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Inside Project X

The digital living room continues to elude companies like Sony and Microsoft. VM Labs, a Valley unknown, has the answer: a platform for all home entertainment. The game is total market penetration.

By Charles Platt

Typical Valley neighborhood: The back streets are unkempt, in need of a makeover, lined with funky wooden houses - which go for US$350,000 and up. Cruise through the little shopping district and you pass folksy businesses with quaint names, such as Village Motors - which peddles Mercedes and BMWs. The local supermarket looks like an overgrown convenience store, but sells gourmet delicacies, and when you reach the checkout, instead of *The National Enquirer* you find air-shipped copies of *The New York Times.*

Here in Los Altos, on the edge of Silicon Valley, new money has driven up the cost of living, yet it hasn't glitzed the environment as it would almost anywhere else in America. The explanation is simple: Money, here, isn't the main focus. It's a by-product.

This explains the strange behavior of stock-option millionaires who continue working 10 hours a day, seven days a week, peering into screens "for the fun of it." Their gratification isn't dollar denominated; it derives simply from disseminating their code among as many PCs as possible. That's the ultimate validation in this insanely competitive intellectual endeavor: *total market penetration.*

Alas, in an industry dominated by large corporations, brilliant software sometimes languishes in obscurity and lone developers have a tough time stealing market share. In the words of Richard Miller, who founded an obscure start-up named VM Labs in January 1995: "The real question was, How could I possibly come up with a world-beating new interactive product without being Microsoft or Sony?"

Twice before, Miller had tackled radical, ambitious business ventures - with unhappy results. In his British homeland, he played a major role in developing the world's first laptop, the Z88, at Cambridge Computer, founded by legendary PC pioneer Clive Sinclair. The Z88 contained just four chips: one for RAM, one for ROM, another for the processor, and one that Miller designed for all the other computational functions. It was a tour de force, a masterpiece - and a commercial disaster.

Undaunted, Miller founded Perihelion Inc. with a modest ambition: Compete with Sun Microsystems. "We developed the world's first parallel-processing graphics workstation," he explains, "a networkable graphics processor, so you could build a board with 50 of them running simultaneously." Atari licensed it, and it too failed commercially.

For a while, Miller surrendered his autonomy and became an Atari employee. But in November 1994 he quit, sensing a once-in-a-lifetime opportunity. A video-compression standard named MPEG-2 had just been announced, creating fantastic possibilities. Miller believed it could enable him to compete on an equal basis with industry giants, catalyzing a new wave in home entertainment.

MPEG stands for Moving Pictures Experts Group, a consortium that pioneered digital video compression. It sounds technical and dull, yet it has already invaded your living room and has the potential to do much more.

Consider the problem of storing a digitized video image. The simplest way to do this is to assign a number to the color of each pixel, then save all the numbers onto a disc or tape. Unfortunately, this process takes up a lot of space: about 300 Kbytes for a 640-by-480 image using 256 colors, or almost a megabyte if you want to do the job right, with millions of colors.

Video in the US runs at 30 frames per second. Without compression, one minute of high-quality full-screen video requires almost 2 Gbytes of storage. Obviously, this is impractical.

If digitized video sequences can be compressed, though, an entire movie can be stored on one neat little CD-ROM-sized disc. Compressed video allows broadcasters to transmit six digitized TV channels in the bandwidth now occupied by just one. It can make videophones practical. It may bring movies onto the Net.

How does compression work? JPEG (from Joint Photographic Experts Group) was invented to process single frames. It divides a picture into squares of, say, 8 by 8 pixels, and averages the color values of each pixel in the block. Storing these averages requires much less space than storing the value of each separate pixel, especially if you ignore small variations in relatively uniform areas such as blue sky.

MPEG took this concept a step further, capitalizing on the similarities between successive frames in a typical video sequence. In a newscast, for instance, the background behind the talking head remains virtually unchanged. In a tennis match, only the ball and the players move significantly. Even if there's a slow panning shot, the image merely shifts laterally. So, instead of storing every frame, you can store the small *differences* between frames.

MPEG-1 used this system, and in China it's still the compression scheme of choice, driving the sale of almost 15 million VideoCD players in 1997 alone; but almost all the content is pirated, because Hollywood never accepted the format. In the United States, MPEG-1 was a failure.

At the end of 1994, most observers doubted that MPEG-2 would do better. It was more powerful but required 2 Mbytes of RAM, which seemed excessive for consumer electronics devices. True, MPEG-2 was being adopted by DirecTV, the satellite system - but in 1994 no one knew whether that would succeed, either. DVDs were going to use MPEG-2, but even they were an iffy proposition, since everyone knew that laserdiscs had never displaced dull old videotape.

