Mr. Synopsys Speaks: The Aart of Tech-Onomic Orchestration of Adjacent Version $n + 1$

Interview with Synopsys’ Co-Founder, Chairman, and Co-CEO Aart de Geus

Erik Jan Marinissen
imec, Belgium

Dr. Aart de Geus made his fame and fortune by co-founding synthesis start-up Synopsys back in 1986 and growing it into the largest EDA supplier worldwide with a $2 billion turnover. While turning 60 this year, de Geus is far from quitting the industry, as he considers Synopsys an adolescent start-up and sees a whole new wave of exciting chip technologies and applications becoming possible in the next decade. At the fringes of Imec’s Technology Forum (ITF) [1], June 4–5, 2014, in Brussels, Belgium, D&T’s Erik Jan Marinissen had an interview with the charismatic and well-spoken de Geus.

D&T: “Let’s start this interview off with a number of dilemmas, in which you should select every time one out of multiple options.”

De Geus: “All right.”

D&T: “First dilemma: Dutch Gouda, Swiss Emmental, or American processed cheese?”

De Geus: “Neither. Actually, I am allergic to cheese except when it is molten, like Swiss fondu.”

D&T: “And if you have to choose between the three countries you have a strong connection with: The Netherlands, Switzerland, and the USA?”

De Geus: “There it is also ‘neither,’ as I would declare myself absolutely a ‘global citizen’ today. I hold a Dutch passport. I feel perfectly at home in Switzerland. And through the opportunities I have had in the USA and through Synopsys specifically, I have become very global. Our business is very international with well over 50% of our people outside the USA. Moreover, the important problems that we face are absolutely all global. As much as I understand the historic necessities of nationalism, the limitations are horrendous in light of the problems that mankind has to solve today. My children actually have multiple citizenships, with a Swiss mum, a Dutch dad, and being born in the USA. For them it is sort of ‘which passport line is shorter?’”

D&T: “Second dilemma: technologist or entrepreneur?”

“Part of my DNA is that I am a ‘tech-onomic’ person.”

Color versions of one or more of the figures in this paper are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/MDAT.2014.2349277

Date of publication: 07 October 2014.
De Geus: “You know, I coined the term techonomics [2]. These half-words are the answer to this question. I sit exactly between those two. As much as I love technology, I always ended up being in the orchestration of technology rather than in the strict development of it. If nothing else, I have an ability to recognize people that have great ideas that can be potentially put in the context of an economic application. Or, another way of saying this: I have long recognized that if the economics do not add up, one cannot develop modern technology; it is too expensive. Part of my DNA is that I am a ‘techonomic’ person, so that is very much the entrepreneurial side as well as the technology side.”

D&T: “Does your entrepreneurial side want to understand technology before investing in it?”

De Geus: “I need to understand enough of it to foresee its implications. In the past, I would understand great detail. Now, we have hundreds of products, and the knowledge required to fully comprehend all of these is both very broad and very deep at the same time. Now thirty years later, synthesis is not the synthesis that I dealt with. Do I understand how each algorithm is refined? No. It is dramatically more sophisticated, refined by people that have spent a life on that; I call that ‘six PhD’s deep.’ Do I understand that it is important to synthesize for low power? Yes. My talent is to focus on the fundamentals that ultimately, generically are most important. I consider low power extremely important. And this goes beyond just battery life of mobile gadgets, it spans from the micro to the macro aspects of power. Micro: the issues you have to deal with when you have very thin oxides, for example. Macro: from a climate control point of view, mankind has an out of control power/climate consumption.”

“Scientists have to seek ‘right’ or ‘wrong’; engineers know ‘good enough’—if it works, it works!”
D&T: “Next dilemma: good with computer languages or good with human languages?”

De Geus, who through his international upbringing fluently speaks a handful of languages, answers firmly: “Human languages, more than computer languages. At the end of the day, communication is at the center of what I do. And that includes dealing with people that can be very precise, as their skill set is in computer languages and algorithms and who have been schooled to be accurate. And yet, many of the decisions that have to be made are very fuzzy, as there is no right/wrong answer. If you are in general management, or leading a company, or entrepreneur, it is all about finding the acceptable answer. For a scientist, 49% or 51% is a big difference; for an engineer it is ‘sort of in the middle.’ I always say: scientists have to seek right or wrong; engineers know good enough—if it works, it works!”

