



*Liber Amicorum*

Jan Willems

On the occasion of his  
70<sup>th</sup> Birthday

Brugge, 16-17 Sept. 2009



Dear Jan,

We first met at some Benelux Meeting on Systems and Control in the beginning of the eighties. To be honest, when and where, I forgot. But I remember the first time we had a real conversation. That was in the south of France, in Antibes, I think in 1986 or 1987, where you attended my talk on the so-called 'Frisch Scheme'. We not only discussed science, but later that evening we had dinner together. Meeting you was an eye-opener. It certainly influenced my decision to stay in Academia. However, fate can take strange twists. Little did I know that five years later, in the nineties, I would find myself in politics, the 'real' stuff. I was the main advisor for Science Policy of the minister-president of Flanders. Not that I lost track of the 'Willems gang'. Very frequently, I had fruitful encounters, mostly friendly, with your twin brother Jacques. At that time, he was the rector of the University of Ghent. Yet, somehow I managed to visit you several times in Groningen, as I tried to keep alive my research activities – at night - while being in politics. One of these occasions was the workshop and birthday party for your sixtieth birthday that we celebrated in Groningen. Another one was the annual Bernoulli lecture, also in Groningen, which I delivered in 2004 on your invitation.



My friend Jan



Jan's 60<sup>th</sup> birthday party in Groningen. Among many others can be seen: Arjan Van der Schaft, Henk Neijmijer, John Doyle, Sanjoy Mitter, Keith Glover, Roger Brockett, Harry Trentelman, Jan himself and me...



Jan listening to rector Oosterlinck telling a joke. The occasion is Lennart Ljung's honorary degree in Leuven in 2004.

At first I was surprised, but then honored, when you asked me whether you could come to Leuven should you retire early in Groningen. So I wrote a formal letter to our rector, also an engineer, who got along quite well with your brother. The rest is history: I got his blessing by phone within 24 hours to invite you to become a professor-in-

residence in Leuven.

Since then, we are all very excited – as a matter of fact, it is persistent excitement, - to have you with us, here, in Leuven.

How many mentors can one have in life ? I got a couple while growing up. I had two in politics and three in my scientific career. Certainly, Jan, you are one of them.

Your drive for mathematical rigor, the way you conceptualize notions that most often are taken for granted, your academic leadership, your carefulness in writing papers and books, your gentleman-like interaction with students, postdocs, staff and visitors, your empathic and clear style in your scientific presentations.

*Ostendit sermo mores animumque latentem.*  
(A person's speech shows his character and inner personality.)

Your patience, your listening ear and understanding, your empathy and sharing wisdom, the lunches where we discuss the world's problems.

*Non omnis qui sapiens dicitur sapiens est, sed qui discit et retinet sapientiam.*  
(Not everyone who is called wise is wise, but rather he who learns and retains wisdom.)

And last but not least:

*Nemo sibi satis est; eget omnis amicus amico.*  
(No one is sufficient unto himself; Every friend needs a friend.)

And a true friend and mentor, Jan, that's what you are.

*Bart and Hilde De Moor – Devoghel*  
*Leuven, September 2009*



Jan and Hilde at the dinner of MTNS 2004 in Leuven.



...together with Anders Lindquist and Paul Van Dooren.



Rector Mille Milnert from Linköping University, Jan Willems and me in 2004



Two Jan's (Van Schuppen en Willems) listening to Laszlo Gerencser explaining a new result in system identification



Doke and Jan posing for a picture at our garden party. Jan is not quite comfortable.

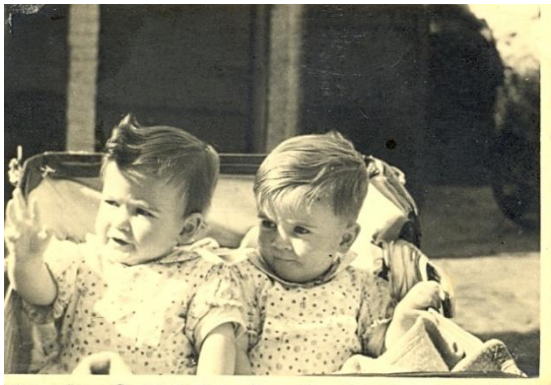


Jan explaining 'behaviors' to Hilde, my wife.



System identification crowd gathered for Lennart Ljung's honorary degree in Leuven in 2004. Jan is on the third row. Also in the picture: Brian Anderson, Michel Gevers, Lennart Ljung, Paul Van den Hof, Albert Benveniste, among many others.

