

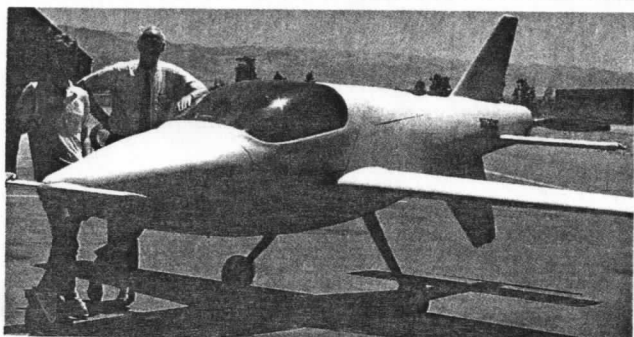
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NEWS FOR DESIGN ENGINEERS

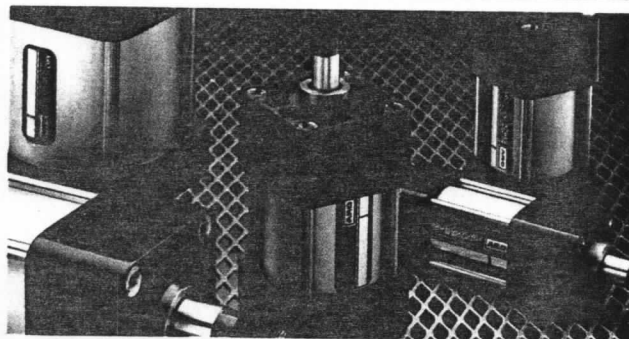
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December 4, 1989
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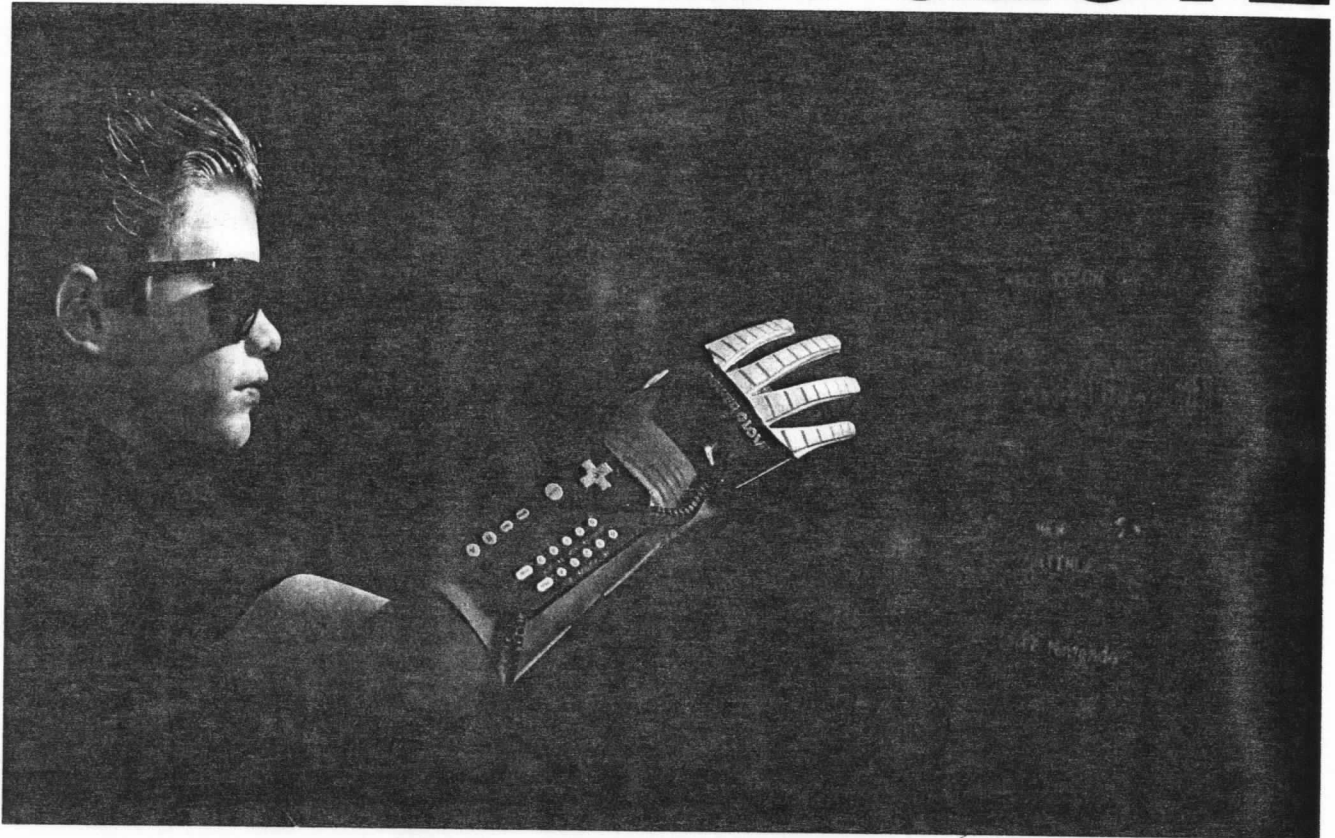
Cover photo by Stuart Watson for Image Design & Marketing

