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Preface

In the early 1990s, as a young technology journalist in the Netherlands, I visited Silicon Valley. There, surprisingly, at a conference in San Jose was where I first encountered ASML, a Dutch company that was embroiled in a technology race with the then-unassailable giants Canon and Nikon.

As a student and fledgling journalist in the land of Philips, I'd never heard anything but complaints about the Japanese and the Koreans and the disruptive effect their unfair methods were having. But in the Fairmont Hotel in San Jose, my countrymen told me a different story. Whatever else happened, they were going to crush their Asian competitors.

It surprised and delighted me that a machinery manufacturer from a small town in the Dutch deep south was playing such a crucial role in information technology. After that first meeting in the US, I kept a close watch on the engineers in Veldhoven. ASML intrigued me: a small high-tech player from my own homeland was determining the pace of the computer chip industry. What's more, the company oozed enthusiasm.

It must have been somewhere around the turn of the century that I began to play with the idea of writing a book about ASML's genesis. It seemed like a fascinating endeavor to lay bare the roots of a Dutch fighting machine that had just beaten the Japanese heavyweights Canon and Nikon.

How can a tiny company succeed where a colossus like Philips threw in the towel? True, after 1984 it took ASML another seventeen years to grow (seemingly from nothing) into the market's unrivaled leader, but it was a success story to die for. I often wondered: who was behind it, and how had they pulled it off?

Yet for years the project sat in cold storage. The dot-com crisis dealt a heavy blow to my company, Techwatch. I'd founded it in 1999 to publish my own magazine, *Bits&Chips*. Hit by the severe recession, my bank account was constantly overdrawn in 2002 and 2003, and my three employees and I had to pull out all the stops

to keep the place afloat—and what's more, I had to write the lion's share of my magazine myself.

Despite all that, in 2003 I visited Wim Hendriksen for a first interview for the ASML book. Wim was part of the first wave of employees who came on board shortly after the joint venture's founding in 1984. He kept repeating one claim: "ASML as it is today—it was planned that way from the start." The company's current culture, its frank, confrontational style of communication, its reckless—"all or nothing"—quest to dominate the market, the revolutionary idea to farm everything out: the seeds were all planted in the earliest days of ASML's existence.

Every self-respecting journalist takes a claim like that with a hefty grain of salt. Can you conceive the culture and essence of a company that makes extremely complex products in the space of a few months—when the preceding years were a shambles? Can it be true that in the spring and summer of 1984 a culture was sown that would still exist thirty years later? I found it hard to believe. It's the nature of human memory to distort the past, and by then I'd gained enough experience to know how differently different people can view the same events.

The death of ASML's former CEO Willem Maris at the end of 2010 was the push I needed to seriously commit to this project. I decided to publish a *Bits&Chips* special issue on ASML and interviewed several insiders for it. One thing became abundantly clear: ASML's history is anything but a straight and neatly paved road. On its way to the top, the technology company has gone through some very deep valleys. And many of the stories and anecdotes making the rounds in the Netherlands' high-tech circles turned out to be quite different in reality. I discovered that the company's history was riddled from start to finish with the bizarrest of turns. In short: ASML was such a thrilling story that I couldn't leave it untold.

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What did I have in mind when I started? To explain that, I need to tell you a little about my work in the nineties as a freelance

science and technology journalist. I enjoyed popularizing difficult subjects, but over the years my interest turned increasingly to the people involved. In particular, it was endlessly fascinating to listen to the absolute kings of technological innovation: the researchers at Philips' physics laboratory, Natlab. It was my great luck to speak with those brainiacs regularly in the nineties, mostly to fuel my contributions to the science insert of a respected national newspaper, the *NRC Handelsblad*. Whenever the bastion of cutting-edge research had an interesting story to tell, I was usually the first one they called.

Those interviews were definitely experiences. They touched on not only the technology, but also market opportunities and what the inventions and systems meant for society. Natlab's scientists and engineers had the most fascinating stories. Searches that took years, intense collaboration and, above all, a lot of bureaucratic tussles with managers and product divisions. The Natlabbers often had a strident opinion of Philips' bureaucracy, too, and the ineptitude and incompetence at the top. And they were perennially skeptical of commercialization.

Engineers are often dismissed as nerds. In popular stereotype, they're socially awkward people, folks who fall somewhere on the autism spectrum. But the engineers I encountered—certainly the inventors at Natlab—had extremely multifaceted interests, cavernous knowledge, and usually a strong opinion on the impact of their work. They brought the technical world to life for me. And rarely were they the awkward dorks of stereotype; rather, they were well-rounded and socially fluent people.

To be clear: often they were, indeed, nerds of the first order. The inventor of ASML's electric positioning table, Rob Munnig Schmidt, has kept searching for the ultimate audio amplifier even in retirement; Natlab director Hajo Meyer made another fifty concert violins after he retired, using a scientific approach he described in academic articles on acoustics; Natlab director Marino Carasso still solders microcontrollers onto PCBs in the basement of his canalside home in Amsterdam.