In fact, the reception for MPEG-2 was so lukewarm that no one bothered to develop new silicon to decode its compressed format. Instead, DVD manufacturers planned to use a kluge of existing general-purpose chips that would be relatively inefficient and expensive. Richard Miller figured he could design a single custom chip, just as he had for the Z88 laptop, that would do the job faster. But the real payoff would come if he made his chip *smarter*.

Today's DVD players are dumb devices. All they do is read discs and display pictures. Miller imagined enhancing a DVD machine with a multipurpose chip like a CPU, enabling many additional functions. It should be so flexible, so programmable, he thought, that it would run game software and do 3-D modeling with unprecedented realism.

Thus, a DVD player could evolve into something like the mythical sub-$500 home computer. It would serve as an all-new hardware platform for a new generation of entertainment software, and since it would plug into any TV set, it could reach millions - maybe hundreds of millions - of homes around the world. Moreover, Miller hoped that by sneaking this new processing power into the living room, he might catalyze a significant shift in consumer tastes: the often-predicted, never-realized maturation of videogames into adult-friendly interactive entertainment.

In March 1995, Miller obtained seed funding. In June he hired his first employee. By the end of the year he had half a dozen people, all sworn to secrecy. A while later, with a fine sense of drama, they started wearing mysterious black windbreakers with "VM Labs" embroidered in silver on the front pocket and "Project X" splashed in garish colors across the back.

The firm rented space at the rear of a two-story cream stucco building in Los Altos, on San Antonio Road. For two years hardly anyone knew what VM Labs was up to, and the people who did know were skeptical, because the plan was audacious to the point of lunacy. Miller wanted his chip in *every* DVD player, *every* digital TV, *every* videogame system, *every* dedicated Web browser, and maybe in some videophones and some PCs as well. He would reach out and touch the TV-oriented mass audience, doing an end run around companies such as Microsoft that had been trying and failing to achieve the same goal.

Today, as the chip enters the market, Miller actually has a shot at realizing this goal.

In a small conference room stands a vintage arcade videogame; *Defender*, by Williams. Software boxes and volumes of documentation have been stacked haphazardly on the kind of bookshelves you can get cheap at Office Depot. A not-very-clean whiteboard occupies the far wall, and some utilitarian gray formica folding tables stand in the center of the room.

At one of these tables sits Bill Rehbock, vice president of third-party development, a jovial and rotund character with a youthful face, like an overgrown schoolboy. He has serious glasses, a calculator wristwatch, and a pen in the pocket of his gray short-sleeved shirt. He's the personification of Thirtyish Computer Nerd. But he also projects an aura of calm, practiced competence. When he speaks, he's definitive and categorical, showing no hint of self-doubt.

Rehbock whips out a small screwdriver, removes the case of a nearby PC, and plugs into it a card that is the culmination of two years of obsessive work. A computer-generated landscape materializes on the 19-inch screen of a Toshiba TV, depicting three spheres drifting through the sky in a graceful, random ballet above a rippling blue lake. One sphere appears chromed; it reflects the lake, and the lake reflects it.

This is the kind of demo computer-animation studios used to create 15 years ago, when several weeks of intensive processing on a chain of SGI workstations was required to render a two-minute sequence. Today, though, the VM Labs board is doing it in real time. Calculations that used to require several hours are now being done in less than a second. Moreover, the program producing this imagery is tiny - less than 2 Kbytes in size.

"And it uses ray tracing," says Rehbock. "No polygons."

State-of-the-art videogame machines, such as Nintendo 64 or Sony's PlayStation, simulate solid objects by dividing every surface into triangles or "quads" - distorted rectangles - and then filling them with color. The processor recalculates the new location of each polygon for the next frame, fills each one with color again ... and so on.

The result has a synthetic, airbrushed look. "It's a caricature," says Rehbock.

Ray tracing doesn't simplify the picture by dividing it into polygons; it evaluates the color of every single pixel by calculating paths of incoming and reflected light in the landscape. This provides greater realism but is far more computationally intensive, making it impractical for consumer products - until now. "A Silicon Graphics 02 workstation can't do this," Rehbock says, looking quietly pleased. "A 333-MHz Pentium can't do it, either."