INSIDE
STORY
ON...

Combine the hottest video game with a \$10,000 computer peripheral, shape it into an inexpensive yet futuristic 'glove,' and you've got this year's smash toy

Dana L. Gardner, Associate Editor

THE POWER GLOVE



Throw away your joysticks, kids. Punching out the heavy-weights and zapping alien spaceships on your home video screen has evolved from two-dimensional wrist-wringing to 3-D arm-swinging. The Mattel Power Glove® has elevated the level of video interaction by an order of magnitude—the difference between a toggle switch and a ray gun.

In design terms, a versatile, \$75 commercial product—replete with sensors, programmable keypad, and microprocessor—was quickly

gleaned from a \$10,000 computer peripheral used by NASA robots in space. Teams of engineers on both coasts bridged the price and application gaps so quickly that even the Japanese decided it would take too long to develop their own.

Ever since Japan's Nintendo Entertainment System® and video game cartridges invaded the minds of America's youth a few years ago, toy designers and inventors have been scrambling to devise the next generation of electronic games. Abrams Gentile Entertainment,

Inc. (AGE), New York, staked its claim on a 3-D peripheral that puts the player through the actual motions of the game. Rather than beat Nintendo, AGE and Mattel engineers joined them by relying on the Nintendo system, but adding a better link between kid and machine.

Ultrasonic transmitters on the top of the Power Glove feed positioning information to the L-bar microphone on the top of the television (not shown). Triangulation algorithms give 3-D positioning of the glove wearer's hand in relation to the activity of the figures on the screen. (Stuart Watson photo)

POWER GLOVE

A new generation of games

"When Nintendo saw the glove, they knew there was no way to bring together the people to do it themselves," explains AGE partner and chief engineer Christopher Gentile. "We were flown out to Japan by a bunch of people who wanted to buy technology from us. It was a little change of pace, to say the least."

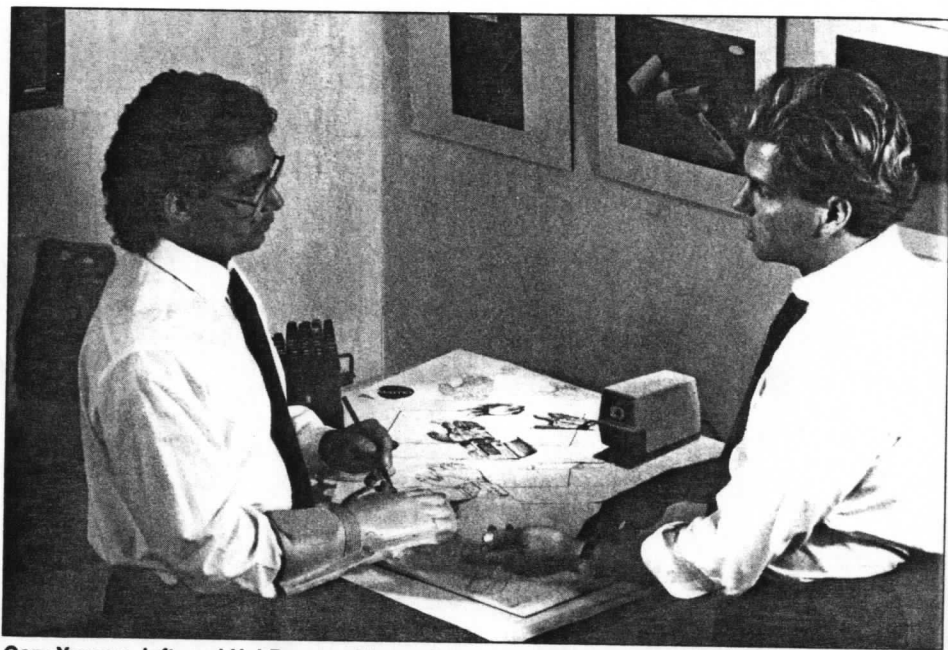
Mattel, Nintendo's U.S. distributor, bought the technological design license from AGE, raced to develop the Power Glove's appearance by using a California image shop, created enhanced software, and put on a multi-million dollar advertising blitz. The giant Hawthorne, CA, toymaker expects to sell a million Power Gloves in the product's first year. The company has a licensing agreement with Nintendo, but will sell the gloves as a Mattel product. This holiday gift-buying season will provide the lion's share of the first-year sales, Mattel marketers predict. Next summer, new game software will emerge designed specifically for the Power Glove so that game players can truly become part of the action.

