AND THAT IS HOW I GOT TO WHERE I FIND MYSELF TODAY

Farewell address Prof.dr. G.J. Olsder

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Farewell address, (abridged version) presented on 14 November 2008, by

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Mr Vice-Chancellor,
Members of the Board,
Fellow professors and other members of the university community,
And all of you who have shown an interest by coming here,
Ladies and Gentlemen,

Poem by Bill Watterson, creator of Calvin and Hobbes

On Saturday 1 January 1944, at a quarter to seven, the milk collector knocked on the lighted window of my parents’ bedroom and called in the Groningen dialect “any milk for me today, Olsder?” My mother was in the process of having her first child and milking the cows had not been the first thing on my father’s mind. And when our family doctor, who had been assisting at the delivery, was towed home in his car by our horse a few hours later, owing to a defective gas cylinder, the whole village knew about the new-born baby. This was the beginning of my life on earth; point of departure of the journey “to where I find myself today”. The title of this farewell speech is the last line of a poem by Bill Watterson [1], creator of Calvin and Hobbes. This line puts one’s life and career into perspective, which I thought appropriate in a farewell speech in which you are invited to think back on your career.

1. **Up to and including secondary education**

There was once a time in which
- you could skate on ditches every single winter,
- everyone knew the Milky Way,
- sheaves of corn were still tied up by hand,
- our village of two thousand inhabitants had seven bakers and five smithies; the former delivering bread to their customers six days a week,
A58 was the registration plate number of the car of our family doctor; the national highway of that number not yet having been constructed.

This was the time of my childhood. St Nicolas gave me a meccano set when I was five. That was my very favourite toy: after bedtime I would secretly construct things under the blankets, losing my little screws and bolts in the process. Fortunately St Nicolas knows everything and a year later on 6 December there were some boxes with additional screws and bolts on the floor in front of the coal heater. It was then, and also some years later, when constructing long complicated networks of corridors in the enormous stacks of straw bales on the farm, that I probably gained my first geometrical insights.

During my secondary school years (Winkler Prins Lyceum, Veendam) my interest in physics and mathematics continued to develop. From the money I earned by helping my father at harvest time I bought maths and astronomy books [2], also English ones, and also the complete Winkler Prins encyclopaedia, all eleven tomes, at Scholtens Academic Bookshop in Groningen, which was quite an expedition for a fourteen-year-old village boy in those days. When my maths teacher, Mr Molenaar --I am now allowed to call him Piet-- had explained the geometric series, with

\[
1 + a + a^2 + a^3 + \ldots = \frac{1}{1-a},
\]

I found an application in the relation between the synodic and the sidereal periods of the moon around the earth. When in the initial situation the sun, the earth and the moon are in a straight line, you want to know when that will be the case again; the time needed for that to happen is called the synodic period of the moon. You then consider the situation in which the moon has completed one orbit (the sidereal period); the three celestial bodies are no longer in line. To make that happen, the moon has to turn a bit further. This leads to a correction, the second term in the geometric series. However, the celestial bodies are still not in line because while the moon was rotating further, the earth moved along its orbit as well. Increasingly smaller corrections need to be carried out and thus a geometric series is created. You see my original notes in the photograph. All this gave me a thrill; Molenaar showed that there was a simpler method, but that did not diminish my joy.

In the next picture you see the constellation of Orion, taken with the very simple camera of my mother. I had discovered by trial and error that the exposure time had to be at least 20 minutes, if you were to see anything at all in the picture, so the camera had to rotate with the heaven. Otherwise you got stripes, or more precisely: pieces of circles. To achieve this rotation I used my meccano to make a mechanism fixed on an old clock, on which I mounted the camera. The pivot pin had to be set in the direction of the North Pole, which means not quite in the direction of the polar star. The result is not perfect, but clearly recognizable. I would carry this contraption of clock, meccano and camera out into the fields, so as not to be bothered by the headlights of passing cars. During the twenty minutes of exposure time I had nothing to do; you look around a bit and see the street lamps on the horizon. Imagine my surprise when I noticed that those lights went out one by one and would be visible again a bit later, and that this pattern shifted from east to north. I had a sudden hunch that there might be something between me and the horizon that was moving slowly and thus blocked my view of the lamps temporarily. This did appear to be the case. Suddenly two policemen made a dash for me; one was our village policeman. They had seen mysterious flashes of light in the field; I had been setting up the whole thing and had used a flashlight. This particular picture-to-be was totally ruined because the policemen had shone their flashlights on the lens.
The original calculations; $S_d = \text{sidereal}$, $S_n = \text{synodic period of the moon}$, $P_o = \text{period of planet earth (one year)}$
It was easy to repeat Foucault’s pendulum experiment on the farm. In the barn you lower a long rope from one of the collar beams, fix a heavy weight to the end of it and attach a little lamp to that. From the collar beam you take a picture of the pendulum motion every five minutes and --lo and behold-- this picture results.

