*Journal of Cellular Automata*, Vol. 11, pp. 265–269
Reprints available directly from the publisher
Photocopying permitted by license only



## Obituary

# Prof. Harold V. McIntosh
# March 11, 1929 – November 30, 2015

Professor Harold V. McIntosh was a prominent researcher who dedicated his life to Science. He was a big promoter of educating young students in several scientic fields simultaneously, such as physics, history, mathematics, biology, chemistry, and computer science.

McIntosh was born in Colorado, USA in 1929 and died last November in Puebla, Mexico. He received a Bachelors degree in Physics from Colorado University in 1949, and a Masters degree in Mathematics from Cornell University in 1952. McIntosh developed a lot of contributions in different subjects, covering mainly: complex analysis, group theory, particle theory, compilers, language programming, computer graphics, flexagons and cellular automata theory.

He started his professional life as a lecturer at Cornell University. He moved to Aberdeen Proving Ground, and he then went to the Research Institute for Advances Studies (RIAS) in Baltimore, both in Maryland. After that, he moved to University of Florida, all of them in the USA. In 1964, he changed his residence to Mexico, initially at Centre for Research and Advanced Studies (CINVESTAV), National Polytechnic Institute (IPN), then at Electronic Calculation Center (currently IIMAS), National Autonomous University of Mexico (UNAM). After that, he moved to the School of Physics and Mathematics (ESFM), he then moved to the National Computing Center (CENAC), all of them at IPN. He worked as well at National Nuclear Energy Institute (ININ) in Mexico City. Finally, he worked until his last day at Department of Microcomputer Applications, Autonomous University of Puebla (UAP), in the state of Puebla, Mexico.

Most of the news about his passing away focused on several of his relevant contributions in computer science, mathematics, and physics fields. McIntosh however, developed other interests since the middle of the 80's. Thus, over more than 30 years, he was highly dedicated to cellular automata, computer graphics, and flexagon theory.

In mathematics, McIntosh was interested to understand and solve problems in differential equations, group theory, complex analysis, and matrix theory [11,21].

In computer science, McIntosh realized a lot of original contributions in Mexico. In computer graphics, he developed a set of powerful libraries to plot functions, named PLOT, in 1975 [6] and GEOM to draw molecules in two and three dimensions [17]. This software was originally written in FORTRAN, evolving to some versions in C for MS-DOS, and with adaptations in Objective-C for Next computers. Finally, at the end of the 90s, some attempts were done to migrate a last version to Java.

In languages theory, McIntosh designed and implemented two compilers: CONVERT [4] and REC [13]. In those years (middle of the 60s), CONVERT was suciently compact, efficient, and practical, based on symbolic manipulation. For his originality and contribution in the field of languages programming, McIntosh was cited by Marvin Minsky in his celebrated book "Computation: Finite and Infinite Machines" [14] and in his 1969 Turing Award Lecture [15].

His interest on cellular automata theory started with the original two-dimensional 29 cell-states Von Neumann's automaton and the concept of universal constructors [19]. One anecdote was his meeting with him in a visit to Princeton University, where McIntosh had the opportunity to hear one of those talks when he was a student. The second influence become with the project Cellular Automata Machine (CAM) [18] developed at MIT by Tommaso Toffoli and Norman Margolus. At the Microcomputer Department in Puebla, McIntosh programmed during this period CAMEX [8], a software able to manipulate an additional video card/monitor to simulate several kinds

of CA. Some years later, CAMEX evolved in a series of specialized software named LCAU for MS-DOS operating system, and NXLCAU for Next computers.[1] These packages implement several tools based on probability, graph theory, set theory, matrix analysis, dynamical systems, and tiling theory; in order to analyze cellular automata in one dimension. Several of these technics also are described in the book "Computational Analysis of One-Dimensional Cellular Automata" by Burton Voorhees [20].

The first formal paper written by McIntosh in cellular automata was submitted and presented in a remarkable workshop sponsored by the Center for Nonlinear Studies, celebrated in Los Alamos Laboratory, New Mexico, USA (September 9-12, 1989). The aim of the paper "Wolfram's class IV automata and good life" [7] is to provide a methodology to recognize complex cellular automata [23]. This methodology is applied in the famous Conway's cellular automaton, the Game of Life, and in one-dimensional cellular automata.

In the same meeting, McIntosh was interested in other kind of cellular automata: the Chaté-Manneville automata and the reversible case. Some years later, his work included as well specific studies on elementary cellular automata rules 22 and 110. Particularly, McIntosh established that rule 110 could be represented as a tiling problem [8].

In 2008, a special issue of the *Journal of Cellular Automata* was dedicated to McIntosh, entitled "Discrete Tools in Cellular Automata Theory," edited by Martínez and Seck.[2] Actually, McIntosh was one of the original editorial board members of the Journal of Cellular Automata.[3]

Luniver Press published his book "One Dimensional Cellular Automata" at United Kingdom in 2009 [12], and it was one of the best sellers of this editorial. In this book, McIntosh presents his contributions in the study of cellular automata in one dimension. In particular, McIntosh explains the use of several graphic tools; for instance: Pair diagrams to detect surjective and reversible rules, and multiple ancestors (preimages) for a given string. De Bruijn diagrams to determine all periodic strings as regular expressions. Subset diagrams applied as general state machines to recognize the language that each automaton is able to yield and Garden-of-Eden strings.