Pictures sent by Jacques Willems



Jan and his twin brother in their baby years (during World War II) (± 1942)



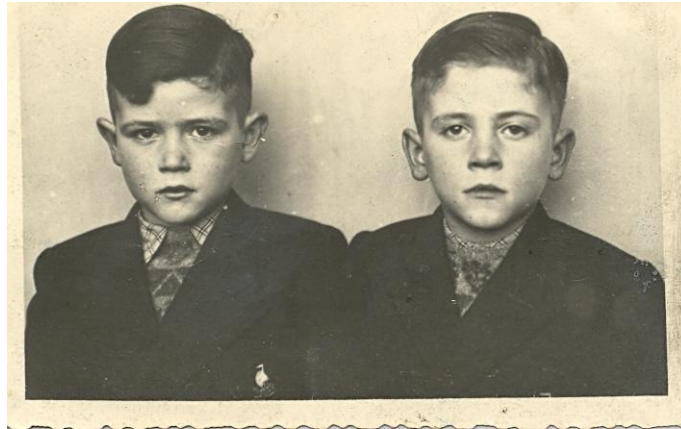
Jan and Jacques with their mother : aren't they good boys ? (± 1944)



The twin brothers (with their parents) at their first communion. Were the marine suits predestination for their trip by ship to the United States many years later ? (1946)



Jan and Jacques in a strong competition. Jan seems to be losing ! (± 1948)



Jan and Jacques in boarding school in Gent (± 1950)



At the confirmation ceremony. Aren't they serious ? (1950)





Are Jan and his twin brother exercising to join the Red Indians ? (± 1952)



Jan (first row, far right) and Jacques (first row, far left) preparing to be Maradona. However in this they were not very successful (± 1953)



Jan and Jacques ready to leave for the US – The great adventure is to begin ! (1963)



Jan stays in the US and says goodbye to Jacques who returns home after his Master's study (1964)

They constitute the first homework assignment of a course that Jan gave at the ETH Zürich in the Wintersemester 1975-1976. The first two pages constitute the type-written version, while the other 4 constitute the hand-written version.

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Eidgenössische  
Technische Hochschule  
Zürich

Seminar für Angewandte Mathematik

Clausiusstrasse 55  
CH-8006 Zürich  
Tel. (01) 32 62 11

Prof. Dr. J. C. Willems

1.16.1976

Exercises in Mathematical System Theory

1. Let  $\dot{x}=Ax+bu$ ,  $y=cx$  be a single input single output system. Assume that  $(A,b,c)$  is minimal and let  $g(s):=c(Is-A)^{-1}b=q(s)/p(s)$  with  $q$  and  $p$  polynomials without common factors. Prove that :
- (i)  $(A+bf,b)$  is controllable for all  $f$
  - (ii)  $(A+bf,b,c)$  is minimal for all  $f$  iff  $q(s)=q_0$  (a scalar), i.e. iff the system has no zeros
  - (iii)  $(A+bkc,b,c)$  is minimal for all real constants  $k$ .

Hint : Use the standard controllable form representation of the system.

2. (i) Prove that a necessary condition for  $p(s)=s^n+p_{n-1}s^{n-1}+\dots+p_0$  to have all its roots in  $\text{Re}(s)<0$ , is that  $p_i>0$  for all  $i$ .
- (ii) Give the necessary and sufficient conditions for the flow

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ a & b & c \end{bmatrix} x$$

to be asymptotically stable.

3. Let  $F$  be a sufficiently smooth function from  $\mathbb{R}^n$  to  $\mathbb{R}$  and  $D$  a constant  $n \times n$  matrix.
- (i) Find the equilibrium points of the flow  $\dot{x} + D\dot{x} + \partial F/\partial s(x) = 0$
  - (ii) Assume that  $F(s)$  tends to infinity as  $|s| \rightarrow \infty$  and that  $D+D^t > 0$ . Prove that all solutions of the above flow approach the set of equilibrium points.

4. (i) Consider  $\ddot{y} + \dot{y} = u$ . Compute the optimal feedback control law which minimizes

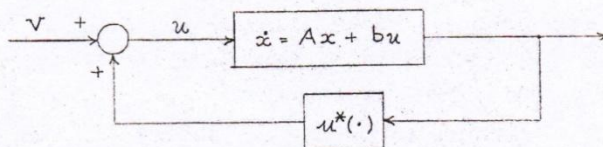
$$\int_0^{\infty} (u^2 + \rho^2 y^2) dt \quad \rho \neq 0$$

Sketch  $J^*(\rho)$  and the root locus of the closed loop poles as a function of  $\rho$ .

(ii) Do the same for  $\ddot{y} - \dot{y} = u$ .

(iii) Compare the root loci of (i) and (ii).