Foucault’s experiment with the pendulum

So the earth does rotate. A good thing my parents did not know about this experiment beforehand; for you had to crawl along these collar beams, about ten metres above the floor of the barn. Attaching the pendulum to the beam had to be done with great precision. Before I found that out I got the following result. In one direction the pendulum swing was longer than in the direction perpendicular to that (see the left drawing; in the right one you see the correct attachment). The frequencies of the swings differ in these two directions and that renders beautiful pictures, but not proof that the earth rotates.

Lissajou figure and attachment of the pendulum
In 1961 there was an almost total solar eclipse in February, in the dead of winter. I was able to record it as follows. Unfortunately it was a bit cloudy, so that not all suns are equally sharp.

I was given permission to stay away from school to be able make these shots. Through my interest in astronomy I had become greatly intrigued by the orbits of planets; these are ellipses. Beautiful figures and lots of beautiful calculations involved. Thus, at the age of fifteen, I decided not to be a farmer but an “ellipsologist” instead.

2. Young scientist in pre-Delft years

There once was a time in which

- at lectures you had to write down everything (i.e. scribble like mad) because no (stencilled) lecture-notes were handed out,
- you did not enter the lecture room anymore if you were late,
- you borrowed cuff-links from a student two houses down the street to be able to be properly dressed for your oral exam,
- you handed your hand-written PhD thesis to the secretary and she would type it out on her golf ball typewriter with different balls for different types of font,
- Tom Lehrer was active as a singer of mostly satirical songs, such as “Hoorah for new math” and “Wernher von Braun” [3].

At university it soon became clear that ellipsologists did not exist. Initially we worked with many epsilons and deltas, less romantic, but the question whether or not you would continue your studies, did not even arise. These epsilons and deltas were --and still are-- small positive numbers. Thinking back on how I chose my major, one of the factors influencing my choice was my impression of the professors as people. My options were: astronomy, physics, and either pure or applied mathematics. No doubt my choice for applied maths was partially the result of my meeting professor Sparenberg on the ice of Lake Paterswolde, near Groningen. It turned out that both of us were keen skaters. When I was looking for a subject for my MSc thesis, he suggested that the two of us study the book by Pontryagin, Boltyanskii, Gamkrelidze and Mischenko [4], which had just been translated into English. The subject was new to him as well. That is how I entered the field of optimal control theory.
After my MSc degree I could continue working on the same subject as a PhD student. I had been sweating away without a feeling of where I was going for two-and-a-half years, when I suddenly had a bright idea and got a PhD a year later. At my first Dutch Mathematical Congress, in 1968, I met Malo Hautus, PhD student in Eindhoven; we decided to visit each other for a weekend every three months or so together with our –then- girlfriends, and discuss each other’s progress, thus stimulating each other’s research. Professor Kwakernaak became co-referee at the finishing stage of my thesis. He was setting up a group at the Technical University of Twente, which is where I went after my thesis had been approved.

Following in Malo’s footsteps, I had applied for a stipend from an institution then called ZWO (Pure Scientific Research), now NWO (The Netherlands Organisation for Scientific Research), for a year’s studying at Stanford University. I was awarded the stipend and we left for California with our two daughters of 18 months and a month-and-a-half, respectively, in the summer of 1972. Initially things were not too easy, especially as the professor with whom I was to work --we had exchanged many letters on the matter-- told me on arrival that he had suddenly decided to go on sabbatical. He showed me my room and said he would drop in at Christmas to see how I was doing. He also said his secretary was not allowed to type out a revised article of mine as it had not been written via a contract at Stanford. I then cut out the Greek characters in the original one by one and pasted them into the new text. After copying -which was allowed-- the result was semi-authentic. In search of a group to work with, I ended up with John Breakwell; in retrospect a blessing in disguise. One of his PhD students was Pierre Bernhard, who will return later in my story. Besides celestial mechanics, Breakwell’s specialisation was differential games. Cooperation with him determined my work for many years. His research was partly inspired by military applications. So I got back to ZWO to check whether that was OK. In the Netherlands a surge of democratisation was hitting the universities and it was not done to have anything to do with military research. However, ZWO had no objections.

My stay at Stanford enabled me to start building up an international network. This continued when, thanks to Huib Kwakernaak, I became active in IFAC, the International Federation of Automatic Control. An example is my contact with Hank Kelley: “Jan” --as is the case with more foreigners he found the name Geert unpronounceable-- “try to realize our ideas within the Mathematics of Control Committee, see how far you can get without upsetting people”. This piece of wisdom fits in well with the paddling-pool-principle, which I will tell you about later. Scientifically speaking, Tamar Başar’s coming to Twente in 1978 for a year was of great influence. We decided to jointly write a book on dynamic games. The book was published by Academic Press [5] and is still in print, albeit now as a second revision with a different publisher. At a workshop in Montreal in May of this year we celebrated its 25th birthday.