In the specialized literature dedicated to the Game of Life cellular automaton, McIntosh contributed with three papers categorized as historical manuscripts given their relevance and originality, in the book celebrating the 40th anniversary of the Game of Life entitled "Game of Life Cellular Automata" edited by Andrew Adamatzky and published in 2010 [1]. Specically, McIntosh established the projection of de Bruijn diagrams in two dimensions as an algorithm to find spaceships in Life-like rules, described by David Eppstein in his paper "Searching for Spaceships" [4].

[1] http://delta.cs.cinvestav.mx/~mcintosh/cellularautomata/SOFTWARE.html.
[2] http://www.oldcitypublishing.com/journals/jca-home/jca-issue-contents/jca-volume-3-number-3-2008/.
[3] http://www.oldcitypublishing.com/journals/jca-home/jca-editorial-board/.

Another exceptional event was the visit that McIntosh had in February 2011 at Puebla from Edward Fredkin. This was an outstanding meeting between two brilliant minds. Subjects as cellular automata, computer science, Second World War, and the project MAC at MIT were some of the subjects of discussion during more than four hours. Also, at the same year, a meeting with cellular automata researchers as Andrew Wuensche, Kenichi Morita, and Genaro Martínez was celebrated in November. Specic topics such as complex cellular automata, reversibility [16], and connections with basin of attractors [22] were discussed in this meeting.

Two papers in cellular automata subjects are in press to be published in 2016, where McIntosh had a great influence. One chapter is included in the book "Designing Beauty: Art of Cellular Automata" [3] titled "Patterns in One Dimensional Cellular Automata" that will be published by Springer. The second one is a collaborative chapter between Martínez, Adamatzky, and McIntosh, entitled "A Computation in a Cellular Automaton Collider" to appear in the book "Advances in Unconventional Computing" [2] that will be published by Springer.

Furthermore, McIntosh was considered an authority in flexagon theory, developing several kinds of them in different levels and topologies [10]. In this sense, Martin Gardner was elaborating a special book dedicated to the history and advances about flexagons four years ago. Garden himself invited McIntosh to collaborate with some chapters, although lamentably he died in 2008 without complete and publish his book.

McIntoshs legacy in different scientic fields is an example of dedication, passion and principles, in order to investigate problems from the easiest perspective, with didactic and visual interpretations, to establish later a formal solution. He was a great mentor and inspiration for many generations of students and researchers, and will be always remembered and honoured as a brilliant scientist and an exceptional person.

Genaro J. Martínez
Escuela Superior de Cómputo
Instituto Politécnico Nacional, México, D.F.
International Centre of Unconventional Computing
University of the West of England, Bristol, United Kingdom.

## REFERENCES

[1] Adamatzky, A. (ed.) (2010) *Game of Life Cellular Automata*, Springer.
[2] Adamatzky, A. (ed.) (2016) *Advances in Unconventional Computing*, Springer.
[3] Adamatzky, A. & Martínez, G.J. (eds.) (2016) *Designing Beauty: The Art of Cellular Automata*, Springer.
[4] Eppstein, D. (2002) "Searching for Spaceships," *MSRI Publications* **42** 433–453.

[5] Guzman, A. & McIntosh, H.V. (1966) "CONVERT," Communications of the ACM **9**(8) 604–615.
[6] McIntosh, H.V. (1975) "PLOT75," INEN Salazar, Edo. de México, México.
[7] McIntosh, H.V. (1990) "Wolfram's class IV automata and good life," *Physica D* **45**(1-3) 105–121.
[8] McIntosh, H.V. (1992) "The CAM/PC exerciser CAMEX," Departamento de Aplicación de Microcomputadoras, Universidad Autónoma de Puebla, Puebla, México. URL: http://delta.cs.cinvestav.mx/~mcintosh/cellularautomata/SOFTWARE_files/camex.pdf
[9] McIntosh, H.V. (1999) "Rule 110 as it relates to the presence of gliders," Departamento de Aplicación de Microcomputadoras, Universidad Autónoma de Puebla, Puebla, México. URL: http://delta.cs.cinvestav.mx/~mcintosh/cellularautomata/Papers_files/rule110.pdf
[10] McIntosh, H.V. (2000) "My Flexagon Experiences," Departamento de Aplicación de Microcomputadoras, Universidad Autónoma de Puebla, Puebla, México. URL: http://delta.cs.cinvestav.mx/~mcintosh/cellularautomata/FLEXAGONS_files/fxgon.pdf
[11] McIntosh, H.V. (2001) "Complex Analysis," Universidad Autónoma de Puebla, Puebla, México. URL: http://delta.cs.cinvestav.mx/~mcintosh/cellularautomata/OTHER_TOPICS_files/complex.pdf
[12] McIntosh, H.V. (2009) *One Dimensional Cellular Automata*, Luniver Press, Bristol, UK.
[13] McIntosh, H.V. & Cisneros, G. (1990) "The programming languages REC and CONVERT," *SIGPLAN Notices* **25** 81–94.
[14] Minsky, M. (1967) *Computation: Finite and Infinite Machines*, Prentice Hall.
[15] Minsky, M. (1969) "Form and Content in Computer Science," Turing Award Lecture, MIT, USA.
[16] Morita, K. (2008) "Reversible computing and cellular automata – A survey," *Theoretical Computer Science* **395**(1) 101–131.
[17] McIntosh, H.V. & de la Trinidad, S.J. (1993) "GEOM: A Program to Draw Molecules," Departamento de Aplicación de Microcomputadoras, Universidad Autónoma de Puebla, Puebla, México. URL: http://delta.cs.cinvestav.mx/~mcintosh/cellularautomata/OTHER_TOPICS_files/geom.pdf