Because I also wanted to take in the feel of the whole company, from the office desk to the factory floor, I spoke not only with founders, geniuses, and senior management, but also with secretaries, research assistants, machinery operators, service techs, and members of the worker representation council. The trade union official responsible for ASML in its early days also granted me a few hours of his time. All these people often had a very different view of the world than did the company's management.

So that's what I had in mind when I was mulling the shape of this book: capturing on paper how all those people had experienced the ASML adventure. I couldn't avoid the technology on which ASML built its success, but I knew that a story about the people, the culture, the money, and the organization would be far more compelling. Because however brilliant the technology may be, it ultimately forms only a part of ASML's success—even if technological supremacy was an absolute prerequisite every step of the way.

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But if I wanted to write a book about the people of ASML, how much of the technology should I include? After all, the stars of the story—including senior management—are all engineers, and the company owes its existence to innovations and technological frontiersmanship. That was my biggest struggle in the whole project: I wanted to write a book that would be accessible to everyone, but I couldn't avoid the technology.

And so, in the fall of 2016, I decided to write two books: a management book and a technical book. I saw the management book as a way to introduce a wider audience to the most extraordinary high-tech company the Netherlands has ever known.

The version of the book you're reading is the technical one. Several people advised me not to publish this version: too much work, and a commercial clunker. But the reactions I got from readers after we published the (pretty darn technical) book *Natlab – Kraamkamer van ASML, NXP en de cd* (Natlab: The Birthplace of ASML, NXP, and the CD) told a different story. For people with an interest

in science and technology, the more difficult passages posed no problem at all.

Even so, this book is also, first and foremost, a book about people, the engineers behind ASML. I popularize the technology and science as much as I can, to keep technically inclined readers who don't have the background from tripping over the text. That means engineers who do have the background won't find any real depth in this book—for them, there's plenty of other technical reading material available. I only emphasize the technology when I think it's essential to the story, or of historical importance.

As it happens, no one's written an extensive popular history of chip lithography yet. There are a library's worth of books about the semiconductor industry, but these tomes say surprisingly little about the strategic technology at its foundation. That's why in this technical edition I also talk about developments in the rest of the world—though Japan receives relatively short shrift.

For me, the human element was essential. That's also the reason why I called this book *ASML's Architects*. The name refers to the development of both the wafer stepper *and* the business.

In science and technology, everyone always refers modestly to the shoulders of giants on which they stand. Researchers and inventors try to downplay their contributions by pointing out they're building on what their predecessors created. I went looking for those giants, and in this book I've tried to shed some light on their contributions.

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It takes teamwork to build complex machines. That's why this version emphasizes the people behind the technology—the engineers. The very first lithographic machine that was developed in the Netherlands, the photorepeater, wouldn't have been as perfect if Frits Klostermann and Ad Bouwer hadn't pushed themselves and each other to their very limits.

This approach has always been crucial. The intensive exchange of ideas—also known as reviewing in today's jargon—is indispens-

able in making complex systems like steppers, and it's a central theme running through ASML's entire history. The way the company's engineers still do this, the way they hold their discussions on the absolute cutting edge of both the science and propriety, has been taken to truly legendary extremes.

I wanted to bring this engineering culture to life. That means this book isn't a quest to name every participant and the credit each is due, either. I've limited myself to the key players, and even there I know a few are missing.

After so many years, it's hard to get a grip on the exact historical course the technology took. Only rarely are brilliant inventions attributable to individuals, and even they usually drew their inspiration from their teams. Even the names on the patents (and their order) don't always do the reality justice.

Most of all, I wanted to make the technical world accessible. To that end, I've highlighted a number of extraordinary or exciting events and discoveries, and only briefly noted the parts that seemed to me more boring—or simply left them out.

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I spent seven years working on this book. I loved reliving the entire adventure from my perspective. The amazing events, the roller coaster ASML has been on for its entire life, the paranoia in the chip industry, and especially the many interviewees and the openness with which they spoke with me, have repeatedly given me that extra push and motivated me to take the time I needed for the book. One interviewee was even glad for the opportunity to confess. He felt he'd behaved so badly during his years of research that the thought of a printed confession helped to ease his sense of guilt.

Running your own company—in my case, a publishing house—is sometimes hard, but more often it's a blessing. Because when you're writing a book, a company like mine provides an extraordinary number of conveniences. For example, it takes at least half a year to transcribe three-hundred-plus hours of interviews. I could

turn all that work over to our student interns. And business kept running as usual during the many months when I spent the bulk of my time writing. Last but not least, it's just plain exhilarating to be in an environment where you can tell the occasional anecdote and share your struggles in the knowledge that your colleagues will understand you.

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To me, the most intriguing task was testing Wim Hendriksen's claim that ASML as it is today was planned that way from the start. Objectively speaking, ASML had a chief architect and that was Gjalt Smit. He was the one who defined the company in its first months. That this architect was full of himself and had a nearly evangelical zeal to crow about his ASML adventure didn't make things easier. At first, I was worried the whole story would turn into a hagiography, and in that case there's only one thing a journalist can do: launch an exhaustive search for opposing voices and less adoring perspectives.

