In Memoriam Floris Takens*

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Els, Leida, Vincent, other family members, friends, colleagues and aquaintences!

1 The scientist

Floris Takens became a full professor of mathematics at Groningen University in 1972, at the age of 31 years. He had gained his doctorate at the University of Amsterdam in 1969 under the supervison of Nico Kuiper. His thesis was entitled The minimal number of critical points of a function on a compact manifold and the Lusternik-Schnirelman category. Following his doctoral studies he spent a year as a guest researcher at the Institut des Hautes Études Scientifiques in Bures-sur-Yvette near Paris (1969-1970). Here he was influenced by both René Thom and David Ruelle.[1] With Ruelle he wrote the paper On the Nature of Turbulence, published in the journal Communications in Mathematical Physics (1971) [1]. This was a groundbreaking paper, in which a new idea was introduced contradicting the established theory about the onset of turbulence in fluid motion as developed by the leading physicists Landau and Lifschitz and the eminent mathematician Hopf. The new idea proposed by Ruelle and Takens was baptized 'strange attractor', this was later incorporated into the theory of chaos.

1.1 Context

Takens's chair was in the field of 'Differential Topology, in particular Dynamical Systems'. Geometrical ideas had been introduced into Dynamical Systems research by the pioneering work of Poincaré, among other things in celestial mechanics. In the 1960s and 1970s an enormous impetus was given in this direction by the input of the Fields medal winners Stephen Smale (University of California Berkely) and René Thom (IHES) and their schools. Both had become famous in Geometry (Topology). Thom, moreover, became renowned for the introduction of 'Catastrophe Theory', which later became somewhat controversial. The former topologist Christopher Zeeman[2] (Warwick) also participated in the application of this theory. This was a culture which suited Floris Takens perfectly. The Brazilian Jacob Palis, who obtained his Berkeley doctorate from Smale, is of the same generation. Floris and Jacob maintained an extensive and extremely fruitful collaboration from 1971 onwards. For a long period Floris was a guest researcher for several months each year at the beautifully situated Instituto de Matemática Pura e Applicada in Rio de Janeiro.

*Eulogy at the funeral of Floris Takens, 25.vi.2010

[1] Known in Groningen from the 1999 Johann Bernoulli Lecture.

[2] Zeeman held the 1993 Johann Bernoulli Lecture.

1.2 Research Themes

Floris Takens wrote dozens of important papers, many of which are influential to this day for researchers all over the world. Roughly speaking two directions can be distinguished in his work, taken together he supervised about 20 PhD students in these areas.

Stability, Hyperbolicity, Bifurcations. With his contributions to structural stability and moduli in the setting of (almost) hyperbolicity and the bifurcations from simple to complex behaviour, Takens is surely one of the founding fathers of the modern discipline of Dynamical Systems. His major scientific stature and his numerous international contacts have greatly benefited both the University of Groningen and the Dutch mathematics community as a whole. His PhD students in this scientific direction at Groningen University were Albert Hummel, myself, Gert Vegter, Fopke Klok, Jan Barkmeijer, Cars Hommes, Ale Jan Homburg, Bernd Krauskopf, Florian Wagener, Evgeny Verbitskiy and Renato Vitolo. Outside Groningen we can add Freddy Dumortier, Bert Jongen and Sebastian van Strien to this list.

Nonlinear Time Series. Around 1980 Floris Takens initiated a new direction in which information can be obtained regarding characteristics of the dynamics, such as dimensions of attractors, entropy, Lyapounov exponents, etc., from time series generated by deterministic systems where the equations of motion need not be known [2]. Many nonmathematicians have appled and adapted this theory, currently known as the 'Takens Reconstruction Theory'. His contributions to chemical process technology earned him an honorary doctorate at Delft University of Technology, an award in which he took considerable and justified pride. In this research direction he acted as an advisor for a number of external PhD students, namely Jan-Pieter Pijn, Pieter Been, Cees Diks and Marcel van der Heijden. In Groningen he was also coadvisor of Svetlana Borovkova.

1.3 Total Mathematician

For Floris Takens the discipline of mathematics was one organic entity, including the applications. This fits well with his own career, in which both the 'pure' Differential Topology and the 'applied' Time Series Analysis coexisted in a brotherly fashion. In his papers, among other things, Analysis, Geometry (in many manifestations) and Measure Theory take their natural place. Furthermore he wrote programs himself in computer languages such as Matlab and C++ when the need arose. It should be noted that the area of Dynamical Systems is closely connected to Mathematical Physics, as is apparent from Takens's early work with Ruelle.

Floris always fiercely resisted the constant threat of fragmentation of the mathematics curriculum. One of his ideals was that all professors would be able to teach all courses in the first three years of the curriculum (corresponding to the Bachelor curriculum). This never came to pass in Groningen, but I'm sure that he himself would have been able to do this without any problem.

Takens was an editor of the Springer Lecture Notes in Mathematics, an honorable task which he continued to perform for a further decade after his retirement in 1999. Bernard Theissier, one of his fellow editors, sent a condolence message highly commending Floris's "immense culture".

After his retirement Floris Takens was still closely involved with the PhD theses of Renato Vitolo (2003, here he acted as a co-advisor) and of Olga Lukina (2008). One of his interests in the last decade of his life consisted of the geometry of torus bundles as these occur in integrable and nearly integrable Hamiltonian systems. This is an interesting area of research related to earlier work by Hans Duistermaat and Richard Cushman, having both classical and quantum-mechanical applications, among other things in theoretical chemistry. Here he could whole-heartedly give free rein to his old passions for Differential Geometry and Algebraic Topology. In addition Floris faithfully attended PhD defenses, colloquia and relevant seminars. Together we worked on an advanced text book Dynamical Systems and Chaos [3] and on the Handbook of Dynamical Systems Vol.3. [4]

2 Additional activities

Apart from numerous teaching duties among which the famous (and somewhat dreaded) Bachelor course Differentiaalrekening in $\mathbb{R}^n$, Floris Takens regularly taught Master courses in Analysis on Manifolds, Differential Geometry, Differential and Algebraic Topology, and he held weekly seminars in his office. These dealt mostly with Dynamical Systems, but occasionally also with Riemann Surfaces, Sheaf Theory, and many other subjects.