D&T: “Chairman or CEO?”

De Geus: “Well, I have both titles. Chairman relates to Wall Street because the Chairman represents the shareholders. The shareholders own the company, and so theoretically, they can say what we should do. What they mostly say is: make sure there are reasonable financial returns on an ongoing basis. The minute shareholders say more than that, it becomes virtually impossible to manage a high-tech company, because the high-tech goes way beyond their understanding. And so, de facto, I think I am much more CEO than Chairman, but the Chairman part has to be done right. Luckily, we have an outstanding set of board members. They have had their own experiences, many as CEOs, and all these experiences are very useful to learn from.”

D&T: “Talking about fellow CEOs, here is your next dilemma: Wally Rhodes or Lip-Bu Tan, CEOs of respectively Mentor Graphics and Cadence Design Systems?”

De Geus laughed, but, politically correct, refused to make a choice. “These are very different people. Wally has now spent quite a while in EDA. He was in semiconductors before. Lip-Bu is more a venture capitalist. We compete with both, and both have very big strengths. We are an industry that is very competitive and extraordinarily deep and complex. And, an industry that for forty years not only kept up with Moore’s Law, but made Moore’s Law work! It requires very skilled people to do that, and those two gentlemen are examples of that.”

D&T: “You are here in Brussels for ITF, but this is also the week of the annual Design Automation Conference (DAC) [3]. And hence, the last dilemma: ITF or DAC?”

De Geus: “I was at DAC this morning, just before I took the flight to Brussels. I think that shows like DAC struggle with internet-based alternatives and the difficulty to provide enough depth in fields that have matured. Corporate conferences, like Synopsys’ SNUG, are much more targeted at the specific practical needs of the designers and get very high review scores. However, as a general overview conference, DAC is unequaled and remains a cornerstone event of our industry.”

D&T: “How is the connection with your Dutch heritage? I already noticed you still speak accentless Dutch.”

De Geus: “All my relatives, uncles, aunts, and cousins, still live there. As a kid, I would go every summer to The Netherlands to a farm and I still have very good connections there. There are still many Dutch traits that I learned as a kid that are part of who I am today. I still speak Dutch fluently, although I do not have much opportunity to practice it.”

D&T: “Are you aware that there is another well-known Aart Jan de Geus in The Netherlands?”

De Geus: “Oh, you are referring to my cousin? He was Minister of Social Affairs in The Netherlands, and after that deputy secretary-general of OECD. I see him every now and then at places like the World Economic Forum in Davos. From time to time we get confused; sometimes, I get his mail. Our grandfather was named Aart Jan and actually four out of his five sons had an Aart Jan as a son.”

D&T: “During your early employment at General Electric, you were managing a team, while still being a PhD student yourself. That seems a very early step into management?”

De Geus: “Now we have to go into my engineering history when I came as a fresh PhD student to the USA. I arrived at SMU, a fairly randomly chosen university, to sign up at the Electrical Engineering office. At the same time a fellow by the name of Ron Rohrer walks in. Ron and his students created a program named CANCER, which later one of the students rewrote under the name SPICE. Hence, Ron Rohrer is really the father of the SPICE program and he is truly seminal in the history of electronic design automation. I had no idea of all of this at the
time. Anyway, he and I got to talk. It turned out to be his first day as new Chair of the Electrical Engineering department. In a matter of minutes, he decided to change who was going to become my academic adviser and put his name in. I had no idea what an adviser was, so it was just fine with me. While Ron was trying to teach me the basics of SPICE-like simulation, as head of the department he received a donation from Texas Instruments in Dallas consisting of ten TI 99/4 personal computers with 16 kB memory, to be programmed in Basic. Ron gave me the assignment to write a program to use these computers as teaching aids in student courses. I made a program that performed student exercises around Kirchhoff analysis. In the end we created a set of about 15 little educational programs. This is all relevant to the management question, because after writing the first program, I realized immediately: I have plenty of ideas what we could do, but it is a lot faster if other people implement the programs. And so I got Ron to fund four students to work for me. In a matter of two months we put together a complete course which we then used in parallel to the 101 electrical engineering course. In the process, I became a manager.”

