Michel Monnerat
Out of Africa — GNSS

The story of a French boy who grew up in Africa, loving math and science and playing soccer before sunrise.

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HUMAN ENGINEERING

"I WAS BORN IN ARLES, in the south of France," says Michel Monnerat, "but I left France before my first birthday. We moved many times, from place to place."

Monnerat's father worked for a civil engineering company, specializing in maritime works — harbor construction, coastal protection, and such. His family lived in Ivory Coast, Cameroon, and Tunisia, but Monnerat spent most of my early life in Lomé, the capital city of Togo.

"In Africa, sometimes the days were so hot," he says. "I remember waking up at four in the morning just to go out and play soccer before the sun came up, just to have some fun with my friends."

Monnerat describes himself in those years as "tenacious, sometimes obstinate. I was excessive in the things I undertook."

So, this is the story of how that tenacious, sometimes obstinate and excessive youngster grew up to become a top engineer for one of the world's leading aerospace firms.

It Started with Math and Science

Monnerat took his baccalaureate in Togo, and then moved to France to attend a superior mathematics school, in preparation for engineering school.

He was curious about new technologies that appeared during his youth, such as computers. "I was fascinated by the instruments I saw my father using. At that time there was no GPS, of course. Precise measurements — for plotting shorelines, for instance — were so important. GNSS has replaced all of those old instruments."

Mathematics and the sciences in general played a big part in his life since my early childhood — "actually, for as long as I can remember," Monnerat says. He remains drawn to all of the sciences, but math holds a special place.

"Mathematics encompasses everything at the same time," he muses. "It starts as a game, lighting the curiosity of a child; it is the expression of one's will to structure the world around us, and it gives us the tools to do so. It stimulates a teenager's desire to understand; mathematics is a universal language, the cement of mutual understanding. It is a form of art."

Eloquent words from a man grounded in the hard reality of space engineering.

Monnerat has been involved in the Galileo program since 1998, from the early phases of the program, particularly in signal design and performance evaluation.

Compass Points

Mentors

"Growing up in Togo, in my final year in high school, my mathematics professor, Mr. Drunet. His way of being precise and rigorous, while at the same time always seeming relaxed, somehow struck me. Later, in France, when I was studying engineering, I had a math professor called Anne Brenac. She gave me the sense of 'real' mathematics, taught me the satisfaction of putting together precise and structured reasoning. And then there was my physics professor, Mr. Brebec. He taught me to see the unity of the sciences, the continuity that one can find across disciplines, and the excitement of the quest for this unification. But I was also influenced by my philosophy teacher, who showed me how both mathematics and literacy play a part in the process of reasoning."

And, Monnerat says he had a remarkable space techniques professor, a certain Philippe Karouby, who is now technical director of the navigation business line at Thales Alenia Space, and, remarkably, Monnerat's boss!

What popular notions about GNSS are most annoying?

"People talking about 'big brother' when they see the incredible LBS positioning performances we can attain, even in indoor environments. Of course, all technologies have their drawbacks, but these people don't appreciate the efforts being made by the 3GPP standardization group to protect privacy. At the same time, these very positioning performances will enable more efficient E112 and E911 services, ultimately saving lives."

Favorite equation

The Cramer-Rao boundary of the accuracy provided by a signal, depending on the inverse of the Gabor bandwidth of the signal.

$$E\left[\left(\hat{\theta}-\theta\right)^2\right] \geq b_i^2(\theta)+\left\{\left[I+\nabla_\theta(b)\right]F^{-1}\left[I+\nabla_\theta(b)\right]^T\right\}_{ii}$$

"This equation is a symbol for me. When I started in GNSS, I used this equation as a central point for all of my analyses."

As a consumer, what GNSS product, application, or engineering innovation would you most like to see?

"The emergency applications I mentioned before, such as E112 or E911 in the USA. Positioning anytime, everywhere, for saving lives."

What would you have been if you had not become an engineer?

"I think that if I hadn't be an engineer, I would have been a teacher. I really like teaching and I do manage to teach my favorite subject – GNSS – part-time in engineering schools."

His core specialty is in signal processing techniques, but Monnerat says he is equally intrigued by the related subject of software programming.

"I have a brother, Denis, who is one year older than I am," he says. "We share similar passions. He always guided me, pushed me to understand, to go deeper, and finally to get pleasure from mathematics. He is now a university mathematics professor and I am proud to think of myself as his first student."

Monnerat counts his brother a decisive figure in his life. "We supported each other, and I am sure I would not have been an engineer without his help."

But his parents also backed his decisions. "They always did all they could to provide a maximum of stability, in particular when it came to my schooling," he recalls. "Even when we were separated by great distances, myself in France and them still in Togo, they were always 'present' and supportive during my higher education."

