FERTILITY

AUTOMATING CONCEPTION

Test tubes make lousy wombs. Now comes a device that nurtures embryos like the real deal

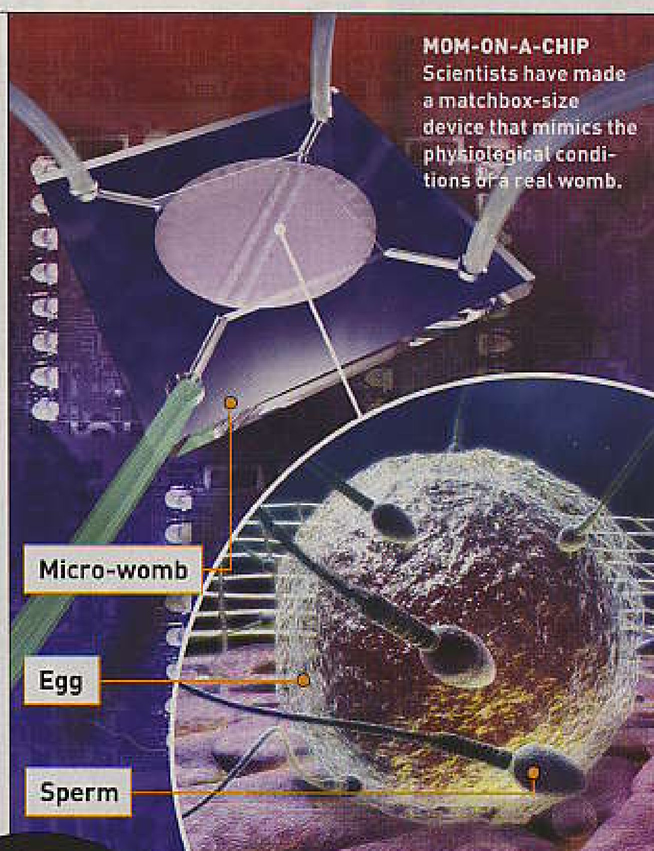
SINCE THE 1978 birth of Louise Brown, the first test-tube baby, in-vitro fertilization (IVF) has produced approximately three million infants worldwide. Although success rates continually improve, the science of making babies in the lab is still hit-or-miss. The Centers for Disease Control and Prevention report that less than 29 percent of IVF attempts result in the successful birth of a child.

Those rates could soon soar, thanks to an innovation by fertility researchers at the University of Tokyo. Teruo Fujii and his colleagues have invented a plastic chip-like incubator that nurtures early embryos like a real womb does. Currently, IVF eggs mature while resting on the floor of a petri dish, a very unwomb-like environment. "We wanted to culture embryos in an environment that is closer to what happens inside the body," Fujii says.

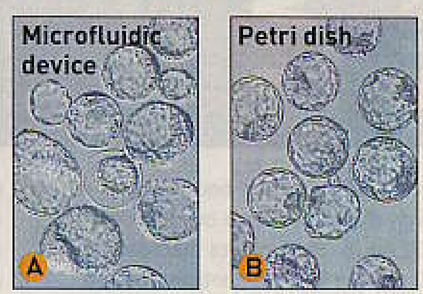
The team's research began with mice, but in March, they graduated to human embryos. While they have yet to implant any of the human embryos, results from the rodent experiments are promising: The team has successfully incubated up to 88 percent of early embryos.

The ultimate goal, Fujii says, is to perfect an artificial micro-uterus that fuses egg and sperm—and easily produces healthy, ready-to-implant human embryos. Such a device could benefit many of the estimated 1.2 million women who visit fertility doctors every year.

To set up the pivotal mouse experiment, Fujii and his team carefully placed 10 mouse eggs, one by one, inside a "cage" on the top floor of a two-tiered silicone microchip. Uterine cells plucked from a donor mouse line the bottom of the cage. Next they added sperm cells, which fertilized some of the eggs, and watched as ▶



MOM-ON-A-CHIP Scientists have made a matchbox-size device that mimics the physiological conditions of a real womb.



MAKING A BETTER BABY INCUBATOR Mouse embryos nurtured in a chip-like microfluidic device [A] mature faster and healthier than those nurtured in conventional environments, such as a petri dish [B]. Clusters of cells, seen here as tiny bumps, are an indication of growth.

