

Transdisciplinarity, Creativity, Elegance (Obituary for Tom Head)

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Thomas J. Head, known by friends and collaborators as Tom, passed away on November 10, 2017, at the age of 83 (he was born in Tonkawa Oklahoma, on Jan. 6 1934). His undergraduate and graduate studies were in pure mathematics, at University of Oklahoma and University of Kansas. He received a PhD in 1962, at the University of Kansas, and held professorships at Iowa State University, University of Alaska, and Binghamton University. Tom was a professor at Binghamton University from 1988 until retirement – and remained professor emeritus of this university until his last days.

Tom's initial area of scientific interest was algebra focused on abelian groups and modules, with the first published paper being "Dense submodules", *Proc. Amer. Math. Soc.*, 13 (1962), 197–199. In 1974 he published a book on algebra, *Modules. A Primer of Structure Theorems*, Brooks/Cole, 1974 whose extended second edition *Modules and the Structure of Rings* was published by Marcel Dekker Inc, New York, NY in 1991.

Around the middle of 1970s he expanded his interest to theoretical computer science, with the first papers written in cooperation with M. Blattner. Two of them were published in 1977 ("Single valued a-transducers" and "Automata that recognize intersections of free monoids").

This was also the time when people started to recognize the informational character of biomolecules, in particular DNA, which prompted speculations about the usefulness of DNA and other (bio)molecules in performing computation (M. Conrad, R. Feynman, Ch. Bennet, etc.). More generally, it was hypothesized that mathematical linguistics, in particular, formal language theory, could be applied in the study of DNA structure and biochemistry. It is worth mentioning here a paper published in 1974 by "the patriarch of the Romanian theoretical computer science", Solomon Marcus (1925–2016), a close friend of Tom Head, with the title "Linguistics structures and generative devices in molecular genetics".

These developments did not escape Tom's curiosity and by the end of the seventies he was studying Lindenmayer systems (L systems), bio-inspired generative devices which model the development of multicellular structures. Although Tom published a series of papers in the L systems area, his history making paper came in 1987: "Formal language theory and DNA: an analysis of the generative capacity of specific recombinant behaviors", published in *Bulletin of Mathematical Biology*, 49 (1987), 737–759. In this paper, Tom Head introduced what he called *the splicing operation*, a cut-and-paste operation with strings modeling the recombination of DNA molecules under the influence of restriction enzymes. Soon, this operation was used as the basic ingredient of *splicing systems*, language generating devices, referred to as *H systems*, with "H" standing for "Head" in honor of Tom. The bibliography of H systems is impressive, with hundreds of papers written by researchers from all over the world.

Thus, 1987 can be considered as the beginning of DNA computing, at least at the theoretical level. In 1994, when L. Adleman reported in *Science* the first lab experiment of computing with DNA ("Molecular computation of solutions to combinatorial problems"), Tom became enthusiastic about the possibility of using biomolecules for computing and got very interested in, and dedicated to, experimental research in molecular computing. He designed several innovative experimental protocols of what he used to call *aqueous computations*, at the same time attracting his students as well as students in other institutions to this fascinating and promising research field. This is an important point to mention: Tom Head was a dedicated mentor, careful as a father, and always very proud of all of his seven PhD students with a visible love – E. Rutter, J. Delaney, J. Harrison, N. Jonoska, A. Weinberger, E. Goode, J. Loftus.

For his achievements, in 2002 Tom received “The Tulip Award” (now re-named “The Rozenberg Tulip Award”) an annual award recognizing a DNA Computing Scientist of the Year awarded by the International Society of Science Computing and Engineering. In 2004 the scientific community recognized his work with the volume *Aspects of Molecular Computing. Essays Dedicated to Tom Head on the Occasion of His 70th Birthday* (LNCS 2950, Springer-Verlag, Berlin, 2004, edited by the authors of this obituary).

Tom was a deeply intellectual person with a broad spectrum of interests extending far beyond science, e.g., arts, philosophy, world religions, “end-of-the-century” culture of Vienna, and music. Music was very important to Tom and he was fascinated by Gustav Mahler. He wrote to one of us (about nine months before he passed away): “I feel like shouting to the World: *You must keep identified with Mahler after I am gone! Don't forget!*”

On the Binghamton University website, Tom Head had humbly listed for his scientific interests algebra, computing with biomolecules, and also *formal representations of communication*. Still this list is way shorter than it should be. Tom’s scientific interests were broad, which naturally led him to creation of original bridges between seemingly unrelated areas. Several of his recent publications deal with “computing with light”. Tom’s most recent paper listed by the DBLP (<http://dblp.uni-trier.de/pers/hd/h/Head:Tom>) has a rather instructive title: “Computing with light: toward parallel Boolean algebra”, *Int. J. Found. Comput. Sci.* 22(7) (2011), 1625–1637. Back to algebra, through computing by light, after many years of molecular computing and L systems – the paper is a testimony of the transdisciplinarity of Tom’s journey in science, as we mentioned in the title. We point out yet another intriguing title, significant for Tom’s wide and deeply original preoccupations: “Does light direct life toward cosmic awareness?”; it was published in *Fundamenta Informaticae*, 64 (1-4) (2005), 185–189, in a volume edited in honor of S. Marcus.

Two great scientists, Tom Head and Solomon Marcus, meet now in “the world of light”, while their ideas remain with us, to be continued, to be developed...