Systems & Control Letters 139 (2020) 104663

Contents lists available at ScienceDirect

Systems & Control Letters

journal homepage: www.elsevier.com/locate/sysconle

Guest editorial

In memoriam Ruth Curtain

Hans Zwart *

University of Twente, Faculty of Electrical Engineering, Mathematics and Computer Science, Department of Applied Mathematics, P.O. Box 217 7500 AE Enschede, The Netherlands
Eindhoven University of Technology, Department of Mechanical Engineering, P.O. Box 513, 5600 MB Eindhoven, The Netherlands

ARTICLE INFO

Article history:
Received 17 February 2020
Accepted 23 February 2020
Available online 25 March 2020

ABSTRACT

In this note we reflect on the work and life of Ruth Curtain. This article is strongly based on the article (Zwart, 2019), which was written in Dutch.

1. Melbourne–Groningen

On July, 16, 1941, Ruth was born in Melbourne as the eldest of four children, all girls. She grew up in a standard working class family, father a painter and decorator and mother a housewife. During those days it was common practise that girls would leave school at the age of 14, to start a job. This was also the opinion of her father, but her mother disagreed. After a heavy domestic fight, her mother won the battle "My mother was a great fighter", and Ruth could continue her education [1]. After this all her three sisters were allowed to continue their education. At high school mathematics was regarded not suitable for girls, they would fail anyway. For Ruth this was an extra motivation to do her utmost, which she did. On the day that the exam scores for mathematics were announced, the students name with their score were read out in front of the class. When the teacher came to the highest score, 100, only Ruth and a male student were left. The male student earned a 100, leaving Ruth quite puzzled. Then the teacher said with a big smile "Ruth Curtain 110 for pure mathematics". Her high-school exam gave her access to the university, and with a scholarship she started her bachelor program. The scholarship came with the condition that after your graduation you would work 3 years as a teacher. Ruth had the luck that she could for fill this requirement by working as a tutor at the university. This enabled her to get her master degree. She did her master project on a topic from algebra, which only fascinated her marginally. During her bachelor she did physics and mathematics, but during her master it was only mathematics, and she missed the physics. The new research field of control theory drew her attention, and since this topic could not be studied in Australia, nor at the standardly chosen foreign universities Oxford and Cambridge, she left for the USA to start a Ph.D. at Brown University. In 1969 she obtained her Ph.D. degree on stochastic partial differential equations [2]. After a 18 month post-doc position at Purdue University and a short visit back to Australia, she started to work at the newly founded *Control Theory Centre* of the University of Warwick. Although this was a very inspiring place, her career opportunities were limited. This is the reason why after six years she left to accept a position in mathematics at the University of Groningen in the Netherlands. Initially, she had the plan to stay there only for a couple of years, but she stayed at the university there until her retirement [3], and she continued to live in the city until her death. That she never pursued a career outside Groningen has two main reasons. First of all it was the very active research atmosphere within the system and control group, including her colleague Jan Willems, but also many students who later became professors. Apart from her own students, there were Henk Nijmeijer, Arjan van der Schaft, Rikus Eising, and Siep Weiland, to name a few. Secondly, she liked the city and the no-nonsense attitude of the Groningers.

2. Infinite-dimensional systems

Infinite-dimensional systems theory has always been the research field of Ruth. As is clear from the title of her Ph.D. thesis, Ruth started with stochastic differential equations. The interest in (optimal) control of stochastic differential equations started with the work of Kalman, solving the quadratic optimal control problem for finite-dimensional systems. Around 1970, these results were extended to infinite-dimensional systems by Lions, Magenes, Pritchard, and Zabczyk. Shortly after, Ruth, initially together with Tony Pritchard, became active in this area. It is important to remark that the general theory describing infinite-dimensional linear differential equations via strongly continuous semigroups was still young at that time [4,5]. In the middle of the eighties Ruth stopped with her research on stochastic systems, but research on the quadratic optimal control problem and the related algebraic Riccati equation (ARE) stayed an important theme. One of her last articles studies the iterative approximation of the largest solution of the ARE [6].

* Correspondence to: University of Twente, Faculty of Electrical Engineering, Mathematics and Computer Science, Department of Applied Mathematics, P.O. Box 217 7500 AE Enschede, The Netherlands.
E-mail addresses: h.j.zwart@utwente.nl, h.j.zwart@tue.nl.

https://doi.org/10.1016/j.sysconle.2020.104663
0167-6911/

During her whole career Ruth had a sharp eye for new developments within the field, which enabled her to extend theory developed for finite-dimensional system to infinite-dimensional systems. Prime examples of this is the work on approximation of infinite-dimensional system by finite-dimension ones with Keith Glover and Jonathan Partington [7], and the work with Akira Ichikawa and her Ph.D. students Job Oostveen and Mark Opmeer on the Nehari problem [8–10]. She always gave to her students challenging topics. Next to the two mentioned above and myself there were Jan Bontsema, Bert van Keulen, Carlos Kubrusly, Amol Sasane and Martin Weiss. All her students could count on her for help and support. Although she advocated for more equitable hiring in the university system, all her Ph.D. students were male. In the newspaper interview [1] she reflected on this in the remark "The believe that women are not good in mathematics is deeply embedded within the Dutch culture". In the same interview she questioned if she, as an unmarried ("marriage did not happen") older woman, was the right role model for young women.