And what do you know: Gjalt Smit was decidedly no saint. His arguments with shareholder Arthur del Prado were notorious—Smit has never given any details on those, and Del Prado also declined to discuss their struggle, but former colleagues had been present. And only just this past year did it become clear to me that three and a half years into ASML, Smit's expiration date had arrived. He was the right man at the right time. After that, many people were glad to see him go. To be honest, I was relieved: Smit turned out to be human, too.

But even though Smit was spat out by many at the end of his ASML tenure, everyone affirms that he delivered a miraculous effort. He planted the seed—whatever the cost and at lightning speed—that enabled ASML to grow from an insignificant minor player to a global superpower. The world got a taste of that even during Smit's short reign. In 1984 ASML was a nobody; at the start of 1987, the *New York Times* mentioned the company in the same breath as Canon and Nikon.

The first fifty employees who came from Philips formed ASML's technological DNA. The most extraordinary thing is that Gjalt Smit turned that burned-out jumble into an impassioned team, and a completely different culture emerged. Dozens of people confirm that the credit belongs to him. The words that Smit used in 1984 and 1985 apparently made such an impression on his colleagues that many of them were able to recite his words back to me verbatim in interviews. I, too, experienced how talented Gjalt Smit is at stakeholder management. When it became clear to him that this book was a serious project, he regularly carved out time during his trips from his home in Switzerland to the Netherlands to speak with me and answer my questions.

ASML is also the story of a merciless work culture. Around the turn of the millennium, I interviewed one of the millionaires who said farewell to the company after cashing in his shares. He was years away from retirement age, so I asked him why he'd left ASML. It was a fantastic company, wasn't it? But at that time he was worn out, and this is how he described it: "Look, eighteen-wheelers are built to do sixty miles an hour. You can make them do ninety, but then you wear them out faster. At ASML, I spent seventeen years doing ninety."

ASML is a success story, and for that reason alone this book differs substantially from the books that have been written about other major Dutch companies such as the ABN AMRO bank (*De prooi* – The quarry), Philips (*Kortsluiting* – Short circuit), and AOL rival World Online (*Nina*). There, the sources are people with lingering resentment and scores left to settle. In my case, I was often talking with people who looked back proudly on their experiences and were eager to share them with me. But even this success story has notes of doubt, revenge, euphoria, and hubris.

The extraordinary thing about this story is that people so often wanted to talk frankly about their own character flaws, miscalculations, and mistakes. To me, ASML's success is built on candor, and I've made grateful use of that openness and honesty.

I confronted many people with less flattering memories. The extraordinary thing is that though they occasionally protested, no one tried to put a different twist on the story.

In the project's final months I realized there's no such thing as partial transparency. I was given access to piles of confidential information that gave me ammunition for further questions. That, I believe, is the major value of, and the courageous thing about, honesty: you transcend yourself by making yourself vulnerable.

All in all, I still think it's an amazing story. Amazing that ASML made it in the first place; amazing to see what you can accomplish with the right people, the right knowledge, a giant sack of money, and the right decisions. Amazing, too, how companies can be entirely dependent on events over which they have absolutely no control. In that regard, I agree with what Gjalt Smit wrote in his own, unpublished memoir on ASML: "I strongly doubt that given the same parameters today the same company would emerge again—if, indeed, any company at all."

René Raaijmakers

Introduction

Thirty-some years ago, the entire lithography market for chips was controlled by GCA and Nikon. The entire market? No—a tiny machinery manufacturer in the unassuming Netherlands kept bravely resisting the gorillas and made life decidedly difficult for the Americans and the Japanese.

The boys from Holland weren't satisfied with the status quo. They wanted to conquer the world. It took nearly ten years before there was real progress on that front, but by the mid-nineties a rise to prominence could finally begin that, another decade later, would result in absolute control of the market.

After that the technology company continued fearlessly on. Now, another ten-plus years later, ASML makes machines that can print such fine-scale structures at such immense speed that no other company in the world can match them. The tiny Dutch town of Veldhoven sets the pace of information technology; it dictates the speed at which chips across the world grow in computing power and information density.

ASML is now an unparalleled success. Its share price has been higher than that of its former parent, Philips, for years. It's the superlative case on many fronts: it's the Netherlands' largest exporter, it provides the most jobs in the country's technical sector (counting its high-tech ecosystem), and it's the world's biggest machinery manufacturer for the chipmaking industry.

With a chip lithography market share of 70 to 80 percent, ASML has been leaving Canon and Nikon in the dust for years. But not only that. It's still investing heavily in the development of ever-smaller chip structures. The current efforts to do that using extreme ultraviolet light are so complex that no other company dares to invest seriously in it. It's an effort we can safely compare to the American Apollo project, and it probably even outshines that.

In the past decade, the company has moved up in the general public's awareness—largely thanks to its performance on the stock exchange and the publicity that has generated. But the gen-

eral public knows very little about how ASML made it so far, where it derives its strength, and what lay the groundwork for its rise to prominence. This book aims to change that.