The VM Labs chip can do it, though. Unlike even the newest game systems, it was purpose-built. "The Sony PlayStation uses a processor similar to the old SGI workstations," says Rehbock. "It's eight-year-old Unix technology. Nintendo 64 is an R4300i with an SGI reality engine strapped on. The Sega Saturn uses a Hitachi SH2, which is a processor used in washing machines." He shrugs dismissively.

But game graphics are just the beginning. The chip can create special effects such as still frames, slow motion, and scaled and tiled images; or it can transform the humble DVD player into a videophone, a Web browser, or, yes, a game machine.

In the past, game systems have been exiled to the kids' room while the adults watch movies on the TV in the living room. But if a DVD player can do games as well as movies, programmers may be tempted to use the extra features, and the artificial separation of games and "serious" entertainment could break down.

If we want scrupulous realism, this may require even more processing power; but the VM Labs platform is designed to be upgradable. "We have a processor road map," says Rehbock, "that takes us from 1,500 millions of instructions per second today to 24,000 mips around the year 2000. Our goal eventually is to give game programmers the ability to do Toy Story in real time, so that you can interact with it."

After Rehbock finishes his demo, three other men enter the room. They look uneasy, self-conscious, like woodland creatures emerging from hiding places and blinking in the sudden light of day. Clearly, these guys are not accustomed to giving interviews. But they've achieved some wild ambitions during the past couple of years, and they're well aware of this fact.

Matthew Halfant is a bearded mathematician, a former employee of IBM and later Apple, who developed low-level routines for the VM Labs chip before the chip even existed. "I made sure the square roots and reciprocals would perform well," he says with a funny smile.

At Apple, he worked on advanced font technology. "But the stuff that I did never saw its way out the door. Another mathematician, whom I know from my MIT days, got very enthusiastic about some of my work and is using it at NASA to stabilize helicopters." Halfant adjusts his glasses. "Personally, I was trying to stabilize fonts."

At VM Labs his work has a better chance of finding its intended market.

Next to Halfant is Louis Cardillo, vice president of engineering. His hardware-design team consists of just six people, including himself, five of them formerly at 3DO - the last great failed attempt to revolutionize videogames.

"It's a tiny hardware team to design a chip of this size and complexity," says Cardillo. "Many companies would have 30 or 40 people. When Intel gets around to this problem - as they will, sooner or later - maybe they'll throw a thousand people at it.

"But," he smiles, "you get more enthusiastic if there are fewer people, because you have a bigger chunk of the design. You work harder."

After his experience at 3DO, Cardillo had intended to start a consultancy business; but the audacity of the VM Labs business plan appealed to him. "It's a gigantic challenge to do something like this, and I knew it would be fun whether it works or doesn't."

Why should it succeed where 3DO failed? "From a hardware point of view," he says, "3DO didn't fail. The technology was pretty good - but it was an early attempt at a CD-based system before the market was ready for it, and they couldn't get the systems out into the market before they could sell the software. It was a chicken-and-egg problem."

VM Labs hopes to avoid this conundrum by making its system so easy to program that everyone will want to write software for it, and so versatile that it'll run existing code with few modifications. *Doom's* source code was ported to run on the VM Labs chipset in just a couple of days by one programmer during his Christmas vacation.

The third person in the group, John Mathieson, is a longtime friend of Richard Miller - a fellow Englishman who did engineering and computer science at Cambridge University. He, too, worked with Sinclair. After that, he says, "I ran a small company in England, and we set out to design the greatest game computer there ever was. The first one never came to anything, so we looked around for someone to back us and sold the idea to Atari. It ended up in the Jaguar, the first true 3-D game computer. But Atari didn't market it properly, and the games took longer to develop than anyone expected, because 3-D is intrinsically harder to program and the game industry had no experience at all with 3-D programming."

So here they are, three veterans of technical tours de force that terminated in commercial disasters. But they don't look worried. They figure that VM Labs has a better chance than all the previous grand schemes put together because the chip is not just powerful - it's cheap. Consumer-electronics manufacturers will be able to buy it for about the same price that they pay for dumb, nonprogrammable chipsets that can only decode compressed video. Thus, a fantastic amount of additional computing power will be offered virtually for free.

This will be possible because VM Labs doesn't plan to make money by selling silicon. Its revenues will come from another source entirely, through a series of unique licensing agreements.

Nicholas Lefevre, chief counsel for the company, spells it out. "Our basic business model is two-tiered," he says. "First we license semiconductor companies to make the chip we developed - but they can only sell it to consumer-electronics companies that also have a license agreement with us. This is the same system that Dolby uses."