ILLUSTRATION: MEDI-MATION; PHOTOGRAPHS, FROM LEFT: DAVID SPEARS/PHOTO RESEARCHERS; COURTESY TERUO FUJII (2)

REALLY ALTERNATIVE ENERGY

TWISTER POWER

A man-made tornado that could power your home, not destroy it

WHILE MOST TORNADO experts try to guard against destructive twisters, Louis Michaud wants to start them—very, very big ones. Michaud, a Canadian engineer, aims to turn tornadoes into power plants, creating—and containing—a 30-foot-wide, miles-high, spinning vortex of hot air that could generate enough electricity to power thousands of homes. His so-called atmospheric vortex engine will suck in hot air through a series of ducts at its base, channel it into an open-roof arena, and then produce a tornado-like funnel of air that would turn power-generating turbines.

Wild as it seems, the idea is garnering serious interest. The Centre for Energy at the Ontario Centres of Excellence, a foundation that funds experimental research, recently awarded Michaud a small grant to study the three-foot-tall model he built in his garage, and several noted scientists, such as hurricane expert Kerry Emanuel of the Massachusetts Institute of Technology, sit on his advisory board.

Naturally, he has critics. There's some question as to whether the energy the tornado yields would offset the amount required to create it. And some tornado experts worry that crosswinds could sap the vortex's power or send it spinning out of control. The start-up energy

INSIDE A VORTEX ENGINE

1 BUILDING UP POWER
The system draws in **hot water**—most likely in the form of excess heat vented from a nearby nuclear power plant—and runs it around the perimeter of the vortex engine.

2 CREATING WIND
Fans stationed in a series of cells spaced around the exterior of the engine suck in **hot air**, warmed by the water, and blow it through angled channels into the engine's open, 330-foot-wide **central air chamber**.

3 TWISTING THE TWISTER
The hot air rushes out along the walls of the chamber and swirls up and out through a 100-foot-wide hole in the top. The flow pattern, plus the constant supply of hot air beneath it, produces a 30-foot-wide tornado that Michaud says could reach several miles into the sky.

4 GENERATING ELECTRICITY
Once the twister starts turning, the fans do double duty as power **generators**. The full-grown vortex spins on its own now, sucking in air through its base to

the "womb on a chip" became home to the rapidly dividing embryos over the next 48 to 72 hours. The embryos that reach about 100 cells are implanted into real mouse moms to gestate.

The natural womb provides a perfect cocktail of fluids. Inside the fallopian tubes and the uterus, cells release chemicals tailored to the changing needs of a growing embryo, delivering the amino acids, proteins and growth factors that help the embryo develop. But a petri dish lacks these complex cellular interactions.