After ten years at TU Twente it was time for a change. I decided to try industry: Hollandse Signaalapparaten (now Thales) in Hengelo. There I worked in the research and development department, called SEAT, managed by Max Ceuleers, and learned a lot about radar systems and signal analysis. Before I could really be productive for the company, the opportunity arose of getting a chair at Delft University. I still feel guilty about this towards Signaal, but did not want to pass up such an opportunity. At a recent reunion of the maths department of Delft University I heard from a former personnel officer that my possible political views were a subject of discussion at the time. I was working for Signaal, producing for the military. I might be too right-wing a person for the university…… The only thing I noticed about this subject was that the board of the faculty wanted me to write a letter stating that in Delft I would not focus on military research while at the university.
3. Delft

And that is how I came to Delft. Those were the days when
- the Apple II+ computer was all the rage,
- every year the university published a study guide (and a telephone directory) in which mathematical studies were mentioned first,
- the Kingdom of The Netherlands had already benefited for more than 135 billion guilders from the natural gas deposits of Slochteren,
- the main building (the “hoofdgebouw”) of the TUD was still functioning as such,
- professors were still appointed by the queen.

Looking back, 1983 till now is a long time --perhaps, I should have made another move-- but during all these years I never had the feeling that it was long. Initially it felt a bit like fighting my way in. There were discussions and controversies about who was best-equipped to succeed Timman --to whose chair I officially had been appointed-- carrying on his thoughts and ideas. My argument to hold my own was a very convincing one; I had taken over Timman’s gown. Another thing I remember from the first year was the problem of which bylaws to adhere to at departmental meetings, which I chaired. Work was highly varied. You built up a group, had contacts with Shell, TNO (Netherlands Organization for Applied Scientific research), NLR (National Aerospace Laboratory) and, hardly surprising, Hollandse Signaalapparaten. In 1999 I also became deputy vice-chancellor.

Now I would like to divide my activities in Delft, and also those before, into three sections: the usual threesome of Research, Teaching and Management. I will be frank and confess that research makes my heart beat just a little faster than teaching and management, especially when you are in a flow of one or more bright ideas. You do not have a lot of additional fuss. Anyway, the reputation of universities is based mainly on good research. Within the field of research I have always been attracted to curiosity-driven research: I agree with van Oostrom [6] that we must not bow too deeply for economic valorisation as such.

3.1 Research

I have been going to and fro --tacking if you like-- between applied and pure mathematics. Pure mathematics is elegant, but the lack of direct useful applications and not being able to tell your story to laymen sometimes felt a bit uncomfortable: motivation for applied mathematical subjects was much easier to convey. However, elegant structures are often lacking in problems that focus on applications. Especially when the final result had been obtained by using sound numerical software, so you could rely on the results, but gained no insight into why exactly that was the answer. When I felt I had gone too far in the one direction, I would shift in the direction of the other, just as light moves in glass fibre cables.

3.1.1 Optimal control theory
I started in optimal control theory. Let us mention two examples: population policy and getting a suntan while biking. PhD students in this field were: Henk de Waard, Han Adriaens, Florin Barb, Stefano Stramigioli, Yusuf Fuad. Day-to-day supervision was done mainly by Willem de Koning. The field grew to maturity in the eighties. “It is now part of the engine” as a colleague will say in similar situations: it’s there but is taken so much for granted that --at least as a layman-- you do not need think about it.

With regard to population policy the question is what the ideal birth rate --spread out over a number of years- would be to make a population increase or decrease, taking into account the
age distribution and the requirement related to the latter that the labour force --say anyone between 20 and 60 years old-- would always make up at least a certain percentage of the total population. This concerns research done in Twente, with Rens Strijbos. We published hardly anything about this subject: only a contribution for a conference. Should we have done this research now, it would certainly have resulted in more publications. For applications you might think especially of China, with its one-child policy. In 1975 a Chinese maths delegation visited TU Twente. I mentioned this research to one of the members, Song Jian. He suddenly showed a lively interest and, back in China, continued the research which we gradually abandoned. Probably on the basis of this subject he went into politics and thus later became a “Chinese Jo Ritzen” (former Dutch Minister of Education). In 2004 he visited me in Delft, in the company of a private secretary, a chauffeur and two bodyguards. The other day I was contacted by a journalist working for Trouw (national Dutch quality paper) doing a study of Song Jian and the one-child policy in China [7]. I did not know that Song Jian was the “scientific architect” of the one-child policy; this becomes very clear in the book Just one child [8] by anthropologist Susan Greenhalgh. She wrote me in an email: “perhaps unbeknownst to you, your research played a huge role in the making of China’s post-Mao population policy”. My wife, while happy for me, needed a while to get both my feet on the ground again, saying that in human terms this had caused great suffering. Whether we like it or not, it may be stated that the scientific roots of the contested one-child policy lie in the Netherlands.

The other application I would like to mention briefly is more light-hearted and is of mainly didactic value. A number of colleagues use this application in their courses. In what direction should you cycle in order for your face to get maximum suntan? In order to formulate the problem more precisely, it is assumed that:
- you leave home at sunrise and return at sunset,
- the sun shines all day,
- you cycle at a positive fixed speed and do not take breaks,
- you always look straight ahead,
- the world is one large paved surface; there are no obstacles such as trees or ditches.