Computer firms are also examining whether engineers and other computer users would benefit from a very similar glove device to drive and control CAD and other graphics systems.

The story behind the Power Glove—racing to meet squeaky-tight deadlines, international haggling in the nerves-of-steel toy business, and searching for innovative technology, software, and appearance—could itself be the basis for a lightning-fast action game. By avoiding the snakepits, wrestling the prize away from the gorilla, and leaving the jungle first—the Power Glove designers are on their way to probable glory and riches.

Shopping for a design idea

The technology for the Power Glove originated with high-technology computer peripherals. The leap



Gary Yamron, left, and Hal Berger of Image Design & Marketing review the exterior design of the Power Glove. Working quickly, they overcame a number of design concerns to effectively blend form with function.

from keyboard to mouse created the demand for free-moving, hand-operated interaction devices. A 3-D ultrasonic pen was developed to move images on a screen. It was followed in 1986 by the \$10,000 Data Glove peripheral by VPL, Inc.

The expense of the glove limited its use to such research and development shops as the MIT Media Lab and NASA Lewis Research Center, as well as on advanced graphics stations and engineering workstations. NASA used the sensor-laden glove, for example, to directly command robots. The robot arm would react in real time to whatever the glove-wearer did with his or her arm. The glove was also part of simulating complex situations on super-computers.

AGE, seeing the possibility of adapting the Data Glove technology to video games, bought the license for VPL's initial glove technology. The firm then went about reducing it to a consumer version that would direct 3-D commands to a video screen in real time.

"The nice thing about the glove, in all applications, is that—unlike

a mouse or a joystick which you have to learn how to use—it's self-contained. The glove knows how you work. You just act naturally and it automatically translates that into commands," says Gentile.

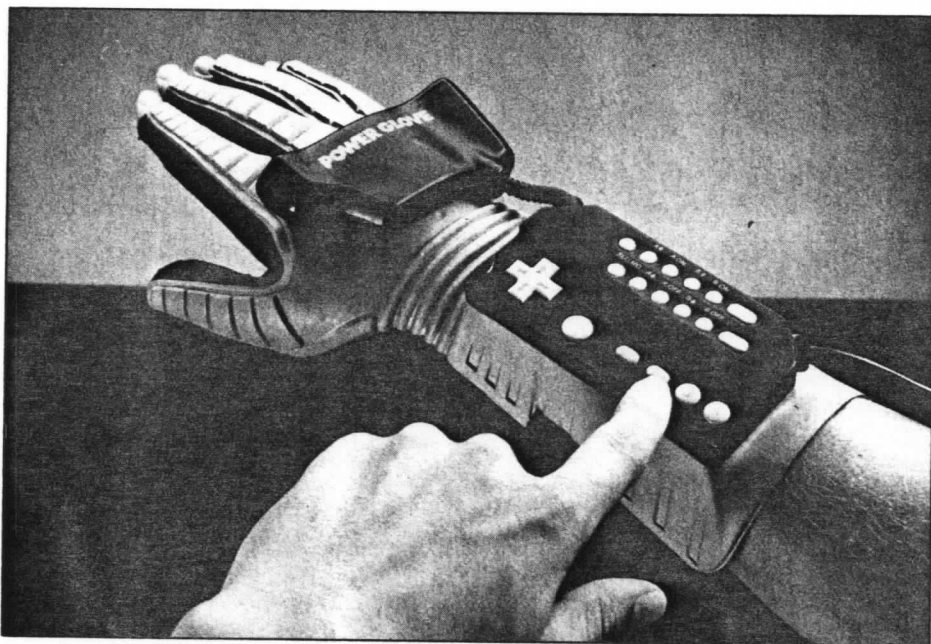
"It's a different animal," says Novak, a Mattel staff designer, of the glove. "Joysticks are two-dimensionally linear. Up. Down. Left. Right. When you go to the glove, you get the z-axis, in and out—and you can rotate and finger-bend so that each finger becomes a trigger."