De Geus: “Not by coincidence, I would say, but by your own choice.”

De Geus: “Yes, I was sort-of a manager when I was seven years old. When playing with other kids in the street, I was always the one suggesting ‘Let’s do this or that.’ A natural orchestrator, I guess. At SMU I ended up with a team of about ten or twelve students.”

De Geus: “It became time to write my PhD thesis. Ron Rohrer had already left SMU, he did not stay there very long. But he was still my PhD advisor. He invited me to come over to his place in Virginia for a few days to discuss what my PhD thesis would be. Meanwhile he was working at GE, so he hired me into GE. My work there moved into synthesis, which was way more interesting. But I still had to finish this horrible PhD thesis in mixed-mode simulation. It was pretty tough to find the discipline to finish it in my nightly hours.”

De Geus: “At GE, initially I was an individual contributor of course. But I figured out that I could hire summer students. And so, the first year I had one summer student, the second year I had five, the next year I think 26. That is when GE discovered that these students needed computers, tables, etc. But they also realized that I had some ability to get good students into the company. I kept the best ones coming back every year. And that became the nucleus of the team that then developed the synthesis tool.”

“At the start, I did not know this was called ‘synthesis.’”

De Geus: “GE was in the gate array business. Those were arrays of NANDs, NORs, and inverters. At the time, I read a paper by GE colleague Shelly Akers and talked to him. Shelly argued that arbitrary logic functions could be implemented more efficiently by using only multiplexers and invertors. So, I got together with a GE designer, and we took up the plan to make a multiplexer array, as opposed to a gate array. That did not quite work, because multiplexers were really transmission gates. Hence we needed logic gates to restore the logic signal values and so the multiplexer-logic (ML) array was born. However, it also became immediately clear that designers did not know how to design with this combination of gates and multiplexers, and therefore we needed a software program to map a design automatically onto the ML array. At the start, I did not know this was called synthesis, and that some researchers were already active in that field for over twenty years! Our tool got the name SOCRATES: Synthesis and Optimization of Combinatorial logic using a Rule-based And Technology-independent Expert System . . . or something like that. One of its unique contributions was that not only did it synthesize pretty well, but also that it synthesized under timing constraints. The simultaneous area and timing optimization made it instantaneously an engineering tool of high value. Pretty quickly, we also had it map to conventional gate arrays, and the ML array disappeared.”

D&T: “How did Synopsys spin off from GE?”

De Geus: “About five years later, GE decided to get out of semiconductors and therefore we were going to be laid off. I did an interview for a new job somewhere and found out: our team is as good as any team, and we have this tool, that in Silicon Valley does not exist. That grew the whole notion of creating a new company out of it. I proposed to GE management to give us the technology that otherwise would have gone lost and a financial investment, in return for a share of the new company. GE
was very gracious and accepted, assuming we would raise some additional funding. Later, when Synopsys went public, GE easily made a $25 million return on their investment, and I am very happy for that. By the time we started, we did have seven people in North Carolina, of which three were really the founding team. Our GE lay-off pay helped us get through the first six months of the new company. And then we decided to move out of North Carolina. There was a choice: Silicon Valley or Boston, around Route 128, which was also very high-tech. But the Boston area was in decline, while Silicon Valley was really coming up."

**D&T.** "And the Silicon Valley climate is so much nicer . . ."

**De Geus.** "As kids, we did not care about that. I do appreciate that now!"

**D&T.** "How important was the move to Silicon Valley? Would you have been able to grow the same company if you had stayed in Triangle Park?"

**De Geus.** "I don't think so, because we would not have attracted the other talents that have been needed to build the company at that time. I was a young kid-manager, having no experience whatsoever in running a business. The first business plan we wrote was a reverse-engineered version of someone else's business plan, not quite knowing what was the difference between orders and revenues. What is the essence of what you are proposing, how big to shoot? What is credible versus just-not-ambitious? In such a first business plan, one takes many steps that have impact for long afterwards: initial funding, but most importantly, who are the people you take aboard and how to put them in charge of different things. And then comes: building a product. Being able to take our prototype from GE into our new company, we had right away something to demonstrate. We would go to a potential customer and ask if they had a design they had been working on. Often they had been slaving on it for months, to optimize it for size and speed. Then we would read it in and literally within minutes, we would generate a new circuit that was 30% smaller and 30% faster. The first reaction from the design team would invariably be: there is an error. They would keep our design and check it out for weeks. Then, once convinced of correctness, their expectations would become sky-high. But then one is engaged. And the minute you have real users, you get real feedback; and that is what is so powerful about having a working prototype from day one. You can do great slides all day long; a prototype is everything. Show them what it can do, and it is even fine if it does not do it well, because engineers have enough imagination to see the potential. In addition, they love to tell you what to do better. We were fortunate that we connected with some great customers in those early days, including Sun Microsystems."