Perhaps not a very useful subject, in these days of sustainability and eco-effectiveness, but an excellent illustration of certain mathematical techniques for solving problems. Besides, everyone will --after a bit of thinking-- have some idea of what the solution should be like. This research was mentioned in the “Annals of Improbable Research” [9], a fact I was quite proud of. The optimal route, at least for the northern hemisphere, is shown in the following figure.
3.1.2. Dynamic games

Through my contacts with Breakwell in Stanford, from 1973 onwards, the emphasis has been increasingly on dynamic games. This was further intensified by a second sabbatical year, now with Larry Ho, at Harvard University, 1979-1980. Two examples are: “he thinks that I think that he thinks that …” and inverse Stackelberg problems. PhD students in this field were: Margriet Klompstra, Kateřina Staňková. In checking this, I am now surprised that it now appears that I had only two PhD students in this field. A few weeks ago, a third PhD student, Marco Timmer, started his research in this area. In my time at Harvard I was also able to work on completing the book with Tamer Başar already mentioned. At the moment publishers are again contacting us, the group of experts in dynamic games, to get our opinion on their publishing new scientific journals in our field.

Game theory means modelling and solving conflicts and forming coalitions. Games are omnipresent: be they auctions, manoeuvring in busy traffic, wage bargaining between employers and employees, nominating political candidates at elections, price wars between supermarkets or the trade in milk quotas or those for CO₂.

Game theory provides mainly fundamental concepts which can be recognized in many decision processes. However, there are at least three factors which are obstacles to game theory becoming an important and visible field, or in any case: there used to be. Firstly: it is difficult to set up models; for human conflicts often have psychological aspects. Secondly, it is assumed that players act rationally, i.e. do not dig in their heels. Thirdly, there are many concepts of equilibrium and it is often unclear what kind of equilibrium players are aiming for. Game theory seems to be making a comeback because of new applications, for instance in biology, especially the theory of evolution, in communication networks, financial mathematics and computer science. As to computer science as a field of application, there have been quite a few publications lately on “multi-agents”, “learning in logistics” and “adaptive strategies”, which often amount to algorithmic versions of the concept of the equilibrium called “consistent conjectural variations” [5], [10] known within game theory for quite some time. The difference between open-loop and closed-loop strategies has gradually become known in economics [11].

Arun Bagchi and I tackled the problem of incomplete information, when you have to make an estimate as to what information the other party has. Estimates of the information of the other party keep improving as the decisions of the other party become known. Point of departure is a dynamic model; to be able to perform analysis, we restrict ourselves to a linear model with noise. Because of this noise, the future of the model cannot be precisely predicted beforehand; the noise models the uncertainties. There are now two players --called agents or actors in modern jargon-- each with their own, in principle different, observations of the model. However, these observations have measurement errors. One player does not know the observations of the other and vice versa. But they both want to minimize their own, quadratic, criterion. This minimization is based on the player’s own observations and the decisions made by both players up to now. So not only do you have to make an estimate of the state of the system itself, but also an estimate of the observation of the other party. This had already been done in a discrete time setting by Warren W. Willmann, a PhD student of Larry Ho, but there was much racking of brains over the continuous-time version. It also appeared that in the limit of the discrete-time version, when the time step approaches zero, the results differed somewhat. The result was a large system of complicated differential equations. Calculations were carried out by an MSc student; not much could be concluded from the numerical results.
With Stackelberg problems you deal with a number of players who do not all, however, participate in the game in an identical manner. In Stackelberg terminology --Stackelberg was a German economist who left for Spain in the nineteen thirties-- they are called leaders and followers. A leader is the superior (or boss), the follower a subordinate. The leader has to be the first to make his decision known. Once the latter is known to the follower(s), they then make their decision(s), based upon the known decision of the leader. You would think that because the leader has to show his cards first, he is put in a vulnerable position which the followers can use to their own advantage. This is not at all the case. The leader can always resort to a decision corresponding to the Nash equilibrium, which means that the players enter the game as equals. This equilibrium is called after the Nobel price laureate John Nash, who gained additional fame some years ago because of the film “A beautiful mind”, based on his life [12]. Back to Stackelberg and the figure below.

Let us assume there is one leader and one follower. The leader chooses a number on the vertical axis, the follower on the horizontal axis. Thus the solution can be visualised as a point in the two-dimensional plane. The values of the cost functions of the two players correspond to the points in this plane. Contours of points with constant costs are given in the figure, as altitude curves in a mountainous landscape. The best choice for the leader is \( u^*_L = 2 \); if the follower is rational, he will then choose \( u^*_F = 1 \). The corresponding costs will then be 20 and 3, respectively.

However, the leader can be even cleverer if he does not choose a number but a function: “My decision \( u \) will --according to a function which I announce-- depend on what the follower is going to do”. In the sense of: if you are nice to me, I will be nice to you, but if you are unpleasant, I will be unpleasant in return. Subsequently, you as a follower, by your decision, determine what the leader is actually going to do. The best solution for the leader in this example is given in the following figure. By having the follower minimize his own criterion along the curve indicated by the leader \( u^*_L = \gamma^*_F(u_F) = 2u_F - 10 \), he helps achieve the leader’s absolute minimum! The costs now are 0 and 25, respectively. Some clever leader!
This theory is now applied in determining fees for toll roads; the Department of Waterways and Public Works is the leader, car drivers are the followers. This is the case in Kateřina Staňková’s PhD research, carried out in cooperation with Trail Research School. A paradoxical phenomenon we found is that if toll fees are allowed to depend on traffic intensity, it may be advantageous to lower the fees when there is more traffic.