Of the 120 Nintendo joystick games, all can be used with the Power Glove. Users can select their own personal hand gestures and finger movements to replace the limited movements of a joystick.

A new game, "Bad Street Brawler," takes advantage of the Power Glove's capabilities. The glove wearer actually makes a fist and punches out at the attacker. "The space in front of the player becomes a space inside the video tube. We call it the 'virtual playfield,'" says Novak. "It's kind of freaky when it happens. It's almost like a mirror, but it's not reversed."

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POWER GLOVE



A programmable keypad on the top of the Power Glove allows the user to tailor hand and finger movements to former joystick commands, or to enhance a game's play. New game software next summer will fully utilize the glove's potential.

Next summer, when the software in the game cartridges catches up to the hardware and sensing abilities of the glove—the Power Glove Gaming Series—the player will be able to control much more of the screen with various hand and arm motions. A handball game with the player using an open or closed palm to swing at the ball, for example, will be possible.

Ways to reduce sensor costs

Engineers needed to make the glove a commercial reality in time for this Christmas. To do so, teams of designers, marketers, and software and hardware specialists from around the country were united. Their starting point, the expensive Data Glove, gave them little more than a template.

The Data Glove's sensor technology was expensive and couldn't be easily mass-produced, both of which presented unique problems for adaption to video games. First, Mattel engineers had to find a cheaper way to gage and communicate the movement of wrist and fingers. The Data Glove uses optic fi-

bers in the glove's finger sleeves to measure and track finger-joint movement. As the finger bends the fiber, less and less light passes through. A photoresistor at the end measures the amount of light to calculate the angle of the wearer's finger at any given time.

A second major hurdle, communicating the 3-D orientation of the hand in relation to the images on the video screen, also had to be overcome inexpensively. The high-end Data Glove used a magnetic sensor that detected the exact position of the glove in a magnetic field to determine its relation to the computer screen or robot.

Ultrasonics provide solution

To solve these problems, designers took a step backward. Remembering that the pen computer peripheral relied on ultrasonics to move cursors, they began developing an ultrasonic sensor system for the Power Glove. Three points of reference were needed between the glove and the television screen so a quick series of triangulation calculations could be done. The process

depended on algorithms and geometry, which required a microprocessor in the glove, to pinpoint the user's hand position.

The designers settled on two ultrasonic transmitters spaced about 3 inches apart on the glove above the knuckles, and two receivers on a 1 ft-long "L-bar" placed on the television's top.

"Each one of the receivers, or microphones, on the TV set has its own little stopwatch," explains Gentile. "We throw out a beep from the transmitters on the glove and clock them. When each of the microphones receives the signal, it stops the clock. Based upon the difference in time between when each of the microphones detects the beep, we use a triangulation formula to determine where the hand is in 3-D space."

The ultrasonic system provides a 1/4-inch resolution at a distance of 5 ft. The digital feedback from the sensors allows the glove to update its position 30 times a sec. This orientation system proves sufficient for use with video games. Both the glove and L-bar plug into the existing joystick socket on the Nintendo game system unit. Power comes from the joystick socket.

Finger bends give commands

To attack the problem of sensing finger movement, Mattel and AGE engineers first sought cheaper materials than fiber optics and photoresistors. Light sources gave way to conductive properties. They thought they found a solution, Gentile recalls, in using conductive rubber, but the rubber didn't return to its prior shape quickly enough. Finally, they found a conductive ink that was supposed to be used to build flexible circuit boards.