5. **The Violin Maker**

As one of Natlab's section directors, former war refugee Hajo Meyer recognizes the value of the optical precision technology that a few years later will serve as a seedbed for the wafer stepper.

In 1950, Hendrik Casimir at Natlab interviews a recent graduate named Hans-Joachim Meyer. Forty-one-year-old Casimir has been leading Philips' research lab for four years. Before that, he attained widespread renown as a scientist. To the sorrow of many, he turned his back on his academic career to focus on managing Philips' now famous laboratory.

Meyer and Casimir click from the start. They're soon engaged in an animated discussion. In 1949 Meyer devoured Aage Bohr's articles on the characteristics of atomic nuclei. On his advisor's recommendation, he read Casimir's articles on the quadrupole moment—the discovery that propelled Casimir to worldwide fame as a theoretical physicist. Young Meyer is thus well versed in the intellectual legacy of the man across from him. What's more, the material inspires him. His eyes twinkle as he talks about it, and that makes a favorable impression on Casimir.

Meyer's sparkling enthusiasm is all the more impressive in light of the young physicist's background. Casimir is interviewing a twenty-six-year-old man who lost both his parents in the recent war, escaped multiple deportations, and barely survived the concentration camp at Auschwitz.

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Hajo Meyer is fourteen when he hears that he may no longer attend high school in his home town of Bielefeld because he's Jewish. It's November 1938, shortly after Kristallnacht in Nazi Germany. In the panic that follows, Meyer's parents put him on the train to Amsterdam in the Netherlands, which is not yet occupied. He will never see them again.

Young Hajo arrives at Bergen aan Zee and passes through five refugee centers. He's bored to death and finds work at a smithy, but the police send him away. Refugees aren't allowed to work. His mother, who speaks good Dutch, lends a helping hand from Germany. She writes to the Dutch Committee for Jewish Refugees, and her son is subsequently admitted to the Jewish Work Village in Wieringermeer, a vocational training center for refugees. There the fourteen-year-old may attend vocational school, where he decides to learn machining.

It's heaven for the inquisitive teen. Most of the center's residents are adults, among them many intellectuals from Germany and Austria. They're learning a trade so they can emigrate elsewhere: America, Australia, somewhere far away. Meyer befriends a math student from Vienna who tutors him, evening after evening. He also studies physics.

Meyer's crazy about engineering and music, and in the letters he writes to his parents he begs for car magazines. He can't get enough of the world around him. He visits movie theaters and museums, enjoys music, and eagerly absorbs all the knowledge that surrounds him. "I've finished my math book," he writes on October 3, 1939. "Can you send me a new one? If so, make sure you buy a very good one, for self-study."

A convoy of buses disrupts the apparent peace in 1941. A year earlier the Germans invaded the Netherlands, and now they're closing down the work village. They send most of its residents to the Mauthausen concentration camp in Austria. Meyer, now sixteen, is miraculously spared this fate. He's allowed to go to Amsterdam, where he may attend the Jewish vocational school after acing its technical admission exams. By then he's a committed atheist, and he doesn't really fit into the orthodox environment that surrounds him. But the young man's eagerness to learn stands out, catching people's attention, and a loving foster family takes him in.

Through friends, Meyer gains admittance to the Jewish Montessori high school in Amsterdam. There he receives afternoon lessons from the crème de la crème among Dutch intellectuals, all of them

Jewish professors fired from their university positions. His foster parents arrange for a well-to-do Amsterdam family to pay his tuition. Amazingly enough, the Gestapo decides the private Montessori school may hold final exams. After passing them, Meyer goes into hiding in the tiny town of Blaricum. The Germans eventually catch him anyway and put him on a train to Auschwitz.

After a few weeks of backbreaking work in the Polish concentration camp, the Germans order him to the Gleiwitz I railroad labor camp. They need skilled labor, and because Meyer has experience as a machinist, he may repair train cars. It's his salvation. The eighteen-year-old works alongside German and Polish craftsmen—in a prisoner's uniform, but the factory is heated. As a Jew, Meyer's diet is restricted to the meager and tasteless Auschwitz rations, but now and then local Polish girls sneak him some extra bread.

Twice he escapes the gas chamber. The first time, the Germans overlook him during selection. The second time—in January 1945, ten months after his arrival—the advancing Soviets force the SSers to flee, but not until they've marched the camp's residents all the way to the Oder river. "If it hadn't gone the way it did, I'd be glue, or fertilizer, or shoe polish now," Meyer later writes.

At the end of the war, the United Nations Relief and Rehabilitation Administration orders everyone to return to the country where they were first taken. And so a grievously ill and pencil-thin Meyer endures an arduous journey through Odessa and Marseille back to the Netherlands. His parents will not survive the war, but they do write a goodbye letter. They've been taken to Theresienstadt, where Meyer senior succumbs to poor health; he contracted tuberculosis a year earlier. His mother takes a cyanide pill she smuggled in with her, after she hears she's been ordered to Auschwitz.

After the war, the younger Meyer's excellent final exam scores win him a scholarship[15] to study physics at the University of Amsterdam. Because there's no money to pay for further study after he graduates, his professor tells him, "You go see Casimir."