Figure of inverse Stackelberg solution

3.1.3. Max-plus algebra
Triggered by a French article I found hard to grasp, I happened to come into contact with max-plus algebra. Many things --many people too, for that matter-- become more interesting as you get to know more about them. The same is true here. Two examples: the train service and min-max-plus algebra. PhD students: Hans Braker, Remco de Vries, Erik van Bracht, Subiono, Gerardo Soto y Koelemeyer. For the last three PhD students day-to-day coaching was also done by Jacob van der Woude. As regards the applicability of this algebra: unfortunately, I am now less positive. The reason for this is the rigid structure, as a result of which there seem to be few real applications. An exception is the study of timetables; more on this subject later. Contacts with the group of Frenchmen who were working on max-plus algebra, François Baccelli, Guy Cohen and Jean-Pierre Quadrat, increased and resulted in a jointly written book: *Synchronization and Linearity*, published by Wiley in 1992 [13] and sometimes called the “green bible” by colleagues, because of its green dust jacket. Together with Bernd Heidergott, who came to Delft as a postdoc in the European Alapedes project – of which more later – and Jacob van der Woude, I much later wrote a more elementary book on the same subject, published by Princeton University Press in 2006 [14]. A sabbatical leave with Pierre Bernhard in Sophia Antipolis, enabled me to work on it. That was my second sabbatical with Pierre there; the first period in Sophia Antipolis gave me some time to work on the first revision of the book on dynamic game theory, already mentioned.

With a PhD student, Hans Braker, I started looking at the timetable of the Dutch Railways (Nederlandse Spoorwegen) from a new angle. If you want connections to be guaranteed and there is a set number of trains available, what then is the best way to create a timetable? Max-plus algebra is highly suited for this purpose. If someone wants to change trains, both of these trains should have arrived at the station in question. The maximum (i.e., the latest) of the two
arrival times is therefore a crucial quantity. When the train leaves, it will arrive at the next station at a moment determined by adding the travel time to the time of departure. You only need the operations maximization and addition to examine how solid or robust a timetable is, or also to design a timetable with the highest possible frequency of the trains. Likewise you can also find answers to where the bottlenecks are and where you had best deploy an additional train.

In the initial stage we had no contacts with the Dutch Railways (NS) and Braker had to lift every single journey time from the NS timetable one by one to put them into our model. He did this only for intercity trains. Later another PhD student, Subiono, did this again for all trains, truly a Sisyphean task.

Gradually we started to get contacts with the NS, later Prorail. First I asked for an appointment with a management team of the NS to convince them how innovative our approach was and get them interested in giving financial support for further research. I was duly admitted and kept my story as simple as possible, with hardly a mathematical formula. I had some experience with such situations; mathematicians are regarded as a special little tribe, not dangerous or aggressive, and sometimes even amusing. Same here: I was thanked most politely but after that: nothing. This changed when some colleagues in Civil Engineering, of Trail Research School in particular, became interested and they started functioning as a catalyst between NS and our maths group. This worked extremely well; NS financed a PhD student and some of our Master students did their final projects with Prorail. Thus early this year Marco Tabak finished his Master’s with Prorail on the subject of connecting the peak-hour-timetable to the one for off-peak hours. We had already mastered the ins and outs of both timetables separately, but the transition of the one to the other still rendered problems. We initiated the software packet PETER (“Performance Evaluation for Timed Event graphs in Railways”), which has in the meantime been taken over by ORTEC, a software business for planning and optimization, in Gouda.

Max-plus algebra is highly useful for research into timetables; for many other applications it appears --as mentioned before-- to be rather rigid. For example scheduling problems --which train will be allowed to depart first-- hardly fit in. Therefore I looked for mathematical extensions by also admitting the minimization operator. We then get into min-max-plus algebra. This algebra mainly provided new mathematical insights. The class of systems described by min-max-plus relations is dense in the class of systems characterized by “non-expansive mappings”. Systems in both classes show periodic behavior.

3.1.4 Filter theory
One of my minor activities was filtering. In filtering measuring noise and system noise have to be filtered out as thoroughly as possible in order for the data that are left to have maximum reliability. In linear systems the mathematical tool for this is the Kalman filter. PhD students in this field were Herbert Tulleken, Henk Blom, Geert Moek, Chris te Stroet, and at the moment also Shah Muhammad. In the future, filtering will remain important by its applications, such as for instance estimating water levels or changes in temperature. All over the place things are being measured. If one intends to make use of the outcomes, what better option than to filter these measurements first?

Now I would like to describe one example in greater detail; it was the beginning of a PhD-research which unfortunately was never completed. When you hear a sound from a certain direction, think of a submarine, you will not know the distance to the source of the sound unless you move and can find out via trigonometry. Let us assume that the source moves as well, at constant speed in an unknown direction. You do not yet know this direction, speed
and distance. In principle you can find these out by measuring at three different points, which should not lie on one line. It may easily be shown that if those points do lie on one line, the time-dependent location of the source is not observable. Assume that you do hear the sound of the moving source continuously, but that the direction from which it is perceived contains quite some noise. The question then is how you yourself should maneuver in order to be able to --say within one minute-- determine the position of the source as accurately as possible? The initial measurements determine the accuracy of the solution later in time. So the optimal trajectory cannot be pre-determined. Clearly the separation principle on filtering and control is not valid here.