The conductive ink, it turned out, didn't work well on circuit boards because its conductive properties changed when it was bent. This detrimment to circuit building, however, was exactly what AGE engineers

POWER GLOVE

were looking for: An inexpensive way of calculating movement—two layers of the ink became a sensor.

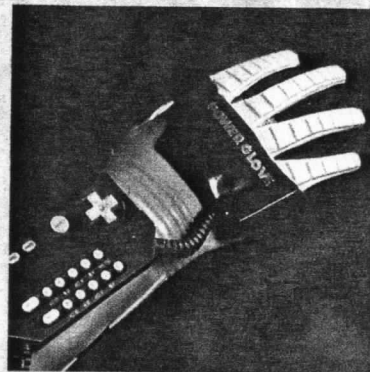
With their basic technology in hand, engineers on both coasts set about, in November 1988, to make the product user-friendly and manufacturable. Scott Goodman was Mattel's mechanical engineer, Norman Grannis was the electrical engineer, while Novak worked out software and game applications for the project. They had until March, or less than five months, to perfect the design and begin testing and debugging. Then they could order materials and tool the Hong Kong factory so production would start in late summer for October distribution to toy stores.

"This was a total fire drill," says Gentile of the AGE team. "We were doing design concepts, software, and hardware design—all parallel."

Capturing a futuristic look

While AGE engineers in New York and Mattel staffers in Southern California were hammering out the choice of sensors, chip design, and 15 configuration programs in the processor, a third party was called in. Mattel hired Image Design & Marketing, Hermosa Beach, CA, to pull all the technology together and fashion the Power Glove's makeup and appearance. Image Design had to allow for a number of design considerations. The glove had to:

- Fit many different hand and forearm sizes.
- Afford the user wrist dexterity.
- Provide a cord to the joystick port that did not interfere with vigorous use.
- Hold up under various amounts of hand perspiration.
- Be turned on and off easily.
- Allow access to change the programs on the keypad depending on the game and game mode.
- Be hazard free and above claims of product liability.
- Look attractive enough to im-



TIME LINE FOR DESIGN

1985

Video game market explodes. Way sought to compete with Japanese products.

1986

VPL, Inc. develops Data Glove for NASA and supercomputer use.

1987

AGE, Inc. buys VPL license to develop consumer version of Data Glove for video games.

1988

AGE gains support and sells license to Mattel, Inc. to develop Power Glove.

1988

Teams of engineers and designers hammer out a Power Glove prototype in five months.

1989

Debugging and tooling allow glove to go into production for worldwide distribution for Christmas shopping season.

press the toymakers, and the 9-to-14-year-old users.

"The biggest challenge was that we had to house the sensors, a pre-existing component, and we had to do it so that it was light, yet still allowed a free-form feel of movement," says Hal Berger, a co-owner of Image Design & Marketing.

Berger and his partner, Gary Yamron, decided on a "Stealth" look for the sensor unit. A slightly curved, manta ray-shaped component above the knuckles holds the

sensors. A short cord connects the sensors to a key pad on the back of the wrist and forearm, from which the cord goes to the television-top Nintendo unit. The key pad provides choices for several operating modes, such as slow motion, and "turbo" for rapid repeat action.

To allow for various hand sizes to fit in the glove, Berger and Yamron left the fingertips and palm open, made the rest of the glove out of stretch material, and added a Velcro™ strap to hold the glove tight to any number of users. But the glove still comes in two sizes.

The top of the glove is plastic and sports the futuristic appearance. The team used an IBM PC and AutoCAD software to design the glove's appearance.

Image Design & Marketing, which is designing the futuristic look of some set components for the new film Robocop II, designed the first Power Glove prototype six days after the concept was developed, says Yamron.

Glove points to the future

As the Power Glove gains recognition and finds itself in more living rooms across the country, other applications are gaining momentum. AGE in New York has already fielded inquiries from Cornell University and AutoCAD-maker Autodesk Inc., Sausalito, CA about designing a slightly better, more expensive glove for CAD use.

"Our next step with our glove," says AGE's Gentile, "is to produce a 'mouse glove' for general-purpose computers. The advantage is that you can do 3-D work, multiple tasking, and CAD becomes very easy."

In a unique twist of technology, a space-age application has spawned a consumer-level product, which may lead to a industrial-level tool to help engineers make other products. □

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