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The misery in Hajo Meyer's life isn't enough to break him. The twenty-six-year-old physicist is radiant, bristling with energy, and he talks just as enthusiastically about nuclear spin resonance as about art, music, and cars.

Casimir sees a kindred spirit in Meyer. "Well," he tells the young scientist, "it won't be easy for you at Philips as a theoretical physicist. So spend half your time as the editor of the *Philips Technical Review*." And so Meyer is introduced to a renowned institution: a scientific journal published in four languages that enjoys global fame. He travels the world with his little notebook, writes a lengthy article each month, and becomes familiar with Natlab's every nook and cranny.

Casimir wants the young researcher to gain a wide range of experience and pushes him toward experimental work, which at Natlab is considered more valuable than theory. So Meyer works in the cryogenics group, among others, and his manager tasks him with writing the very first reports on transistors. Meyer also visits AT&T's Bell Labs in Murray Hill, New Jersey, where he and section director Haaijman receive training in the use and manufacture of transistors (appendix 1).

After that, Meyer teaches other Natlab researchers the ins and outs of transistors and how to make them. To share that knowledge with Japanese colleagues, he also spends ten weeks at Matsushita, a company with which Philips has close ties.

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The bond between Casimir and Meyer grows. Natlab's director is fond of the energetic, upbeat young man and he feels a kinship with the young researcher who, like himself, studied theoretical physics. Casimir regularly asks Meyer to visit him at home in nearby Heeze. Sometimes for a glass of wine, sometimes for dinner with their wives. They talk about Casimir's time with Niels Bohr in Copenhagen, about music, and about philosophical questions.

Meyer goes on to lead the lab's gas discharge group for a few years, and then in 1964 Casimir asks him to succeed Eddy de Haan as the director of the lab's vacuum tube research section. In addi-

tion to vacuum technology and electron guns, he'll also be responsible for optics.

As a section director, Meyer is exposed to the turmoil surrounding Hendrik de Lang, one of the few optical engineers at Natlab. De Lang studied under Frits Zernike, the inventor of the phase contrast microscope. He's an exceptionally bright and creative researcher. His specialty is the conversion of optical signals to electrical ones, a step that's crucial in signal processing and signal-based measurement and control.

De Lang is not an easy man. At the lab he's known for being infinitely stubborn and difficult. By the time Meyer becomes his boss, fifty patent proposals are stacked on De Lang's desk. None of them have ever been submitted, because the recalcitrant engineer is on fighting terms with everyone in the patent department.

Eddy de Haan has been De Lang's manager for years, and the problem weighs heavily on his shoulders. It's one of the first things he brings up while he's training Meyer to take over. "That De Lang's a very bright kid. But he picks a fight with everyone. See what you can do with these, because they're important," De Haan says as he hands Meyer the patent proposals.

One lovely weekend day that summer, Meyer settles into a patio chair to look through the pile. He's deeply impressed by the work. Meyer is interested in optics, but it's his experience as a craftsman and machinist that make him realize that machines using De Lang's inventions could achieve much greater precision. The section director is determined to protect that body of ideas for Philips.

Meyer's understanding of his optical patents earns De Lang's respect. All the patents are ultimately filed. A few years later, Meyer will create a research group that combines optics, precision mechanics, and photochemistry. It will turn out to be a crucial decision, one that seeds the ground for the development of the video long-play disc—the predecessor to the compact disc—and the wafer stepper, the lithographic chipmaking machine.

As the sixties progress, Meyer and De Lang develop a friendship. On a personal level, the director and the group leader share a love

Hans-Joachim "Hajo" Gustav Meyer

for music. Both play the violin. Meyer discovers that De Lang is a talented violin maker. *I bet I can do that, too*, he thinks. His experience as a machinist serves him well there. After he retires in 1984, he immerses himself in the craft and makes some fifty instruments, so good he's even able to sell them to professional concert violinists. He also publishes scientific articles on acoustics. Accordingly, many a Natlab researcher will later refer to Meyer as "the violin maker."

23. **The Reunion**

Gjalt Smit is handed a demoralized team that's convinced Philips has rigged up a special gallows to rid itself of them.

In the spring of 1984, forty-seven Philips employees have little to look forward to. They've been selected by Wim Troost to move to the company's new joint venture, ASM Lithographic Systems, on April 1. It's a dispirited group that's been saddled with a single employee from ASM International, seventeen unsellable machines, and a terrible image. Meanwhile, market leader GCA has hundreds of steppers on the market and runner-up Nikon is quickly gaining ground. ASML's market share? Zero percent.

Renowned market analyst Rick Ruddell proclaims the joint venture between ASM and Philips dead in the water. Ruddell is an expert on the lithography market. In the mid-seventies he tracked the rise of Perkin-Elmer, and he watched as in the early eighties the market leader came under pressure from GCA, which brought the first commercial wafer stepper to market in 1978. In 1981 semiconductor companies bought as many steppers from GCA as they did projection aligners from Perkin-Elmer and Canon.[2]

In the seventies Ruddell wrote admiringly about Natlab and the highly advanced stepper it developed in late 1973. He praised the pioneering Dutch spirit. But his enthusiasm vanished in the early eighties as GCA scored customer after customer and S&I just didn't seem to grasp the game.

