamentals,” Miller says. “No one is looking at this.” Plus, any day you ski a double black diamond while setting off bombs is a good one. —*Ben Paynter*

WES JACKSON

GREEN THUMB

MORE MAD SCIENCE

For 10,000 years, humans have drained aquifers, poisoned land and sea, and eroded once-fertile plains into wastelands—all so we can grow food. Plant geneticist Wes Jackson wants to reverse all that. His plan: Reboot agriculture by domesticating perennial crops.

Nearly all the problems of traditional agriculture, Jackson says, stem from the fact that grain crops are annuals—they grow, make seeds, and die in a single year. Replanting every season tears up the ground and disrupts delicate soil ecosystems. But don't blame Big Agriculture or the high-input, high-yield Green Revolution of the 20th century. Blame the Neolithic brainiac who first saved a handful of seeds and poked them into the ground instead the stew pot.

The first farmers domesticated annual grains (wheat, corn, barley) and pulses (lentils, peas). They had the biggest seeds and highest yields, but they're parasites, returning little to their environment. It's perennials that build extensive root networks and healthy soil, conserve water, and recycle nutrients. (After harvest in the fall, they grow again from their roots in the spring.) Natural systems function best when diverse species live together. Yet we blanket the Midwest with crops of genetically homogenous corn—and we plow, spray, and fertilize the heck out of them. It's a system that modern agriculture can't sustain, says Jackson, "but without a new green revolution, we'll destroy our soil trying."

So for the past three decades, Jackson has been looking for alternatives. His Land Institute, in Salina, Kansas, is now a booming research center with half a dozen PhD scientists, a new tornado-proof seed-storage facility, seed-sorting robots, and research plots. Newly domesticated Kernza, a perennial relative of wheat, should be farmer-ready within a decade, Jackson says, and perennialized sunflower–Jerusalem artichoke hybrids are undergoing work to improve yield. Illinois bundleflower, a native legume, may be one of the first new legumes to be domesticated. After all, what's 30 more years of effort compared to 10,000 years of toiling in the fields?
—Thomas Hayden

started hiring researchers. He began with Chris Young, a 34-year-old with degrees in math and biochemistry from the University of Washington and one of the plummest jobs in cooking, running the development kitchen at Blumenthal's Fat Duck. But in 2007, he was ready to come home. Five years in the town of Bray, 30 miles west of London, was enough for Young; he was set to move to a job at a San Francisco Bay Area restaurant when he emailed Myhrvold, with whom he had corresponded about food science, to give him his new coordinates.

Three minutes later, a message from Myhrvold appeared on Young's screen. It had the subject line "Crazy Idea." The note was one line long: "Why don't you come work for me?"

Young signed up and brought in Maxime Bilet, a young chef he had worked with at the Fat Duck, to run the kitchen day to day. Wayt Gibbs, a former editor at *Scientific American* who works at Intellectual Ventures, was drafted to handle the editing, while photographer Ryan Matthew Smith joined the team after responding to a craigslist job posting.

Myhrvold then let them explore largely on their own. "Nathan creates a dynamic, free-thinking environment here," Young says. "This is a unique place to work. You'll be in the kitchen, and then someone like Neal Stephenson will wander by." So, for example, when the chefs were working on the part of the book focused on gels and thickeners, Myhrvold was having them concentrate on exotic hydrocolloids like agar or gellan. But then Bilet and the culinary team came to him with a suggestion. They wanted to add egg gels—custards, basically. "They're just as valid," Bilet told Myhrvold. "They're just as cool." Myhrvold gave them the green light, and the team hit their library of hundreds of food science books to see what people already knew about eggs and how they cook.

Then they started collecting data, cooking hundreds of batches of egg custard. Each time, they tweaked a variable—temperature, yolk-to-egg-white ratio, amount of liquids.

It took them two weeks, all for a deceptively simple chart. Temperatures are on one axis and the ratio of egg to liquid is on the other; cross-reference the two and you can choose a texture, from a runny crème anglaise to a firm flan. "All that work and it condenses down into this one little teeny table," Myhrvold says. Of course, that table is an unprecedented master course in egg cookery. "It's really cool to be in an experimental kitchen like this," Young says. "If you need to, you can talk to an engineer or a physicist. We have access to all of their analytical tools, and if our equipment breaks, we have these PhDs here to help us fix it. It's just really eclectic."

Working next to all those other projects has required a few adjustments, however. One night, the cookbook team was in the kitchen late, testing new recipes. The photonic fence team was also working late, seeing if their tracking software could follow mosquitoes at long distances. They had put a box filled with bugs at the top of a set of stairs at one end of the 100-foot-long Cooking Lab and set up their laser at the other end. As the chefs stood at their stoves, the beams started flashing above them. "I guarantee that we are the only kitchen in the world that had lasers overhead," Young says. "They told me they were firing at a nonkilling intensity."