5. Let  $u^*(\cdot)$  be the optimum state feedback control law for the minimal system  $\dot{x} = Ax + bu$ ,  $y = cx$  and  $J = \int_0^{\infty} (u^2 + y^2) dt$ . Consider now the system



and assume that  $x(0) = 0$ . Assume further that  $v(\cdot)$  is continuous at zero and that  $v(0) \neq 0$ . Prove that

$$v(t) u^*(x(t)) \leq 0$$

for  $t$  sufficiently small and positive.

Comment: This shows that the optimal control generates a "negative feedback" correction signal for  $t$  small.

6. Let  $K_1$  be a positive semidefinite solution of

$$A^t K_1 + K_1 A - K_1 B R_1^{-1} B^t K_1 + C_1^t C_1 = 0$$

with  $(A, B, C_1)$  minimal,  $i=1,2$ . Prove that  $R_1 \geq R_2 > 0$  and  $C_1^t C_1 \geq C_2^t C_2$  imply  $K_1 \geq K_2$ .

Hint: Use the optimal control interpretation of  $K_1$ .

7. Assume  $(A, b, c)$  to be minimal, and the initial state of the system defined by the triplet above to be  $x_0$ . Let  $J = \int_0^{\infty} (u^2 + \rho^2 y^2) dt$  and  $J^*(\rho, x_0) := \min J$ . Prove that:

(i) If  $\text{Re}(s) < 0$  for all  $s \in \sigma(A)$ , then  $\lim_{\rho \rightarrow 0} J^*(\rho, x_0) = 0 \quad \forall x_0$ .

(ii) Prove that this cannot hold for all  $x_0$  if  $\text{Re}(s) > 0$  for some  $s \in \sigma(A)$ .

These problems will be discussed during the lecture of January 30.

Problem 1: Let  $\dot{x} = Ax + bu$   $y = cx$  be a ~~single input / single output~~ <sup>system</sup> ~~with~~ <sup>discriminant</sup> ~~discriminant~~ <sup>before final</sup> ~~before final~~ <sup>system</sup> ~~system~~ <sup>system</sup>  $\Sigma$ :

Assume that  $(A, b, c)$  is minimal ~~and that~~ and let

~~let~~  $g(s) \triangleq c (sI - A)^{-1} b = \frac{q(s)}{p(s)}$

with  $q$  and  $p$  relatively ~~prime~~ <sup>prime</sup> polynomials without common factors.

Prove that: (i)  $(A + bf, b)$  is controllable for all  $f$ ;

(iii)  $(A + bxc)$  ~~is minimal~~  
 $(A + bxc, b, c)$  is minimal for all  $x \in \mathbb{R}$ .

(ii)  $(A + bf, b, c)$  is minimal for all  $f$  if and only if

$q(s) = \alpha q_0$  (a scalar), i.e., if and only if  $\Sigma$  has no zeros;

Hint: Use standard controllable form representation for  $\Sigma$ .

Problem 2: (i) Prove that a necessary condition for

$p(s) = s^n + p_{n-1}s^{n-1} + \dots + p_0$  to have all its roots in  $\text{Re } s < 0$

is that  $p_i > 0$  for all  $i$ .

(ii) give the necessary and sufficient conditions for the flow

Problem 3:

$\dot{x} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ a & b & c \end{pmatrix} x$  to be asymptotically stable

Problem 3: Let  $F: \mathbb{R}^n \rightarrow \mathbb{R}^n$  be sufficiently smooth ~~and~~ <sup>times continuously differentiable</sup> ~~and~~ <sup>and</sup>  $D$  a constant  $(n \times n)$  matrix. ~~with~~ <sup>and</sup>  $F(x) \rightarrow 0$  as  $|x| \rightarrow \infty$

Prove that all (i) ~~characterize~~ <sup>What are</sup> the ~~stable~~ <sup>points</sup> equilibrium ~~solutions~~ <sup>solutions</sup> of the ~~flow~~  $\dot{x} + Dx + \frac{\partial F}{\partial x}(x) = 0$

(ii) Assume that  $F(x) \rightarrow +\infty$  as  $|x| \rightarrow \infty$  and that  $D + D^T > 0$ . Prove that all solutions of the above flow approach the set of equilibrium points.

Problem 4: (i) Consider ~~the~~ ~~system~~  $\ddot{y} + y = u$ .

Compute ~~Construct~~ the optimal feedback control law which minimizes

$$\int_0^{\infty} (u^2 + \rho^2 y^2) dt \quad (\rho \neq 0)$$

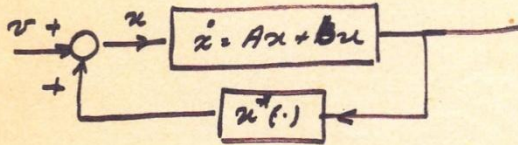
~~characterize the~~  
 sketch ~~the~~  $J^*(\rho)$  and the ~~the~~ root locus of the closed loop poles as a function of  $\rho$

(ii) Do the same for  $\ddot{y} - y = u$ .