Ruddell visited Eindhoven, but as the years passed, S&I's vision and plans grew fuzzier. As the American analyst became increasingly negative about the Dutch multinational, he praised Japan's up-and-coming Canon and Nikon. He published his conclusions in lengthy reports, well substantiated with statistics and analyses. In the early eighties he ripped the activities in Eindhoven to shreds. Ruddell kept repeating the same humiliating message: Philips doesn't know what it wants to do with its steppers.

In the Ruddell & Associates report for 1983, the Dutch company was a laughingstock. "Since Philips chose not to respond to our questionnaire, we shall attempt to provide what information that we have," Ruddell wrote, referring to the first reports of a joint venture with ASM. He instantly put his finger on the problem: "Philips has never been able to 'get off the dime' and give this system the sales support that it deserved." Then he got vicious: "Imagine, one of the largest corporations in the world was unable to take even the first steps that [Liechtenstein's fledgling stepper manufacturer] Censor has accomplished. And the irony of it is that until very recently, Philips probably had the finest stepper in the world."

Ruddell wryly concluded that it was no surprise, then, the Dutch company wasn't able to "get their act together and come up with some response" to his survey and repeated phone calls. Then he hung Philips out to dry. He listed every question he asked the company. Beneath nearly all thirty-one of them was written "No comment."

Ruddell's observation was painful, but he was right. After Troost issued his 1979 edict to build a stepper with a hydraulic table, S&I's engineers stubbornly kept working on an unsellable concept. S&I didn't look outward, at competitors and customers, but poured all its energy into completing a machine no one was interested in having.

In 1982 S&I did deliver the technology to IBM, but no orders followed. Subsequent attempts to create joint ventures with Cobilt, Perkin-Elmer, and Varian ran aground. And all that while, Philips wasn't investing in optical lithography. It wasn't freeing up money for a sales division. For nearly two years, development at S&I was at an effective standstill.

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The engineers that Philips has transferred to the joint venture are all too aware of their position. They're the joke of the lithography market. No one is betting even a penny on their resurrection. No wonder ASML's employees view their new home as a leveraged die-

out, a play on the term *leveraged buyout*: a spinoff created for the purpose of going bankrupt. It's how Philips has decided to shed its unnecessary baggage, they're all steadfastly convinced.

But then Troost organizes a meet-and-greet with Del Prado and Smit in the Bilderberg hotel. For Smit it's a veritable reunion. He encounters former colleagues such as Joop van Kessel and Ger Janssen, people with whom he got along well eight years ago in his time at S&I. A few years back he even tried to convince Van Kessel to come work for him.

When Smit climbs onto the podium and, full of fire and passion, tells the group he plans to conquer the world with their wafer stepper, his words are met with disbelief and skepticism. Then Van Kessel takes the stage. He knows Smit made quite a career for himself at ITT, and he knows the man from the time they did business for S&I together in Italy. Van Kessel knows that Smit's extremely talented. "You can trust Gjalt Smit," Van Kessel tells his peers. The mood after the meeting is more positive. Troost and the HR employee in attendance clap Van Kessel on the back. "Great work, Joop. You've done these people a huge favor."

Smit is also glad of Van Kessel's presence. They go way back. Smit knows this natural skeptic is a go-getter with a good feel for sales and an ability to lead others. Van Kessel will soon grow into Smit's most vital pillar of support.

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After the meeting, Smit immediately contacts Van Kessel. He wants to know what's really going on. Van Kessel calls Richard George and Ger Janssen to join them, and the three men tell Smit a tale that confirms the rumors he heard at ITT. "Gjalt, not to burst your bubble, but we think you're crazy to come back here. You've agreed to run a hot mess. The staff don't want to be here; it's a catastrophe waiting to happen. The steppers are a bottomless pit. Philips just wants to be rid of them. This gig is dead in the water."

With just a few weeks left before the joint venture officially launches, its new CEO's understanding of the situation is growing

sharper. He's not enthused. Stepper development was on hold for years at S&I. There's a PAS 2000 gathering dust at IBM in Burlington; Philips has two more in Nijmegen and Hamburg. And that's it: no more have been sold. There are ten machinery manufacturers in the world focused on chip lithography. Philips ranks dead bottom on the list.

Cees Doesburg, Richard George, Herman van Heek, and Joop van Kessel are the stepper team's point men. Even before he officially starts work on April 1, Smit holds long talks with them—often deep into the night. They talk about their colleagues' resigned attitude, about customers, about competitors and missed opportunities. The conversation often turns emotional. Their new CEO turns out to have no clue about the semiconductor industry, which only heightens their belief that Smit's been hoodwinked. Janssen is always there with them, too. He's well versed in the lithography market and wrote business plan after business plan at S&I.