LUNCH AT THE COOKING LAB: First comes raspberry gazpacho with piquillo peppers and macadamia nuts. Foie gras and horse mackerel are served with sous vide ponzu. Mushroom omelets are cooked in a steam oven, keeping them moist and tender. Comte cheese is turned into an aerated sponge with a vacuum machine and is served with hazelnut cakes. It's 12 courses overall, each one highlighting a different cutting-edge tool or technique.

When spot prawns and carotene butter show up—cook carrots in butter and then separate out the solids with a centrifuge—Myhrvold takes a bite, thinks for a moment, and then asks Bilet to hang on a second. "This is great, Max," Myhrvold says. "You know what I think it needs? It needs something crunchy."

iPad Extra: For a video tour of Intellectual Ventures and the Cooking Lab, download WIRED from the iTunes Store.

This *Modernist Cuisine* cutaway gives a true inside look at vegetables in the middle of the canning process.

"A little texture?" Bilet asks.

"Yeah. How about some freeze-dried carrot? Little chunks."

Bilet hesitates, looking at the dish. He seems dubious.

"Either that or something else crunchy," Myhrvold says. "Because it's fantastic but could use a texture element."

"We could do something with coconut," Bilet suggests. "To balance the carrot. Maybe a savory coconut tuile with freeze-dried prawn powder."

"That would do it," Myhrvold says. He goes back to eating.

Myhrvold is not a professional chef, but he's turned himself into a professional eater—thousands of hours of culinary training and meals at hundreds of the world's best restaurants. He's a scientific Falstaff, a rare combination of rationalist and sensualist. In fact, lunch at the lab would stand up to the food at some of the most avant-garde restaurants in the world. That's an abiding passion of Myhrvold's, right there in the title of the book. For him, there's nothing in the food world more exciting than the science-driven cooking he calls modernist.

Over the past two decades, a wave of chefs—Blumenthal, Grant Achatz of Chicago's Alinea, and Ferran Adrià, whose restaurant El Bulli in Spain is considered one of the world's best—have looked beyond tradition for ways to manipulate their food. Adrià uses everything from industrial food additives to freeze-drying in the pursuit of otherworldly effects, like a soup that changes temperature in your mouth as you eat it. It's what some writers (though not the chefs themselves) called "molecular gastronomy," and a major thrust of *Modernist Cuisine* is to explain just what the hell is going on in these high-end kitchens. "There's a set of cooking techniques that go back 20-some years that are hugely interesting to people, very useful, poorly understood, | CONTINUED ON PAGE 138

PHOTOGRAPHS BY MODERNIST CUISINE, LLC

ZHENAN BAO

SKIN JOBBER

MORE MAD SCIENCE

You gotta have thick skin to survive in this crazy world—but that skin has to be sensitive, too. Robots and prosthetic limbs have the first part solved, with shells of titanium and carbon fiber. But the second part? No artificial coating can compare to real skin. ¶ Chemist Zhenan Bao aims to fix that problem. She's working on "pressure pixels" made of stretchable, microscale organic field-effect transistors—building 40 years of advances in silicon chip design and nanofabrication into a flexible sheet. Last year, her team at Stanford University sandwiched finely textured sheets of a polymer called polydimethylsiloxane—PDMS, for short—between flexible electrodes. Apply pressure and the PDMS compresses, causing a measurable change in capacitance, the ability to hold an electrical charge. As a result, her material can theoretically detect pressures as faint as 3 pascals—roughly equivalent to the footfall of a housefly—and can do it quickly enough to "feel" each foot falling. ¶ "Mimicking skin function will still take a long time," Bao says, but several other groups are trying to tackle the problem, and new approaches are beginning to emerge. There's no shortage of possible uses, like prosthetic hands sensitive enough to manipulate small objects, artificial skin-graft material for burn victims, or remote-control surgical tools that let surgeons feel—not just see—the guts they're exploring. ¶ The coolest part is that there's no reason to stop at simply replicating skin. "We could integrate any kind of function beyond what skin already has," Bao says. How about chemical sensors—gunpowder-sensing gloves for enhanced TSA gropes, anyone? Or biological probes to detect infections at prosthetic limb attachment points? And, yes, the potential applications for telepresence sex are self-evident. ¶ For now, Bao and other groups are focused on developing new sensing materials and increasing signal-processing capability. Full integration with the human nervous system is "still very far out," Bao says, "but with the technology being developed, you can see them converging." —*T.H.*

Myhrvold

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and almost impossible to learn," Myhrvold says. "The best you can do is to go cook at a few restaurants that do this, and you come away with like 1 percent of it."

Until now, there's been no comprehensive reference. And the ingredients require a precision unfamiliar to many cooks. As Myhrvold observes, "It's a superbad idea to put a 'pinch' of xanthan gum in something." *Modernist Cuisine* sets out to explain and expand the chef's toolkit. "One of the wonderful things about the book is that it makes it clear what these things are good for, what they're not good for, what their strengths and weaknesses are," says Harold McGee, author of the seminal food science book *On Food and Cooking*. "I think it will go a long way toward demystifying and also expanding the number of people who can play with them and come up with new things."