Thus, a famous chipmaker acquires the right to fabricate silicon based on the VM Labs design, and since it offers extra functionality for negligible extra cost, several major consumer-electronics companies have already agreed to buy it. In fact, some will be using it in their entire DVD product lines.

"But the real money will come later, from the second tier," Lefevre adds. "Any software-development company that wants to write for the new chip will pay VM Labs a royalty on every copy of each game sold."

It's a classic Silicon Valley vision: VM Labs doesn't build anything - it licenses its intellectual property to other, bigger firms that do the capital-intensive work of manufacturing and selling things.

Lefevre has an interesting background. "I went to law school at Georgetown in the mid-1970s," he says, "but got the computer bug and started staying up all night programming Radio Shack's TRS-80, then the Atari 400 and 800."

He tried to set up a private practice in Washington, DC, specializing in computer-related law, but it wasn't the right place or time, and he became general counsel for Commodore, in the Commodore 64 era. In 1983 he had the fine distinction of bringing the first antitrust lawsuit against Microsoft, when it had an alliance with IBM, which Lefevre termed a "symbiotic monopoly."

"We asked for $32 million," he recalls. "We met to settle, Gates yelled his head off, then we settled."

In 1995 Lefevre saw Richard Miller's business plan for VM Labs. "In private practice you see a lot of business plans, you try to be polite - but this was one of the few I had ever seen that was really compelling. This was contemplating conquering the world, becoming the standard for interactivity in the home - a vastly expanding market."

Inevitably, this market interests other, bigger players. "It does not escape the notice of Grove and Gates," Lefevre agrees. "But Andy Grove's shareholders would have a hard time accepting the profit margins in consumer products, where the processor has to sell for less than $50 direct from the fab. So, Intel doesn't have a solution for this problem. They'd rather push computers into the consumer arena while maintaining relatively high price points."

And Microsoft?

Lefevre chooses his words cautiously. "Their ComCast investment, TCI initiative, and WebTV acquisition suggest that they'd like to press into the consumer-electronics field. Presumably, their deal with Sega means that the next Sega system will have WinCE available, and, conversely, I assume that they want to bring entertainment to WinCE platforms."

VM Labs, however, believes that its chip is so powerful and versatile that it will establish a new hardware standard for entertainment that's vastly more attractive than anything that will run on Windows. Actually, Windows CE could probably run on the VM Labs chip, but would Microsoft pay royalties for this privilege? That's hard to imagine.

In effect, then, VM Labs has chosen to be Windows incompatible. It is defying the biggest, most feared company in the history of software.

Richard Miller's office is small and unobtrusive, halfway down a hallway at the back of the building. Miller, likewise, is soft-spoken and unpretentious. With a pale complexion, intent, serious eyes, and bushy black hair flanking a high rounded forehead, he looks like the stereotypical scientist who'd rather be in a lab somewhere, wearing a white coat.

His ambitions, though, have always been grand. "When Jack Tramiel interviewed me for a job at Atari in 1989, he asked what I'd like to be doing in 5 to 10 years, and I said that within that time I intended to compete with him." Miller shrugs. "He gave me the job anyway, as vice president of technology, in charge of all the engineering and R&D."

When Miller left Atari in 1994 with little money and no definite prospects, he had a clear idea of what he *didn't* want to do. "I knew I didn't want to compete in the business of manufacturing and selling consumer electronics," he says. "The manufacturing cycle for Christmas begins in June. You have to anticipate the market beyond any reasonable level of foresight, and it's essentially impossible. So you often get it wrong, and then you have to recover. Success is not determined by talent or any other rational basis."

From the beginning Miller imagined licensing his product, rather than selling it directly. But he still needed capital to take him through the product-development phase, which entailed a sacrifice he didn't want to make: surrendering his autonomy to venture capitalists.

Instead, he approached some wealthy friends. "One of them listened to my plan, which focused on the technology and the opportunity that MPEG-2 was presenting, and he said, 'Do you have a business model?' And I said, 'Uh, what's a business model?' He explained that I needed a way to finance myself, to get to this Valhalla in the future where there would be a wonderful stream of content royalties." Miller smiles at his own naïveté. "I went home," he says, "and had to think about it."

His ingenious two-tier scheme was the result. If he could tempt the semiconductor companies and the consumer-electronics manufacturers by offering them a low-priced product, then the software publishers would fall into line and provide him with his profit margin. "They're pure businessmen," Miller says. "If you present them with an opportunity to sell their software to a new category of consumers, and if it makes sense, they'll do it; and if it doesn't, they won't - or they'll pretend to do it, or they'll ask you to pay them to do it, which is the situation that failed games-machines manufacturers have found themselves in. But if software publishers see more than a million units in the next 12 months, they will probably embrace the platform."