Smit says that De Kruiff, Del Prado, and Troost all promise they're going to pour money into the steppers, but no one believes him. "Gjalt, with all due respect, we've asked for money a hundred times over the last several years. Wim Troost was never able to get us even a cent. We've written many a business plan, and every one has been rejected."

It will take a lot of money to breathe new life into stepper development, they know. What's more, the entire industry is on the eve of a leap in technology. They don't even have customers for the PAS 2000, and they should really already be working on the next-generation stepper.

At the time there are seventeen PAS 2000 steppers, most of them still being assembled. George, Van Kessel, and Janssen are pessimistic about them. Van Kessel has managed to keep a lid on overproduction by making sure they only ordered parts for twenty PAS 2000 machines, not forty. Customers aren't lining up to buy systems with oil-based positioning tables, though there's still some hope that chip manufacturers will want to try out their superior alignment technology with an eye to buying a future stepper

with a different drive system. Against their better judgment, everyone's clinging to that superior, but unsellable, technology.

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When the company launches, sixteen PAS 2000 wafer steppers are under construction and one PAS 2000 demo machine is standing on the S&I factory floor where ASML is temporarily located. These machines and other inventory are valued at $1.8 million on opening day. As agreed, Philips deducts this amount from the $2.1 million each founding partner has promised to invest in the joint venture. The company transfers three hundred thousand dollars to ASML's bank account on April 1, 1984. ASM transfers $2.1 million a few days later.

64. **A Movie for IBM**

Iraq's invasion of Kuwait in early 1991 creates a bizarre twist. ASML's fate seems sealed, but Evert Polak thinks up a trick.

ASML's first stepper of its own, the PAS 2500, wasn't enough to interest high-caliber chip makers. The PAS 5500 is supposed to change that. But the machine contains a lens that's extremely critical and appreciably more complex than anything that's been made for wafer steppers so far. Lead customer IBM also views the lens as a potential showstopper. So everyone in Veldhoven breathes a sigh of relief when Zeiss says the optics are moving in the right direction.

If Zeiss can prove the optical column is of good quality, we'll win Big Blue: that's the steadfast conviction in Veldhoven. That means the November 1990 review meeting with the Americans in Oberkochen is crucial.

That month, ten people from ASML and IBM zoom to Brussels by taxi. John Kelly and his team have inspected the assembly activities in Veldhoven with representatives from Zeiss, and now Martin van den Brink and IBM account manager Ken Pynn are flying on to the actual goal: the optics in Oberkochen. Van den Brink is fully convinced that if IBM gives these lenses the green light, then the starting gun will have been fired and the orders will start coming in.

When the two taxis arrive at Zaventem Airport, it's a madhouse. Air traffic has been shut down. IBM's Boris Lipkin keeps insisting, "Call Willem Maris." Van den Brink starts to get annoyed. What's Maris supposed to do about it? Lipkin says Maris needs to wrangle them one of Philips' private jets: "This is mission-critical."

Van den Brink ignores Lipkin's request and takes Pynn to see if he can arrange two rental cars, but everything's gone. They finally find an obscure company that can give them a BMW 7 Series and a Jaguar X-Type. That little joke costs a few thousand dollars, but landing an order from IBM has priority. They pull out their credit cards.

By then it's nine p.m. They have a meeting at Zeiss the next morning. "Do you mind if I lean on the gas?" Van den Brink asks as Kelly gets in beside him, with Boris Lipkin and another colleague in the back. Once they're on the highway Van den Brink puts the pedal to the metal. His own car is a creaky Ford Sierra that runs on natural gas, and he happily cranks the BMW 7 past 125 miles per hour. The Jaguar, with Richard George at the wheel, is right behind him with the rest of the crew.

Van den Brink doesn't notice how his passengers blanch. Kelly points out to him that he's passing eighteen wheelers at twice their speed and notes that he'd pay a hefty fine for that in the US. Sweating, the IBM manager says it looks like the cars in the right-hand lanes are parked there. Van den Brink doesn't pick up the hint.

It's not until breakfast the next day that Van den Brink realizes his passengers were pissing themselves the previous evening: they discuss his driving style with visible relief. "Based on how fast you drive, you guys are going to build those machines in record time," Kelly jokes.

After Oberkochen the American visitors fly on to Japan, where they have another stepper review meeting in Tokyo. News of the drive precedes them. The Canon employees who pick them up at the airport apologize for not having a BMW or Jaguar, and for having a lower speed limit on the drive to Tokyo.

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Kelly is the man who writes the checks. His is the final vote and he's getting better and better at convincing his management team that they should buy their lithography equipment in Holland.

But all eyes at IBM are trained on him, so Kelly moves with extreme caution. Even after his visit to Zeiss Big Blue doesn't place an order, though the Americans are still interested in evaluating the PAS 5500 that ASML originally promised to send them on April 1, 1991. The deadline has since been adjusted, but it's now firmly set for April 30. Van den Brink knows how hard it is to get a chip maker to open its wallet that first time for machines from an

unknown supplier. Purchasers aren't eager to lay out a few million if they're not sure a completely new wafer stepper is going to work.