Summary
When I look back on my work, then it is only a small number of articles I am still proud of. They really have substance. All the other articles in journals and conference proceedings are more directed at colleagues in the sense of “hi, I am still here!” And judging by the proliferation of conferences and conference contributions, I tend to think that goes for many colleagues. But this is an incidental remark.

Over the years I increasingly appreciate the importance of clear communication, in speaking as well in writing.

3.2 Teaching
I have had the privilege of supervising eighty-five Master students in the final phase of their studies. In the peak years, the late eighties, some eight or ten students would get their MSc degrees in systems theory each year. They stimulated each other and even published their own journal: “The Hamiltonian”. Of course I enjoyed this greatly, and I was expected to write a column in every issue. The nineties brought a great reduction in the number of maths students. There are signs that things are now improving. What a pity that I am now almost 65.
For many years I taught the course “Mathematical Systems Theory”, first alone, later with Jacob van der Woude. This resulted in our book with the same title [15]. It is also used at other universities.

Of all the subjects for Master’s theses I would like to mention briefly one of the first and one of the last. In both the focus is on Kalman filtering. Nico de Reus did his MSc thesis at NLR (Dutch Aerospace Laboratory) in 1985. It concerned the first calculations on the accuracy of the Navsat system, a predecessor of GPS. Last year Tessel van Ballegooijen was awarded her Master’s degree, having written her thesis at TNO (Netherlands Organization for Applied Scientific Research). It was on forecasting --as accurately as possible-- the movements of flocks of birds near airports.

3.3 Management
I will go briefly into three of my activities: DISC, Alapedes and having been deputy vice-chancellor. In addition there were editorships of a number of professional journals, memberships of International Program Committees, memberships of accreditation committees, board memberships of some national and international professional organizations (such as IFAC and the International Society of Dynamic Games).
3.3.1. Dutch Institute of Systems and Control (DISC)
The Dutch Institute of Systems and Control started in the early eighties, especially thanks to the enthusiasm of Jan Willems and Huib Kwakernaak. DISC later became a research school; it was the first to organize national lecture courses for PhD students in Utrecht; an example for many other research schools set up later. In an organizational sense I did not play a crucial role in DISC, but the institute was very important for the development of systems theory in the Netherlands and at DISC gatherings you would meet your colleagues in the field.

3.3.2. Alapedes
Alapedes is the acronym for “Algebraic Approach to the Performance Evaluation of Discrete Event Systems”. Some colleagues and I submitted a proposal with this name to the European program “Training and Mobility of Researchers programme 1994-1998”. The core group consisted of the authors of the book on “Synchronization and Linearity”, which does not mean saying anything negative about the other participants in Alapedes. The participation of an industrial partner, Hewlett Packard in Bristol, UK, was essential in getting the proposal accepted. I was appointed network coordinator and as such I learned to negotiate with Brussels. That was not always easy and this lead to (positive) encounters with the department of legal affairs of our university.

3.3.3. Deputy vice-chancellor
Why I was asked for this function, I do not know. Perhaps, because the office of the beadles was staffed exclusively by women? I had some experience at home in any case, with my wife and three daughters. I realized only later that one of the perks was that pieces of birthday cake were often passed on to me, perhaps not unusual in our slimming culture. Whenever anyone asked what exactly a deputy vice-chancellor does, I often answered: “he picks up anything that falls off the vice-chancellor’s desk”. In reality you were on a number of committees, often as chairperson, such as the grants committee, the technostarters committee, the committee for VSB grants, on the editorial board of Delft Integraal and Delft Outlook. Also, a bit outside the main scope of vice-chancellor activities, you did some work for the International Visitors Foundation and Het Bataafs Genootschap der Proefondervindelijke Wijsbegeerte (Batavian Society for Experimental Philosophy) in Rotterdam. However, the most important part of the job is the role of vice-chairman of the Board for Doctorates and managing the accompanying administrative work. You gained a good insight into the cultural differences in the various faculties and departments. The Faculty of Architecture often had opinions quite their own, which would make life interesting. The meetings of the Board for Doctorates were always both inspiring and enjoyable; you would learn things about different disciplines. This would also be the case when you were preparing speeches in honor of colleagues from other fields, to be presented on the day of their inaugural or farewell lectures.

