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.