Ready for Launch

Monnerat graduated as an engineer from the *Ecole Nationale Supérieure d'ingénieur de Construction Aeronautique* in Toulouse, now known as the *Institut Supérieur de l'Aéraunotique et de l'Espace*.

He got a job with Alcatel Space in 1997, working on space radar programs, in particular on the development of the signal-processing unit of the Poseidon 2 altimeter.

After that, he moved to onboard processing systems, working on the ARGOS/SARSAT payloads, and to the development of the ARGOS/SARSAT spaceborne processing instruments (ARGOS 3 and SARP3), designing the new-generation beacon signals.

Monnerat began working in GNSS for Alcatel Space, now Thales Alenia Space, in early 1998, and was involved in the early stages of European GNSS, including work on signal definition for Galileo and EGNOS — the European satellite-based augmentation system (SBAS).

The turning point that led him to GNSS was the launch of the first Galileo studies." The first one, he says, was a national feasibility study carried out by the French Space Agency (CNES) and the French Department of Defense. The second, the EU architecture study, GALA, was aimed at sketching out the overall Galileo structure and deriving the system's requirements.

When the proposed Galileo evolved from concept into a real program, he says, several issues had urgently to be addressed, among these the signal definition itself, but also the International Telecommunication Union (ITU) frequency filing to which Monnerat contributed and compatibility with other RF systems (whether GNSS or not)).

"I made an effort to interest myself in all of these issues, also encompassing security aspects, and in the end found it all so exciting that I never left the field."

Then, in 2000, Monnerat says, everything changed. First, there was the plenary session of the European Navigation Conference, in May 2000 in Edinburgh, Scotland, where NASA head Dan Goldin announced the Clinton administration's decision to remove selective availability from GPS signals.

"This, for me, was a revelation," he says. "From that moment on, applications could be developed for the mass market, which, as we know, really changed the face of GNSS forever."

And, in that same year, at the World Radiocommunication Conference in Istanbul, the Galileo filing was agreed, paving the way for the development of Europe's own GNSS.

A Name for Himself

Today, Michel Monnerat manages the Localization Infrastructure and Security Department within the navigation business segment of Thales Alenia Space France. According to his company profile, he is in charge of, "developing innovative positioning solutions, providing a high level of quality of service for highly demanding applications."

He has, crucially, been active in all Galileo development phases — from very early ones to the current status — an alphabet soup of activities encompassing in-orbit validation right through to full operational capability, without forgetting the search and rescue service, for which he has a particular interest having been involved in COSPAS-SARSAT developments for a long time.

Monnerat also rapidly became involved in downstream application developments, from GNSS receiver design to any kind of hybridization involving mobile telecommunication signals and GNSS signals. He made important contributions in support of European GNSS standardization, to insure its penetration in day-to-day life.

He mentions "one of the most exciting projects in my life," the development of location-based solutions at Thales Alenia Space, one of which involves blending mobile telecommunications signals – 2G, 3G, 4G or WiFi — and GNSS signals for improved quality of service, including indoor positioning.

"The field of mobile telecommunications is intense, fast-moving, and innovation-driven," Monnerat says. The mass market, particularly mobile phone users, will be among the main user groups of GNSS, and that means developments and changes in GNSS must take this community into account.

In addition to his work in LBS, Monnerat is also active in the transport arena. These are areas that require a high level of quality of service, in terms of integrity, interference mitigation, or simply in terms of accuracy or time to first fix. "The work we do can be summarized by one word: blending — blending GNSS signals with telecom signals and other integrated navigation technologies."

One indication of the significance of Monnerat's work are the more than 40 patents he currently holds, covering, among other things, GNSS receiver technologies, indoor positioning, and integrity of positioning.

Coming Full Circle

Monnerat's Thales role has also allowed him to keep in touch with his African roots, including involvement with the SAGAIE project.

Designed to model the ionosphere over the sub-Saharan region in support of a prospective SBAS over the area, SAGAIE saw Thales Alenia Space, the Agency for Aerial Navigation Safety in Africa and Madagascar (ASECNA), and the French Space agency CNES cooperate to deploy a network of GNSS sensors stations — including at a site near Monnerat's childhood home in Lomé, Togo.

As with many professional scientists, however, Monnerat has had to make some sacrifices in terms of his personal life. He is not married and has no children.

"Yes," he says, "science implies a lot of time. It is hard but fascinating work, and we often do not notice the time running or the years going by. And time is the main sacrifice, the time I have devoted to my work.

"Even if it is an exciting life," Monnerat continues, "I also know that there are many things that I will never be able to do, things that I might have liked to. But one's life is not infinite, after all."

Does he ever think of a life after engineering?

"I must admit," Monnerat says, "I do not. If I can, I will just continue, always. It is not a job for me; it is a way of life." IG