I often compare the role of a deputy vice-chancellor with someone in a row of skaters, skating up front - but not in first position. Let me explain this metaphor. Skating in the leading position, as the Executive Board of the university does, is very difficult. You have to maintain a good rhythm to make sure the others are able and willing to follow. Assume that you are skating alone and a group of skaters joins in, following your rhythm and speed. You should not pay any attention. If you do, you will probably start skating irregularly or go faster. Sometimes you have the idea that the whole group is following nicely and then, looking behind you, you discover that apparently everyone has long since dropped out of line. In front position you have a good view of the quality of the ice. You are the first to see the cracks, so you can choose the best path to take. That is harder when you are further behind:
you see mainly the back of the person in front of you. At the very back of the row you cannot
discern any cracks at all, there is too much powder on the ice covering the cracks and you are
always slowing down or speeding up as is the case when driving in a column. You will
understand that skating at the rear is much more difficult than doing the same further up front,
so I greatly respect those who do the former. At the rear people are still thinking in terms of
DIOCs (Delft Interfaculty Research Center) and primary research themes ("speerpunten")
while at the front quite different things are the focus of attention, such as TimEnterprise (time
recording system) and DRIs (Delft Research Initiatives). So that a really good position is just
behind the front skaters; you have a reasonably good overview and it is a good place in times
of headwind; with tailwind everyone thinks s/he can skate in first position. It is essential --
whatever your position in the row is-- to watch out for any slip-up of the skater in front of
you. This person might suddenly make some unexpected movement backwards and hit you.
There are also skaters in super-tight speed suits in phosphorescent colors who overtake you
with a lot of noise. These Speedy Gonzaleses yell "hoog op" (meaning: “out of the way”),
wanting you to go aside. Two rounds later you see them resting and chatting. A little while
later: there they are again: “hoog op!” This process is repeated a number of times. These
constitute the much-ado-about-nothing category, also called hulaballoo-ers.

Members of the Executive Board as rink sweepers

Should someone ever want to invite me to give a management course --not that I put great
faith in such courses--: besides providing insight into Stackelberg games, I am also willing to
work out this skating metaphor in greater detail.

4. The future

There is a time in which

- people stay fit by going to fitness centers,
- you communicate by computer to submit an article to a journal, or, if you are an editor, to indicate whether or not you accept an article,
- you now use wikipedia, in the same way you used to use an encyclopedia, browsing from one subject to the other out of sheer curiosity
- wine bottles increasingly have screw caps instead of corks,
- even women skaters overtake you.

That is where I am at now. You will understand that I do not welcome some of the underlying processes. The worst thing is that these processes are irreversible.

4.1 Plans

A much-asked question is: “What are you going to do after being an emeritus?” I then answer that I hope to be surrounded by angels; but should someone mean what I intend to do during my life as an emeritus --some clarity of expression is in order here-- then the answer is that I have many plans, some more realistic than others. The title of this farewell address may express the idea that many things in life happen by chance; to some extent this is true, but one the other hand we do have some influence ourselves. I will mention a few plans. In some years’ time we will know whether or not they came to fruition.

When you look back on your career, you realize that for many years you were “formed” by your own specializations. You have acquired a certain way of thinking, possibly making it difficult to come up with fresh ideas. Perhaps it is good, not only for houseplants, to be repotted now and then. The saying “ignorance pays” for a new start, holds some truth. In order to dissociate myself a bit from mathematics I have lately started thinking about some philosophical subjects such as nature striving for maximum entropy and --as a counter-movement-- science trying to create some order in chaos. Well-known names in this field are Henry Bergson and Ilya Prigogine. This issue also comes up indirectly in Konstantin Paustovskij’s book The Bay of Kara-Bogaz. For that matter, talking about writers and literature, our guest writer at TU Delft this year, A.F.Th. van der Heijden, also claimed in his Vermeer lecture here in the auditorium on June 4 that “writing is creating order in the chaos of nature”. Apparently science and literature can be characterized in the same manner. I would not mind starting out again as a student of geology or civil engineering. But probably my plans should be a bit more realistic; after all, there is a saying that you cannot teach an old dog new tricks…..

Writing a book prompted by having taught a HOVO-course
In 2006 I was invited to teach a HOVO-course at TU Delft; HOVO meaning Higher Education for Senior Citizens. I thoroughly enjoyed teaching that course; the enthusiasm of the participants of whom the oldest was 86, was infectious. The subject was: “Mathematical aspects of coalitions and conflicts in game theory”. The American textbook we used contained many examples, also from politics, totally oriented towards U.S. culture. I am toying with the idea of writing a textbook more oriented towards Europe, or even the Netherlands, also with many corresponding examples. I would then also deal with other subjects, such as Stackelberg equilibriums and consistent conjectural variations.

Partridge and hunter
In game theory many pursuit-evasion games have been studied. A problem a few colleagues and I are working on at the moment is one I have called “the partridge and the hunter”. The hunter knows there is a partridge somewhere that he would like to shoot. The color of the partridge serves as camouflage; it is sitting on the ground very quietly and the hunter can only shoot him if --striding along-- he can get the bird right in front of his feet. The partridge --not
able to see where the hunter is—can fly to another spot to hide there. So the partridge either stays put or flies from one spot to another. The hunter either moves along or stands still. Only when the hunter stands still can he look around. Should the partridge at that moment be in flight, his life is over. So there are two ways in which the life of the partridge can end: in flight while the hunter is looking around; or sitting still while the hunter happens to pass by that very spot. The hunter wants to shoot the partridge as quickly as possible, whereas the partridge wants to put off this moment for as long as possible. We do not yet have any clue as what would be the right strategies for the two players in this highly stylized problem. For some motivation beyond the purely mathematical kind, replace the partridge by a terrorist and the hunter by the Criminal Investigation Department. The flight of the partridge then corresponds to vulnerable behavior on the part of the terrorist such as crossing a border, paying money into a bank account, or sending an email message.