3. Books

After her retirement she worked at home on problems that interested her. Furthermore, she made many touristic travels. At Christmas she did not send out greetings cards, but a long e-mail accompanied by photos which she made during the trip of that year.

Teamspirit was a learning goal in Australia, and this has really a reflection in Ruth's work. A quick count in MathSciNet shows that she wrote approximately two-third of her papers with co-authors. Furthermore, she valued good textbooks. In 1978 she published together with Tony Pritchard a book on infinite-dimensional systems theory [11]. Since they realised that not every potential reader would have the necessary background in functional analysis or operator theory to understand this new field, they also wrote a book explaining these topics [12]. After my Ph.D. in 1988 she asked me to jointly write a new version of these books. The plan was that this book should contain exercises and thus become more of a textbook. After seven years, this book was published [13]. Like her earlier books, this book became very quickly a standard reference within the field. Already in 2003 the first plans were made to revise this book, but the real work started around 2011. We had regular contacts, via e-mail, phone, fax, but also visits to her house, to discuss all the changes and additions. In 2017 the process was close to finishing, but in June she was diagnosed with lung cancer in an advanced state. At the end of that year we heard from the publisher that they wanted to publish our new book. Unfortunately, Ruth has not seen the final product, since she passed away on March 18, 2018.

After her death many researchers, male and female, contacted me expressing that Ruth always supported them and that she has been an inspiring role model for them. Hence her doubt expressed in the above mentioned newspaper interview was groundless.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This article is strongly based on the Dutch article, [14]. I am very grateful for the permission of the publisher of *Nieuw Archief voor Wiskunde* to publish the English version in Systems & Control Letters. Furthermore, I would like to thank Kirsten Morris for her support in preparing the English version.

References

[1] NRC, Als enige vrouw in de wiskunde val je wel op (Dutch) (Being a woman within mathematics you catch the eye), 2015, Newspaper interview, August 15, 2015, URL https://www.nrc.nl/nieuws/2015/08/15/als-enige-vrouw-in-de-wiskunde-val-je-wel-op-1523725-a657945.
[2] R.F. Curtain, Stochastic differential equations in a Hilbert space (Ph.D. thesis), Brown University, ProQuest LLC, Ann Arbor, MI, 1969, p. 156.
[3] R.F. Curtain, An Australian retrospectieve, NAW 5/7 (2006) (in Dutch). An English translation of her farewell lecture on which this article is based is available upon request.
[4] E. Hille, R.S. Phillips, Functional analysis and semi-groups, in: American Mathematical Society Colloquium Publications, vol. 31, American Mathematical Society, Providence, RI, 1957, p. xii+808, rev. ed.
[5] K. Yosida, Functional Analysis, in: Die Grundlehren der Mathematischen Wissenschaften, Band 123, Academic Press, Inc., New York; Springer-Verlag, Berlin, 1965, p. xi+458.
[6] R.F. Curtain, H. Zwart, O.V. Iftime, A Kleinman-Newton construction of the maximal solution of the infinite-dimensional control Riccati equation, Automatica J. IFAC 86 (2017) 147–153.
[7] K. Glover, R.F. Curtain, J.R. Partington, Realisation and approximation of linear infinite-dimensional systems with error bounds, SIAM J. Control Optim. 26 (4) (1988) 863–898.
[8] R.F. Curtain, A. Ichikawa, The Nehari problem for infinite-dimensional linear systems of parabolic type, Integral Equations Oper. Theory 26 (1) (1996) 29–45.
[9] R.F. Curtain, M.R. Opmeer, The suboptimal Nehari problem for well-posed linear systems, SIAM J. Control Optim. 44 (3) (2005) 991–1018.
[10] R.F. Curtain, J.C. Oostveen, The Nehari problem for nonexponentially stable systems, Integral Equations Oper. Theory 31 (3) (1998) 307–320.
[11] R.F. Curtain, A.J. Pritchard, Infinite dimensional linear systems theory, in: Lecture Notes in Control and Information Sciences, vol. 8, Springer-Verlag, Berlin-New York, 1978, p. vii+297.
[12] R.F. Curtain, A.J. Pritchard, Functional analysis in modern applied mathematics, in: Mathematics in Science and Engineering, vol. 132, Academic Press [Harcourt Brace Jovanovich, Publishers], London-New York, 1977, p. ix+339.
[13] R.F. Curtain, H. Zwart, An introduction to infinite-dimensional linear systems theory, in: Texts in Applied Mathematics, vol. 21, Springer-Verlag, New York, 1995, p. xviii+698.
[14] H. Zwart, In memoriam Ruth curtain: Een scherp oog voor nieuwe ontwikkelingen, NAW 5/20 (2) (2019) 135–136 (in Dutch).