



Einar Smith

Carl Adam Petri

Life and Science



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Einar Smith
Fraunhofer-Gesellschaft SCAI-
Institute for Algorithms and Scientific Computing
Sankt Augustin, Germany

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Foreword

Whoever had the privilege of meeting Carl Adam Petri in private or public conversation remembers a very modest, humble person willing to patiently listen to his guest. When it came to his view, however, he was an adamant visionary who never allowed himself to sidetrack from his ultimate aim: to establish a comprehensive formal basis for informatics. In the cumbersome age of paper tape and punched cards, Petri rightly predicted a central usage of today's computing devices in his PhD thesis, 'Communication with Automata'. In times when only stand-alone, one-processor computers were available, Petri suggested concurrency as a fundamental phenomenon of discretely evolving systems.

Carl Adam Petri is renowned for his invention of what is known as 'Petri nets' all over the world, with places to contain tokens that are moving along transitions. Petri himself considered this concept just a starting point for a far more comprehensive theory of informatics. During his professional life, Petri carefully observed the quickly evolving world of informatics, from its inception in the 1950s until the first decade of the new millennium. He early envisaged some of the later outcomes; others he considered irrelevant. He always was missing a comprehensive discussion of the formal, theoretical basis of informatics. He never agreed with the narrative of adopting the concept of computable functions over sequences of symbols as the only fundamental basis of informatics, as frequently suggested, in particular during the hype of the 'Turing year', 2012. Instead, he had a clear vision of theoretical concepts, in accordance with the laws of physics, information flow, and information processing.

You may wish to learn more about the person with such autonomous spirit. This is what this book offers: An inspiring biography, illuminating both the personal and the professional evolution of Carl Adam Petri. Knowledgeable readers may find new perspectives to Petri nets; other readers may learn what Petri nets are about in the first place.

The author, Einar Smith, has been the most close collaborator and friend, especially of the late Carl Adam Petri. Nobody else could have better selected and described the highlights of Petri's life as a scientist.

I am very happy that Einar has compiled this text. This book adds valuable insights into an exciting aspect of the short history of informatics. I wish this book wide recognition in the informatics community and beyond.

Berlin, Germany
June 2015

Wolfgang Reisig

Preface

Carl Adam Petri passed away at the age of 83 in 2010. He spent most of his professional life as head of institute in the Gesellschaft für Mathematik und Datenverarbeitung (GMD, German National Center for Mathematics and Computer Science) in Sankt Augustin near Bonn, Germany.

In recognition of his contributions to the GMD, to basic research in computer science, and to computer science in general, the management board of the Fraunhofer Gesellschaft (in English known as the Fraunhofer Institute), with which the GMD merged in 2001, initiated a project to document Petri's life and works. Central to this project was the preparation of a biography.

I am very grateful that I was asked to undertake that task, because in this way I got the opportunity to pass on at least a small part of what I have learned from my revered teacher and friend Carl Adam. In innumerable long conversations, he explained to me, with great patience, his radical and visionary understanding of informatics and computer science and showed me the route to my own research. Also after his retirement, even when he was already heavily plagued by serious illness, he continued to share his insights with me.

The worldwide dissemination of the Petri nets, named after him, has developed a dynamic of its own; there is no end in sight, neither for theoretical research nor practical applications. This gives me the opportunity to concentrate here on the "history of ideas" behind the origins and background of nets and also on the person Carl Adam Petri himself.

This history includes research insights and approaches that have influenced net theory, even if the connections are not always obvious. If one considers Petri nets as fungi, we shall then be mainly concerned with the generating mycelium.

The main guideline we shall follow is the chronology of the principal character; however, whenever the content requires it, we give precedence to a clarification of the thoughts and their interrelations.

In compiling this biography, besides my own conversations with Carl Adam Petri, the contributions of his close collaborators Hartmann Genrich and Wolfgang Reisig were also of great use. I am also very grateful for all the helpful personal background information that Carl Adam's son Tobias gave me.

I was also able to profit extensively from written contributions from Tobias Petri, who for instance has prepared an entire CD with data, stories, and photos of his father. The text of a laudatory speech delivered by a colleague and friend of Carl

Adam's, Lu Ruqian from the Chinese Academy of Sciences, on the occasion of Petri's 60th birthday was also very useful.

The most important material was, however, a loose collection of more than 300 handwritten A4 pages that Petri perhaps intended to use himself in a future autobiography. Where there were still some details missing, I made extensive use of the Internet, to the development of whose predecessor, the ARPA-net, Petri contributed in the 1960s.