**Zeros of Chebysjev polynomials and of a system of equations.**

About a year-and-a-half ago I came across the following similarity. If the zeros of the system of equations

\[
2x_j^1 - 2x_j^2 + 2x_j^3 - \ldots + 2(-1)^{n-1}x_j^n + (-1)^n = 0, \quad j = 1, 2, \ldots, n,
\]

are called \( s_j \), \( i = 1, 2, \ldots, n \), and if \( c_i \), \( i = 1, 2, \ldots, n \), are the zeros of the Chebyshev polynomial of the second kind \( U_n(x) \), recursively defined as

\[
U_0(x) = 1, \quad U_1(x) = 2x, \quad U_k(x) = 2xU_{k-1}(x) - U_{k-2}(x), \quad k = 2, 3, \ldots, n,
\]

then \( 1 + c_i = s_i/2 \), \( i = 1, 2, \ldots, n \). There is bound to be an explanation for this. In the limited time I have so far been able to spend on this problem, and also after consulting some more analytically oriented colleagues, I have not yet been able to find it.

**Improving one’s skating skills.**

Last winter I was skating on the rink called the Uithof in The Hague when I was suddenly approached by an elderly skater, about 75 years of age, who asked me if it was okay for him to tell me something. He had seen me skate; I also seem to remember that he used the word “plodding away”. In any case: according to him my style was wrong. If it were better I would be able to skate much faster. I felt slightly humiliated and thought I had better respond as best I could. “But I have three crosses”, I said timidly. (The medal one gets after completing the Eleven Cities Tour in Friesland, skating 200 kilometers in one day, has the form of, and therefore is called, a cross.) He did not react, we talked a bit more and then he skated off, casually remarking: “oh, and I have five”. So after this conversation I should perhaps go and have some lessons.

You may wonder what on earth skating has to do with mathematics. The answer is that there were a number of times, especially during skating or biking trips, that I suddenly had a flash of insight leading to a breakthrough in maths problems whose solutions had eluded me before then.

**4.2 Advice**

Before I finish, I would like to give you—and especially my younger colleagues—two pieces of advice; after all, at this age, one is allowed to do so. I will follow two principles. You might think that such ideas do not arise until one has gained a lot of experience in life. With me, that
was not the case, as you will see. Not until much later in life do you realize how important these principles are.

*The paddling-pool principle.* When as a little boy I went to the swimming pool for the first season, I was allowed only in the paddling pool; half of it was white sand and the other half was water, at most 20 cm deep. Waves came rolling in from the adult part of the pool, separated only by wire mesh in the water itself. Even as very small children we would build polders; reclaim as much land as possible by building dikes to withstand the incoming waves. There were two ways of doing this. One was to get sand from that part of the “sea” immediately in front of where the dike was to be built and then make quite a high, steep dike. On the side of the “sea” you would then have a deep hole. The waves that came rolling in easily eroded the dike, which would subside after a while. The other method was to build dikes with gentle slopes, not high at all, which could be built using relatively little sand. The waves gradually lost their force on the gentle incline, which cushioned them off slowly over a greater distance. This paddling-pool principle is a metaphor for many decision-making processes, local, national as well as international.

*The oats-sack principle.* On the farm we sometimes had to lift heavy sacks of oats onto a wagon. You did that with two people, both taking hold of two opposite corners of the sack. You would call out: “one, two three” and then heave ho! with a big swing you threw the sack onto the wagon where someone else would take it. If you lifted it just before the count of three, just a split second before your partner started lifting it, you did not have to lift much weight; the sack tilted a bit and most of the weight fell to the other person. This is what I call the “oats-sack principle”; it is a symbol for taking the initiative; be on the ball, ready to act. However, I must add that this manner of acting should not be at the expense of colleagues…..

5. **In conclusion**

Now that I have almost come to the end of my farewell lecture, I would like to say that I have done my best to gain publicity for TUD. See this picture in Lhasa and the following one in my alma mater, Groningen. Of course I have not dared not spread my TUD campaign to the province of Friesland, knowing that this area is already in very good hands elsewhere, even if campaigning there is probably not done by bike (our vice-chancellor is Frisian). My choice of the latter picture was not a random one; in it you also see my wife, my soul mate through thick and thin, in good times and bad. I hope we will be allowed to make many more trips together, in the literal but also the symbolic sense, whether or not on our tandem. When a colleague in Utrecht gave his farewell lecture the other day, he also had some advice for younger people. One of his examples was: “find the right partner”. I could not agree more.

And now, for the very last lines. I am proud of this university and very happy to have been allowed to work here for over 25 years. I can only hope I have made my contribution towards its success, be it just an epsilon one.

Ladies and gentlemen: that is how I got to where I find myself today. Thank you for your attention.
On my bike in front of the Potala, Lhasa

With the tandem in front of the main building of Groningen University
Notes


[7] Martijn Roessingh (journalist Trouw) is studying the Chinese one-child policy.