Floris also performed his share of administrative tasks. From around 1990 he served for several years as the chairman of the Math Department. Also he served a term as chairman of the national Mathematics Research Institute.[3] Floris was one of the founders of the Dutch FOM/SWON program Mathematical Physics and also acted as chairman for a period. In 1991 he became a member of the Royal Netherlands Academy of Arts and Sciences (KNAW), while much earlier he was already made a member of the Brazilian Academy. Within the KNAW he was also involved in administration, among which the chair of the Mathematics Section.

Floris Takens never shirked the demanding tasks that came his way. An example is the inter-university Teaching Assessment that took place in 2008 in both the Netherlands and Flanders. When the acting chairman Jacques van Lint suddenly passed away in medias res, he took over this responsibility.

3 The ‘mensch’

Floris had a reputation for being a meticulous man with a strong sense of duty and consistently high standards. This applied both to his daily practice of the flute as well as his precision in all matters at the department or elsewhere. He used to arrive at work with a Spartan punctuality every morning, whether or not he had partied long and hard the previous night. I remember numerous joyful open-air sessions in Rio de Janeiro and in Trieste, with a view on the Atlantico or the Adriatico and a table filled with empty bottles: eat, drink and be merry, meanwhile talking about life itself.

As we have seen, Floris never shirked his duties but rather fought hard for his beliefs, not always effectively. In fact, his attitude was a bit soldierly, stoically accepting one’s responsibilities and doing one’s duty without complaint. In return he could not bear

[3] Jointly with the Universities of Nijmegen, Twente and Utrecht.

tardiness in others. It must be said that Floris was not always an easygoing person, neither for himself nor for others.

Ovr the past twenty years I remember Floris to an increasing degree as a good colleague and a warm friendship grew between us. This also had to do with the change in his personal circumstances, finding himself in calmer waters after his move to the village of Bedum.

3.1 Culture

For Floris Takens Mathematics was embedded in a much larger scientific culture, in which Minnaert's De Natuurkunde van 't Vrije Veld, the Feynman Lectures on Physics, as well as Gravitation by Misner, Thorne and Wheeler, were never far from his desk. Apart from this, he was also very interested in painting and music. He owned a large collection of paintings and regularly visited museums and exhibitions. For music he could be seen cycling through all weathers around the province of Groningen to performances in Leens, Feerwerd, Thesinge or in the Groningen Oosterpoort.

He was also actively involved in performing music. I cherish precious memories of numerous evenings in Bedum where Floris and I practiced and performed flute sonatas by Händel and Bach, now and then relaxing with Mozart's Andante for Flute in C or Gluck's Dance of the Blessed Spirits. Floris played the traverso and I accompanied him on a virginal. An integral part of these evenings were the conversations afterwards, obviously with a good glass of wine. Apart from small talk and (local) politics, we also got around to matters of philosophy and theology. Floris had a clear affinity with the ideas of Spinoza and he was somewhat inclined to a form of pantheism.

Unfortunately Floris was witness to the undeniable decline of the scientific culture in our society over the past 40 years, as demonstrated by the decline in educational standards. Overly strict attention to market principles in research and education tends to replace true scientific quality and interest with a mere search for funding in the name of science. In a sense, the university itself has somewhat degenerated into a PhD thesis factory, often at the expense of scientific depth. The type of research that is driven by personal curiosity has too frequently been forced to abandon the field. In my opinion these developments sadly contributed to the fact that Floris Takens took early retirement at the age of 59.

A fitting anecdote in this regard is Floris's farewell lecture in 2001, where he discussed a report on the Monty Hall problem featured in the NRC newspaper some years previously. A series of articles and letters on the subject had been summarized by a journalist with the words: "Stop, stop, stop sending letters. The misunderstanding between common sense and the mathematicians is clearly unbridgeable". Floris observed this contempt for mathematics in a much broader sense, also within science. This tendency seems only to have grown stronger with time, and Floris acquiesced with a certain nostalgia.

To end on a more joyful note, let me say something about Floris's own free research which gave him much pleasure till the end of his life. This concerns the geometry of torus bundles, as mentioned before. In the very last months of his life Floris produced an interesting sketch of a Morse Theory of monodromy and Chern classes, which will further occupy a number of us in the near future.

Finally I wish to express that a fascinating human being has passed away with unmistakable grandeur. To Floris in person I say “Old soldier: it was an honour serving with you!”

References

[1] D. Ruelle and F. Takens, On the nature of turbulence. *Comm. Math. Phys.* **20** (1971), 167-192; **23** (1971), 343-344.

[2] F. Takens, Detecting strange attractors in turbulence. In: D. Rand, L.-S. Young (eds.), *Dynamical Systems and Turbulence, Warwick* 1980, Lecture Notes in Mathematics **898** (1981), Springer-Verlag.

[3] H.W. Broer and F. Takens, *Dynamical Systems and Chaos.* Epsilon-Uitgaven **64** (2009); Appl. Math. Sc. **172**, Springer-Verlag (2010).

[4] H.W. Broer, B. Hasselblatt and F. Takens (eds.), *Handbook of Dynamical Systems* Vol. **3**, North-Holland (2010).