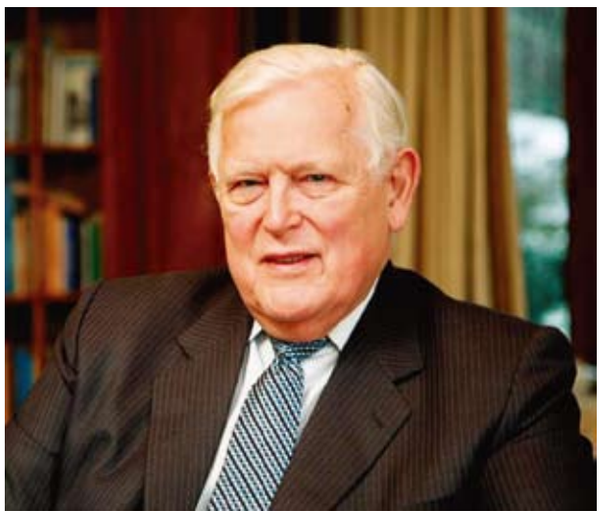
# 讣告：一代科学巨匠卡尔曼逝世

## Obituary: Rudolf Kalman

Trbor Vamos

【编者按】2016年7月2日，一代科学巨匠、著名控制科学家卡尔曼不幸逝世，享年86岁。为沉痛悼念卡尔曼逝世和缅怀卡尔曼的杰出贡献，本刊特转载IFAC顾问Tibor Vamos教授提交刊登在IFAC Newsletter 2016年第4期上的讣告。



The Kalman filter! This concept is well known by many. Indeed, those who are at home in the technical world even know that nearly all our devices which are meant to safeguard a situation or a target state in a secure way, contain a Kalman filter.

But what is known by fewer people is that this device was born as a product of the modern systems theory and more precisely, by the discovery of the mathematical basics in control theory that bears such an important role in our technical thinking as John von Neumann's basic foundations do in the construction of computers.

Rudolf Kalman died on 2 July 2016, aged 86, still in his full mental capacity.

He summarised the discernible and calculable signals coming from systems performing a high variety of tasks and operating amidst various external influences, into a single athematical structure which is capable to filter out the characteristics of the desirable state by using a learning, adaptation algorithm, and filter them from any disturbances. Hence comes the naming of both the concept and the device. This filtering warrants the target tracking both in its physical reality and notional interpretation, should it be in electronic networks or large economic systems. It has enabled to calculate and analyse the systems' past behaviour and also their future options. Based on this, re–evaluating the past deviations and events, predicting the next ones to come have become possible but also estimating the limits and constraints of the calculability of, and deviations from them.

The starting point is a conceptual, philosophical idea: everything is a system or the system of systems, but the final, partly virtual elementary particles of physics. Systems science tries to build a framework of common features of

注：Rudolf Kalman（photo courtesy of ETHZ）

systems for observation and possible control of system operations, movements, changes. This is the subject of IFAC and the common language of system observation and control in mathematics, nowadays realized mostly by computer programs.

Systems are moving, changing by their own internal features and external influences. These external influences are partly controlled by our control instruments and intentions and by noises and disturbances. Good examples are vehicles by which we try to reach our destination and the disturbances due to meteorological phenomena.

The Kalman filter is the general device for separation of useful motions and changes from the disturbances. It observes the signals of the system behavior by statistical–probabilistic algorithmic, computable methods and learns by these observations the genuine nature of the system behavior and the phenomena of disturbances. This knowledge is fed back to the system control and by that maintains the system on the desired root.

This online observational, tatistical, probabilistic calculation was a complicated, expensive task at the early period of the filter idea and used first for the control of rockets, missiles. Now, it can be realized in single complex chips and is applied in many millions of moving objects, cars, airplanes, and GPS–based instruments such as smart phones.

It is not only the millions of pieces of equipment but also hundreds of thousands of researchers, developers and maintenance experts who have been nourished from this pattern of thoughts. The extraordinary impact is demonstrated by the vast number of references in publications and by the thousands of new patents each year.

Kalman himself regarded his own filter despite its tremendous importance and success as a finger exercise only in his general mathematical opus of systems theory. He had been working until his death on the unsolved problems of systems calculations and he had raised questions which we have been sluggish or not courageous enough to ponder on.

Kalman was taken by his father from the torments of the Second World War to the US when he was 13, where he studied with the pioneers of the mathematical–technical elite on the Western coast and it was here that his radiant and permanently creating talent was discovered. His genius was recognised in the US and he had received the most prestigious awards there as well as in other countries with highly developed cientific culture. His being awarded by these prizes is the yardstick of their real value. He was an honorary member of numerous academies and received honorary doctorates from high ranking universities.

Kalman always stressed his Hungarian origins and he spoke his native Hungarian brilliantly without any accent. After the cold war period he rendered ever more frequent visits to Hungary where he had the honorary membership of our Academy of Sciences but he could feel at home especially at SZTAKI, the Institute of Computer Science and Control in Budapest, where he had his own studio and where he kept a substantial portion of his Zurich library.

He was a genuine intellectual who was open in his thinking, and had an amazing knowledge of and interest in music. When at home he regularly attended concert and opera performances and made us astound by his immense knowledge in history and especially cultural history.

The big gift in Kalman’s life was his wife, a lady of high culture and origins in Greek Alexandria. From his big family, one of his daughters volunteered in works of charity in Hungary for about a year. Recently he wrote us that he was preparing for his next visit in autumn to Hungary. From now, we can only take care of the stimulating heritage he had left us by his genius.

Submitted by Tibor Vamos (HU), IFAC Advisor
IFAC President 1981–1984