Still, Miller had to make sure his chip would satisfy programmers' demands. Here he felt confident, because existing systems were so hacker-unfriendly. "In PC graphics cards, Microsoft said, 'If you want to write a game title that will work on the PCs of the future, you have to write for our system, Direct3D.' Well, there's a lot of things missing from it: It's inadequate for TV, PC oriented, and very restrictive."

During 1995, Miller hung out in bars with game developers, asking them what they really wanted. "The answer was, something totally programmable, with no restrictions, where they could get down to the metal and tweak the pixels in any way they chose and not have to answer to Microsoft or Sony."

He chose a parallel-processor architecture: "Parallel processing is virtually useless for running Windows or Microsoft Word and has received a bad rap because of that. There have been some spectacular failures, because it is not appropriate for business applications. But it's ideal for graphics. We have four processors in the first generation, and in the next we'll have" - he hesitates - "more." In his polite British way, he sounds almost apologetic at not naming the number.

But do families really want interactive entertainment? "Nobody has ever brought a successful, truly interactive platform to the center of the family household," Miller admits. "They've all failed. But the kids who grew up playing videogames are bringing up their own families now, so they'll be interested in having it in their living room. I don't think it's been proven that people prefer not to have any interactivity. It's a question of *to what degree* they want it."

This still doesn't explain, though, why videogames have remained a market for kids. "Game consoles attract medium to hardcore gamers, because of their cost," Miller responds. "Therefore, the titles that succeed are appealing to core gamers. But now we're offering interactive capability to families that never thought about buying a game machine. This opens a new market."

He tries to make the scenario sound uncompromisingly positive, but there's still a look of hesitation and caution in his eyes - and with good reason. Some of the fundamentals to enable his vision are still not in place. MPEG-2 has become the preferred method for video compression, as he predicted; but fewer than 500,000 DVD players had been bought by consumers as of April 1998, and the format may take years to displace VHS. Also, Compaq, Gateway, and other computer manufacturers have started selling PCs with DVD-capable CD-ROM drives built in. These drives use the internal processing power of a PC instead of a VM Labs chip. The result is vastly inferior - but will consumers realize this? Will they care? History is littered with smart computer products that were beaten out by dumber ones, as Miller is well aware.

And he's concerned about potential competitors. "This is no time to rest on our laurels," he says. "We heard about a company recently that is trying to do something similar to us. In two years they got through $50 million. In the first two years of VM Labs we got through $3 million. We've run this on a shoestring - not entirely by choice."

Still, Miller emphasizes VM Labs's unique advantages. It's well ahead of the competition, and he believes that his team is intellectually unmatched. Also, "we can change direction very quickly, without venture capitalists," Miller says. "That's been an absolute pleasure - not worrying whether the person with the money will agree with our vision. So, I believe we will consistently beat our competitors with technology, and maintain a lead there, and maintain a better time to market."

He sounds as if he's rerunning the business plan in his head. In the US, home movies are a $15 billion industry, home videogames $7 billion, and the VM Labs chip can handle both, with extra power to spare ... so, yes, it could work. It *should* work.

Let's suppose that it does work. What's the best possible outcome that Richard Miller can imagine?

The question disconcerts him. "We're not great on big fancy visionary quotes around here," he says with a forced laugh. He pauses for a moment, thinking. "I hope we will enable software developers to get really creative again," he says finally, "and take off the shackles. I hope, and believe, we can establish a whole new standard for interactivity."

He sounds sincere about this goal, perhaps harking back to the days when he and his contemporaries were first hooked on computers, long before the era of huge software companies selling boring products designed by committee and slowed by bloated code. Back then, in the late 1970s, one teenager could create something exciting and wonderful, using fanatical ingenuity to squeeze it into 48 Kbytes of RAM.

Among the employees at VM Labs, this spirit endures. "They put their lives into this business," Miller says.

Why do it? In the hope of a big payoff? "No," Miller says. "They just love working with other great engineers - coming up with ideas, where you know when you've solved a problem, it's a great solution, and probably no one has ever done it before."

Yet even this is not enough. If a technical tour de force remains a secret shared only by a few, it has not realized its true potential. It must be disseminated as widely as possible.

Miller makes no secret that he recognizes this fact. "I'd like our chip to be the Dolby of interactivity," he says, flatly and simply. "I want it to be in every living room in the civilized world."

In other words, total market penetration.

The ultimate Valley dream.

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