**D&T.** "Originally, the company was called Optimal Solutions."

**De Geus.** "Correct. When we moved to California, we did a name check, and there were about eight or ten Optimal Solutions in California alone. It was not a unique name, and, frankly, in hindsight, not a very good name either. I started to look around for names and came up with Synopsys: Synthesis and Optimization Systems. Initially, in the graphics, the ‘op’ had a little bit different color, but that did not copy so well and hence disappeared. But the name stayed till today."

**D&T.** "Many people unfamiliar with the company spell its name as ‘Synopsis’?"

**De Geus.** "Yes, the word ‘synopsis’ is of course a summary of the essence—a bit what good synthesis tries to do! I remember an article in the British Times stated that we had destroyed the word ‘synopsis,’ because we got a lot of people to misspell it!"

**D&T.** "How did the company grow?"

**De Geus.** "In the first three months, we sold a couple of copies to Harris Semiconductor, who also decided to become an investor. That gave a lot of impetus to raise money. We ended up with both venture capital investors and technology investors, like GE and Harris. I learned that everything is always about risk minimization. For the technology guys, it is comforting if VCs are on board: oh, now it is an enterprise. For the VCs, it is comforting if tech guys participate, as they understand the technology. They strengthen each other."

**D&T.** "That is tech-onomics too."

**De Geus.** grin from ear to ear: "Yes! The next step was to take our product, grow it rapidly, and then go public as a company. For that, you need to have a steady financial stream and a positive outlook of multiple quarters. We had revenue of over $60 million by the time Synopsys went public, so compared to what is customary today we were relatively late. I hired several key people, including a President, Harvey Jones, who then became CEO,
and brought EDA business experience; I learned an enormous amount from him in the process and without Harvey, it is unlikely that Synopsys would have survived. We hired sales people. We became global very early: Japan, Europe, in the second year. As a public company, one is under a different scrutiny; and then you learn all the lessons that come with that.”

De Geus: “Then came the question: how do we diversify? We followed the notion of adjacency, a great way of minimizing risk. Adjacency can be one of three: same technology (such as a common library), same channel (meaning you can sell it through the same sales people), or same customer (if you have sold something already, they know you). I always look at these three; if you can get all three, that is the best case, of course. We started to develop more products and gradually also started to acquire companies. Initially, we expanded from synthesis-only to cover the entire (digital) functional domain, including verification and test. We got into the physical design about ten years into our existence. At that time, the implementation flow was still separated in the functional part (synthesis and simulation) and the physical part (place-n-route and extraction). We made technically a mega step forward by introducing a very fast placer inside the synthesis tool. It allowed the synthesizer to get a better approximation of the physical distance of gates and thus more accurate timing results. As a next step, we added a very fast router, to address the killer problem of routing congestion. Today, one needs to work with a very integrated design flow, otherwise you do not get good-enough results. As a next step, we added a very fast router, to address the killer problem of routing congestion. Today, one needs to work with a very integrated design flow, otherwise you do not get good-enough results.

De Geus: “It is all about optimization. The thing that transcended everything in the early days of EDA was correctness: just do not drop some little detail in the litho by accident. People literally verified by hand that the layout was correct. Next came minimizing area, as both cost and yield are directly impacted by that. After area came timing. Our synthesis was timing-driven, and that immediately put it in touch with physical reality. With the advent of the mobile market, low power became a key force.”

D&T: “And the next transcending optimization issue might be heat dissipation.”

De Geus: “Absolutely. In 3-D integration, with multiple layers of transistors, heat is not going to be trivial. Heat is not only destructive, but also changes the electronic properties.”

D&T: “And when did Synopsys move into the IP business?”