Van den Brink also knows that development is running behind, but there's a growing need to convince IBM that ASML has a very promising stepper to offer—and on time, to boot. So he's thought up a plan. He wants to show Kelly that the system's almost finished and that everything's on schedule. To that end, he's invited IBM to come see it all with their own eyes in mid-January 1991.

Van den Brink has given all the project leaders clear instructions. When IBM arrives, each of them will demonstrate their own piece of the machine, one by one. All together there are ten or so subsystems: lens, reticle handler, wafer handler, wafer stage, and so on. It's a full day of programming that's been scheduled down to the minute, and the assembly teams will also get their moment in the sun. In just a few hours they'll connect up all the modules. It's a feat that's never been done before. Van den Brink is certain his modular approach will make a big impression, because there's no stepper in the world that can be whipped together and taken apart like a model kit. When service engineers have to replace a lens at a chip fab, it usually takes weeks and costs buckets of money.

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ASML's engineering effort has been a pressure cooker for months. Employees are starting to push back. Their wives complain they're never home. But in that fated weekend before IBM's visit, everyone absolutely has to be there to dot the i's and cross the t's. Van den Brink even goes so far as to call one of the company's partners. "Sorry for the late notice, but we desperately need your guy this weekend."

On Friday, January 11, 1991 Van den Brink gets a call from IBM. Kelly and Lipkin aren't coming. They aren't allowed to fly. The US Congress has given President Bush permission to take military action in the Middle East conflict and IBM has forbidden all its employees from traveling eastward. Van den Brink loses it. He doesn't give a crap about Iraq, Kuwait, or anything else. In his head there's only room for one thing: meeting the deadline for the PAS 5500.

Van den Brink carefully puts down the phone, and then he explodes. He knows damned well that ASML has hit rock bottom. Everything stands or falls with an order from East Fishkill. "We're not coming? We're not coming? They can't do that!" He stomps over to Evert Polak's office and storms in cursing. "We're fucked. Those bureaucrats aren't allowed to travel." Polak doesn't respond. "Evert, they're not coming and if they don't come, we won't get the order."

"Take a seat," says Polak. He's a man of few words. He lights a cigarette and doesn't say a thing while Van den Brink spits it all out. On that fated Friday, everything seems to be falling apart because of a war that isn't even theirs. Years of work for nothing. Game over.

Polak takes another drag on his cigarette. Then he suddenly says, "You know what? We'll just go to IBM!" Van den Brink is stunned. To IBM? But they don't have a machine, do they? "What can we do there?" Polak suggests they set up a video crew. "We'll run the whole show just the way we've planned," he says. "But we won't tell anyone. We'll make sure everything's ready Monday morning. Everyone will show up as planned. We'll run the scheduled program and record the whole thing. On Tuesday we'll fly to IBM and on Wednesday we'll show them the tape." Polak's thought up the whole solution on the spot. Van den Brink is ecstatic.

Polak hires a video production company. On Monday, a film crew records the entire demonstration. That evening Richard George takes the tapes and a video editor to an editing studio in Den Bosch, where he spends the whole night cutting and splicing.

The next morning Maris, Van den Brink, and Polak drive to Schiphol Airport, tape in hand. Only after they've boarded the plane do they leave behind their own cocoon of cleanrooms and deadlines. There, in economy class, they're suddenly plunged into the real world. You could cut the tension with a knife. Half the plane is filled with Jews flying through Amsterdam on their way from Israel to New York.

In New York they join up with ASML's sales director, Doug Marsh, who's flown from the West Coast to the East. The review meeting

with Kelly and his team starts on Wednesday. They fall out of their chairs as they watch the film. They've never seen anything like it. The whole room is emotional. The teams from ASML and IBM have been talking for a long time now and both sides have been fighting to make this project a reality. Kelly's team needs to meet its deadlines, and those depend on the PAS 5500. They've been fighting a long, often political battle over it in their own company. But now they can see they're going to meet their goals. Some of them have tears in their eyes.

Kelly invites his visitors to dine that evening at the Culinary Institute of America, the international cooking school in Hyde Park, near Poughkeepsie. It's an extraordinary gesture. IBM employees occasionally take their suppliers out to dinner, but never to such an upscale establishment. "You guys are special," Kelly says during the meal. "You're not just our partners; you're also our friends."

A little before eight p.m. the waiter tells them that George Bush will shortly be making a televised address. Kelly and his guests rush into the kitchen, where the chef has installed a tiny TV. They watch as the president announces live that the US has started bombing Iraq. The next day the ASML men fly home. Once again in economy class, but this time they can stretch out on a whole row of seats. No one's brave enough to fly east.

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ASML delivers the first PAS 5500 on exactly May 1, 1991. Subsequent benchmark testing in East Fishkill proves that ASML has the best technology. What's more, Kelly is convinced that the Dutch lithography firm has the best road map. It's an extremely risky decision: ASML is, certainly by IBM's standards, a very tiny company with barely a track record to speak of.

Kelly is willing to put his career on the line because of one person: Martin van den Brink. He's never met a better engineering manager who can combine such depth of technical insight with effective leadership.