This book is intended both for readers with previous knowledge in computer science, whether including Petri nets or not, and for "interested nonprofessionals," who might perhaps develop an interest in a further study of Petri nets. Lastly, it is also intended for readers who simply want to get to know a remarkable personality of contemporary science. The text is organized in such a way that skipping over formal details should affect the overall understanding as little as possible.

The text is a slightly revised translation of the German original *Carl Adam Petri. Eine Biographie*, published by Springer-Verlag in 2014. Whenever it seemed necessary, however, I have added additional notes that could be useful to readers not familiar with Germany and the German language.

The translation was a two-phase process. First, I made a raw version myself, which was then corrected and refined by a native English speaker, Tim Denvir, a software engineer, computer scientist, and a regular consultant and book reviewer for Springer. In fact, Denvir's contributions were not limited to the linguistic level. In many cases, his critical remarks helped me to clarify the formal argument. However, I myself am responsible for any remaining idiomatic idiosyncrasies.

For further studies of Petri's life and works, the reader is referred to the Deutsche Museum in Munich, where Petri's scientific estate, donated by his son Tobias, has been meticulously curated and archived. There Petri is in the best of company, for instance with Ernst Mach and not least Konrad Zuse.

For stimulation and encouragement, I would in particular like to thank Tobias Petri and Wolfgang Reisig from the Humboldt University, Berlin. I am also grateful to Tobias Petri for his permission to use drawings and photographs from his father's private archive.

Wolfgang has supported the publication energetically, not least by establishing contact with Springer-Verlag and by offering to write a foreword.

Finally, I would like to thank all those involved at Springer-Verlag, especially Hermann Engesser and Dorothea Glaunsinger, for their friendly and constructive cooperation.

Sankt Augustin, Germany
June 2015

Einar Smith

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Petri nets are a world-renowned means of modeling distributed systems, with applications in vastly different sectors such as banking, economics, telecommunication systems, workflow management, conflict resolution, process-control, biochemistry and system biology.

Through their easily understood principles and intuitive graphical descriptions, Petri nets can visually depict and explain complex structures and relationships also to non-specialists. On the other hand, they offer profound mathematical analysis methods to the expert.

Less well known is the fact that the founder of net modeling, Carl Adam Petri, developed most of the central ideas of his theory during his work at the Gesellschaft für Mathematik und Datenverarbeitung (GMD, German National Center for Mathematics and Computer Science) in the small town of Sankt Augustin near Bonn, at that time capital of Western Germany. Petri's personal development, his works and achievements within the GMD until his retirement—and also beyond—are the subject of this biography.

The reader does not require any previous knowledge of Petri nets, but a basic grasp of the fundamental concepts will of course facilitate his/her understanding. In the present chapter we provide a short introduction. How short? To cite one of Petri's favorite poets, Bob Dylan (the others were Sappho, Alcaeus and Horace): "And just how far would you like to go in? Not too far but just far enough so's we can say that we've been there."

1.1 Petri Nets

The basic idea behind Petri nets is quite simple: A net consists of *places* (represented by circles), which can be marked by a token to indicate the *holding* of a possible state, and *transitions* (represented by squares), which permit a change of the state. According to context, the term “condition” is also often used for “place”. Referring to a condition, we may also say that it “is satisfied” instead of it “holds”. In such contexts then often also the term “event” is preferred over “transition”.

Example

Figure 1.1a shows a situation in which a lamp is turned off, represented by a token on the place “off”. The transition “goes on” is *enabled* because the input-place is marked. Through the *occurrence* of the transition the token is withdrawn, and the output-place “on” is marked instead.

Figure 1.2 shows Petri’s son Tobias as observer of the system in Fig. 1.1.

In the example above the transition “goes on” has only *one* input- and *one* output-place. The power of the nets, however, arises from the fact that there may be more than one. In general, to *enable* a transition, *all* input places must be marked. The transition then withdraws the tokens from the input-places, and marks the output-places instead.

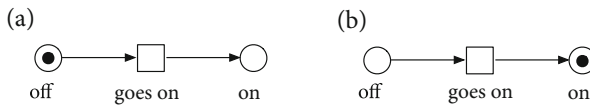


Fig. 1.1 (a) shows the situation before the occurrence of the transition “goes on”, (b) the result



Fig. 1.2 Fiat lux! Drawing by C. A. Petri