De Geus: “I observed already in 1994 that EDA was all about assembling building blocks. Over the years, the building blocks moved from rectangles on a layout, to transistors, to gates, to little macros like shift registers and multipliers, all the way to processor cores and hardware/software subsystems. Looking at the ITRS Roadmap, it was completely clear that design productivity would not be able to keep up with process technology if we were not going for ever higher levels of abstraction. The IP business really took off in the early 2000s. It is a combination of the number of available gates being so large that designers do not have time to design things from scratch, and individual building blocks becoming complex but not differentiating. Engineers often think that what is difficult is also differentiating. That is not true for the many interface standards. USB-3, for example, is highly sophisticated, but not differentiating, because it’s a standard. More and more companies realized that they had to put their top engineers on the differentiation and should buy blocks that are standardized. Synopsys came in and became the largest company providing design IP for all the interface standards. We have a huge development effort in porting this IP to the latest emerging technology nodes, now 14 nm and 10 nm. Today, IP is 25% of our business and we are the second-largest IP vendor in the world.”

D&T: “And the concept of adjacency applies also here.”

De Geus: “Absolutely! The customers are the same, although for EDA tools, you interface with the CAD department, while for design IP, you talk to the design teams.”

D&T: “Is Synopsys today a mature company in a mature market?”

IEEE Design & Test
De Geus: “Oh no, we are adolescent; we just got
our driver’s license. The big thing is always still to
happen.”

D&T: “Being the anchor person at Synopsys,
going through these various stages, what did it do for
you personally?”

De Geus: “I have created an equation, which
I apply in many discussions: ‘Version \(n + 1\).’ With
software products, there is always a Version \(n + 1\), in
which all bugs of today’s Version \(n\) will be fixed and
fabulous new capabilities will be added. If you truly
believe there is always a Version \(n + 1\), you also have
to believe there is a Version \(n + 1\) of yourself, and of
the company, and of everything you do. It has become
a life philosophy, which is the philosophy of learning. If
you believe there is always more to learn, there is a
desire and openness to be on a pathway that enables
that. Synopsys provided that pathway. The challenge,
though, was that being in an anchor role at Synopsys
all the time, there was never an on/off button. And
every so often, it would have been so wonderful if
there just would have been an off-button.”

D&T: “Have you always and continuously felt the
responsibility for the company?”

De Geus: “The responsibility, the fun, and the
paranoia of everything that could go wrong. There
were phases where the learning was very tough,
because it was like drinking from a fire hose, all the
time. There were some very bleak nights there. But at
the same time, it is a gift to be in a position where
you are challenged every day: in the technology,
entrepreneurial, business, and people space.”

D&T: “If, as you said, the company Synopsys is
only a teenager, it still has a whole life in front of
it. At some moment you might have to retire from
the company. Will it be difficult to let go?”

De Geus: “No, it is not difficult to let go. It is
difficult to prepare to give it to the right people at the
right time. The succession is important.”

D&T: “Is that the co-CEO thing?”

De Geus: “No, there is a whole different story
behind that. Chi-Foon and I have been working in a
complete trust relationship for almost 25 years, and
being co-CEOs is a great way of having multiple
people in charge of something which is very
complex. It also does add security for Synopsys: if I
get hit by a beer truck tomorrow, then there is still a
CEO, and actually a very good one.”

D&T: “But it might also be confusing, in the sense
that the ship has two captains.”

De Geus: “That is as confusing as having a mum
and dad. Sure, kids learn to ask to watch TV from the
right parent: ‘Mum said it is okay,’ but we have very
little of that. Most people appreciate the value that
comes from discussing complex situations with
somebody else. Chi-Foon and I have worked like
two-in-the-box for a long time. Formalizing the titles
felt natural and lets both of us speak for Synopsys
with full authority. It may not be obvious, in the
sense that very few companies do this or have been
successful with it. I think we are. While we each have
our areas of focus, we both feel totally responsible
for the well-being of the company and the employee
team. We probably agree 90% of the time, and
whenever we disagree, my immediate reaction is:
there is an angle that he sees that I do not see yet and
after all these years, I still learn a lot from him every
time we talk. There may be challenging moments,
but that is true in any relationship, and relationships
always strengthen by navigating through challenges
together.”