That's a big change from cooking's artisanal roots. "You were taught how to make a hollandaise sauce, and you were never really taught why it works," says Thomas Keller, who runs Per Se in New York City and the French Laundry in Northern California and is generally considered the best chef in the US. "You were just taught how to make it, and you were taught how to fix it if it broke, and that was it." Myhrvold and his team want cooks to understand the science behind the technique. So *Modernist Cuisine* explains the avant-garde by emphasizing the most basic elements of cooking: heat and water.

Myhrvold has a favorite riddle: "If you have two steaks, one that's an inch thick, one that's 2 inches thick, how much longer does the thicker one need to cook?"

If you said the thicker steak takes twice as long, you're making the same mistake most cooks do. "It's four times as long. It goes roughly like the square," Myhrvold says. "How come cookbooks don't tell you that?" he asks, nearly bursting with indignation. The fundamental laws of heat, he figures, are the fundamental laws of cooking. "The physics of heat is diffusion," Myhrvold says. "So that's also the physics of drying things or of marination. They're all about diffusing things. The physics of heating things is also the physics of cooling things. It's the same basics over and over."

Then there's water. "Three things about water affect almost all of cooking," Myhrvold says. "First are the hydrogen bonds, which is why it has an incredibly high boiling point. Another is that it's a polar molecule, so that it dissolves a lot of things, and there are things that won't mix with it. And then there's how much energy it takes to heat water. That's why steaming food works; that's why pressure cookers work."

This isn't like most writing about food science. McGee's science-minded *On Food and Cooking* is a de facto reference in every professional kitchen—and many amateur ones. McGee says he's a fan of Myhrvold's work; the two men are friends, in fact. "I'm much more interested in the chemistry of flavor than Nathan is," McGee says. "That has to do with the diversity of compounds that you find in nature, how they get there, and how we detect them."

It's a polite sort of turf-carving, and Myhrvold is in just as much of a rush to establish his own. "In terms of broadly looking at food science and chemistry, and trying to explain it to a lay audience, Harold led the way," Myhrvold says. "But we have a physics-oriented book." Most cooks focus on the difference between filet mignon and rib eye. Myhrvold and his team want you to comprehend the whole cow. "If all you want to do is follow recipes, you don't need insights," he says. "If you want to do new things, you have to understand what the hell you're doing."

The ambition, the sheer bigness of *Modernist Cuisine*, does trigger the oh-come-on meter just a bit. Saying cooks need to understand the physics of diffusion is a little bit like saying a home woodworker needs to understand quantum mechanics. Sure, Planck's constant helps explain how nails go through maple, but calculating the one doesn't help you hammer the other.

Ironically, *Modernist Cuisine* will start tormenting UPS drivers with its bulk at the same time that the movement it celebrates—avant-garde, science-driven cooking—is waning. Ferran Adrià is closing El Bulli this year. Achatz is opening a new restaurant this spring that won't emphasize the techniques he helped popularize. "I think the book will have long-lasting importance in gastronomy," Achatz says. "But the particular style of cooking that it highlights might not. It's clear that the tide is turning. I don't think many chefs will continue to take the wholehearted scientific approach."

The tools and techniques that chefs like Adrià and Achatz popularized are trickling down. Flip on *Top Chef* and you're likely to see someone mucking about with liquid nitrogen and vacuum sealers. But the artistic part, the creativity of avant-garde chefs that Myhrvold finds so inspiring, seems to be shrinking. If that's so, *Modernist Cuisine* isn't the *Principia* of the kitchen but its *Consolation of Philosophy*, the book that collects and summarizes all the knowledge in a field at the moment the field implodes. It's a eulogy.

Myhrvold has certainly considered that possibility. To get this book out, he spent hundreds of thousands, maybe even millions, hiring staff, building a lab, setting up a separate company to self-publish it. And while he might be relatively immune to financial pressures, there's another judgment that the market will make. "One of the names for small-volume personal publishing is vanity publishing," Myhrvold says. "So, is this useful to people, or is it entirely vanity? That's a fascinating question. If no one wants it, you have to ask yourself, what am I doing it for?"

It's almost impossible to comprehend all of *Modernist Cuisine*. It seeks to be the first and last word in its field, to settle every argument, to capture all of human knowledge about cooking. And, ultimately, it's a book that utterly reflects Myhrvold. "We had a focus on physics. We had a focus on computer modeling. We had a focus on photography," Myhrvold says. "Those are all things that I'm completely into. We had a focus on the history and the philosophy of this kind of cuisine. Again, that's totally what I'm into." That's why the criticisms won't matter too much to Myhrvold. In the end, *Modernist Cuisine* is more than a cookbook. It's an autobiography—the world's most oblique memoir, so accurate a reflection of its creator that he might be the only person in the world who fully understands it.

Special projects editor **MARK MCCLUSKY** (mark_mcclusky@wired.com) *wrote about Nike+ and Apple in issue 17.07.*