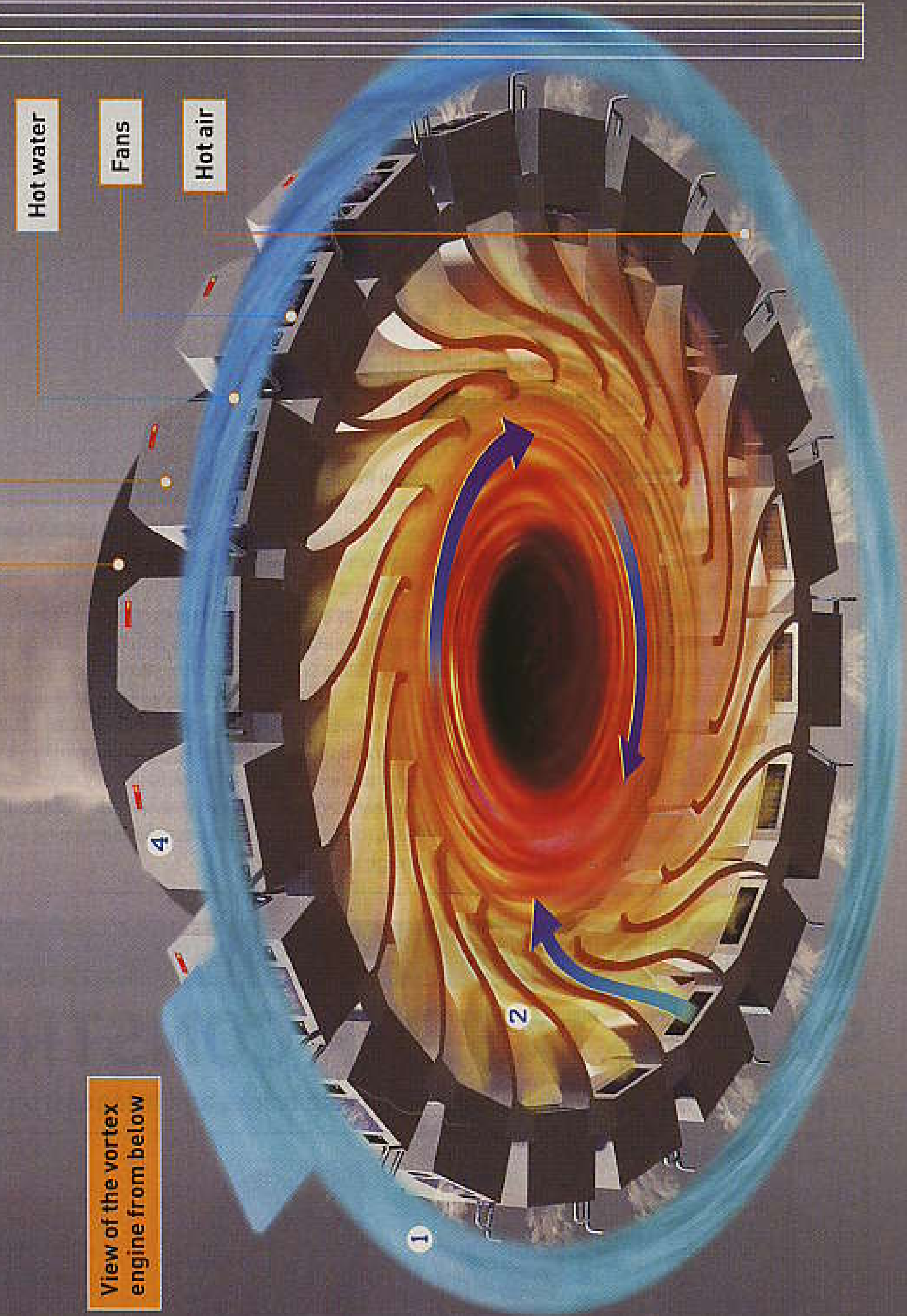
The chip functions a bit like a gentle car wash, using pumps to periodically bathe the cells in the fluid needed to keep them alive. It can be programmed to infuse its contents with as little as one trillionth of a liter of liquid and employs tiny chambers to contain the eggs and prevent nutrients from becoming too diluted.

Another benefit of the chip is that there's less stress to an embryo when it's not sucked into a pipette, which can cause physical damage or fatal changes in pH or temperature—downsides to life in a test tube.

The use of microchips creates a new

would be free, Michaud counters, in the form of heat vented from other power plants. As for safety, he points out that the vortex can be shut down at any time by closing the air-intake vents. "It's a tethered tornado," he says.

The real first test of the machine's safety and power should happen this spring, when Michaud hopes to complete a 12-foot-wide demonstration model in Sarnia, Ontario. Here's how it should work.—GREGORY MONE



View of the vortex engine from below

continue spinning. This influx of air turns the fans, which convert the mechanical energy into 100 megawatts of electricity.

The ultimate goal is to perfect an automated micro-uterus that fuses egg and sperm.

paradigm, where artificial wombs mimic the small-scale environment in the fallopian tubes, says Matt Wheeler, a reproductive biologist at the University of Illinois who is developing automated IVF systems.

Beyond making babies, the devices could also be used to grow genetically modified animals and stem cells, and might someday help grow implantable organs. Fujii is quick to note, however, that fertility treatment is still an invasive, psychologically challenging procedure and that it could take upward of five years for the technology to reach clinics. To perfect the device, the researchers must first gain a better understanding of exactly what happens inside the body, what an embryo needs, and in what sequence—in other words, how mom does it.—SHARON GUYNUP

AA REPS