D&T: “Why, in your opinion, is the EDA industry
so U.S. centric?”

De Geus: “The history of EDA has been very U.S.
centric, because the universities that led in EDA
were initially Berkeley and Stanford, and later
Carnegie Mellon and MIT all preceded by great
research at Bell Labs and IBM. There were also great
activities in Europe and Japan, but the critical mass
was clearly in the U.S. This was augmented by
Silicon Valley rising up right next door to Stanford
and Berkeley and driving Moore’s Law like crazy. The
reality today is: EDA is very globalized. More than
half of Synopsys’ developers are outside the U.S., for
a combination of customer proximity, cost and,
more importantly, available talent.”

D&T: “With the move of the semiconductor
industry eastwards, do you think it is feasible that
one day we will have an Asian start-up to become a
leading EDA supplier?”

De Geus: “Possible but unlikely. It is not worth
the investment. As much as I am saying that
Synopsys is an adolescent, the reality is that the
EDA industry is actually quite mature with layer after
layer of technology that all new work depends on.
There has been a tremendous consolidation in
recent years, for techonomic reasons. The absorp-
tion of the smaller companies is a testimony that
they do bring point-technology innovation. But it
also says that economically they had no chance

September/October 2014
whatsoever in going public or becoming larger companies. The aggregation of development is an economic necessity to continue to invest sufficiently in Moore’s Law.”

_D&T:_ “Do you believe in first-time right silicon?”

_De Geus:_ “Yes, I believe strongly in that. And then there is reality. What I mean with that: if you do not shoot for first-time right, you are not going to make it.”

_D&T:_ “But there is also a customer waiting, so at some moment, you need to go to tape-out.”

_De Geus:_ “Ah, you have to not be a scientist, but an engineer again. Recently, I had an executive dinner with about ten customer CEOs and I asked them about their percentage first-time-right silicon. 80% claimed first-time-right. But in the discussion that followed, it became clear that first-time-right really means ‘no catastrophe,’ but maybe small spec updates or software workarounds. My sense is that today, there are more first-time-right chips than ten years ago due to enormous efforts in verification and pre-verified IP. Also, the implementation tools are so much better. The fact that we can synthesize pretty much everything and do enormously large place-n-route automatically is astounding; those programs are pretty much fault-free. On the other hand, the need for first-time-right is growing, given the costs associated with a tape-out and new mask set. That same question is now also growing for application software. In the past, the penalty for errors in hardware was very high, whereas for software, it was a patch on a patch on another patch. That is coming to an end, and that is why I believe verification of software is now becoming important.”

_D&T:_ “Is there enough adjacency in that market for Synopsys?”

_De Geus:_ “Absolutely! Just this spring, we bought a company called Coverity. This is our entry in the emerging market of software verification. Coverity is not a little start-up; they do about $75 million. Their tools are very similar to what we have done twenty years ago for hardware in applying formal techniques, but now applied to software verification. It is adjacent for us as half their business is verifying embedded software. That’s close. But it also reaches far away, with verification of application software for financial, health, and oil companies; people we would never have talked to in the past. So, this is
really exciting, because suddenly we see many more customer opportunities.

D&T: “What is your forecast for the future of the semiconductor industry?”

De Geus: “We absolutely see another ten years of Moore’s Law [4]. Our TCAD team is now working on 7-nm and 5-nm technologies. This represents the technological side of Moore’s Law. The economic side of Moore’s Law is probably shifting somewhat. But, frankly, I do not think it matters. As more compute power opens up great new capabilities and applications, I think the customers will be willing to pay a bit more for their chips, which are, after all, only a small fraction of the overall system cost. For me, the next big thing is not the Internet of Things. IoT says everything will be connected; sure, but that is stating the obvious. To me, what captures the future better is ‘smart everything.’ And ‘smart’ of course also implies interconnected. But the notion ‘smart’ means that the computational power, either in the cloud, or, preferably, on location, is going to grow so much in the next twenty years that insanely great apps will become possible. Some chips that are being demonstrated at Imec today show your blood pressure and ECG. Add some intelligence to that, which would enable life-saving warnings; would you not pay a hundred bucks for that?”

References

Direct questions and comments about this article to Erik Jan Marinissen, imec, Belgium; Erik.Jan.Marinissen@imec.be.