~~Any comments?~~ (iii) Compare the root loci of (i) and (ii).

Problem 5: Let  $u^*(\cdot)$  be the <sup>state</sup> optimum feedback control law for the minimal system  $\dot{x} = Ax + Bu$  and  $J = \int_0^{\infty} (u^2 + y^2) dt$   
 $y = Cx$   
 ~~$A, B, C$  assumed~~

~~Consider~~ Consider now the system



and assume that  $x(0) = 0$ . ~~Prove that~~ ~~Assume~~ ~~and~~  
 Assume that  $v$  is continuous at

$t=0$

~~differentiable at zero and that  $v(0) \neq 0$ .~~

$t=0$

that  $v$  is ~~smooth~~ continuous at  $t=0$ . Prove that

~~$v(t) u^*(t) (x(t)) \geq 0$~~

$$v(t) u^*(t) (x(t)) \geq 0$$

~~for~~  $v(t) \leq 0$  for  $t \in [0, \epsilon]$  suff. small.

provided  $v(t)$  is continuously differentiable at 0 and  $v(0) \neq 0$

Comment: This shows that the optimal control generates a

"Nyquist feedback" correction signal

Problem 6: ~~Construct a Lyapunov function for~~

~~Prove that~~

Let  $K_i$  be the ~~unique~~ <sup>semi-</sup>positive definite solution of

$$A^T K_i + K_i A - K_i B R_i^{-1} B^T K_i + C_i^T C_i = 0 \quad (\text{Riccati})$$

with  $(A, B, C_i)$  minimal ( $i=1, 2$ )

prove that  $R_1 \geq R_2 > 0$  and  $C_1^T C_1 \geq C_2^T C_2$  imply  $K_1 \geq K_2$

Hint: Use ~~the~~ <sup>the</sup> optimal control relationships of  $K_i$

Problem 7: Assume  $\dot{x} = Ax + bu$ ,  $y = c^T x$ ; ~~and~~  $x(0) = x_0$ ; and

$(A, b, c)$  minimal.

Let  $J = \int_0^{\infty} (u^T R u + y^T Q y) dt$  and  $J^*(p, x_0) = \min J$

$$J^*(p, x_0) = \min J$$

(i) Prove that if  $\Re \lambda < 0$  for all  $\lambda \in \sigma(A)$  then

$$\lim_{p \rightarrow 0} J^*(p, x_0) = 0 \quad \text{for all } x_0.$$

(ii) ~~Prove or disprove~~

(i) Prove that this ~~cannot~~ <sup>cannot</sup> hold for ~~all~~ <sup>all</sup>  $x_0$  if  $\Re \lambda > 0$  for some  $\lambda \in \sigma(A)$ .

These problems will be discussed during the lecture of January 30, 1976.

$$V(\tau) = V(0)$$

$$\int_0^t f(t-\tau)$$

$$\varepsilon: \ddot{x} + D\dot{x} + \frac{\partial F}{\partial x}(x) \geq 0$$

~~W~~

$$V(x, \dot{x}) = \frac{1}{2} \dot{x}^T \dot{x} + F(x)$$

$$\dot{V}(x, \dot{x}) \Big|_E = \dot{x}^T (-D\dot{x} - \frac{\partial F}{\partial x}(x)) + \left( \frac{\partial F}{\partial x} \right)^T \dot{x} \stackrel{E}{=} 0$$

$$= -\dot{x}^T D \dot{x} \leq 0$$

$$E = \{x \in S \mid W(x) = 0\}$$

$$\left\{ \text{all } E = \left\{ \dot{V} \Big|_E = 0 \right\} \quad \dot{x} = 0 \right.$$

Invariant sets  
in E

$$\begin{aligned} \dot{x} &= 0 \\ \Rightarrow \dot{x} &= 0 \end{aligned} \Rightarrow \frac{\partial F}{\partial x}(x) = 0$$



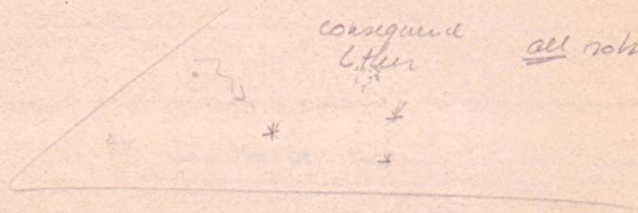
since  $\dot{V} \leq 0$  and  $t \rightarrow \infty$  as  $\begin{pmatrix} x \\ \dot{x} \end{pmatrix} \rightarrow \infty \Rightarrow$  sols cannot go to  $\infty$  by L. Theorem 3.3b

$$x = x_{eq}$$

consequence  
L. Theorem

all solns go to largest invariant set in E

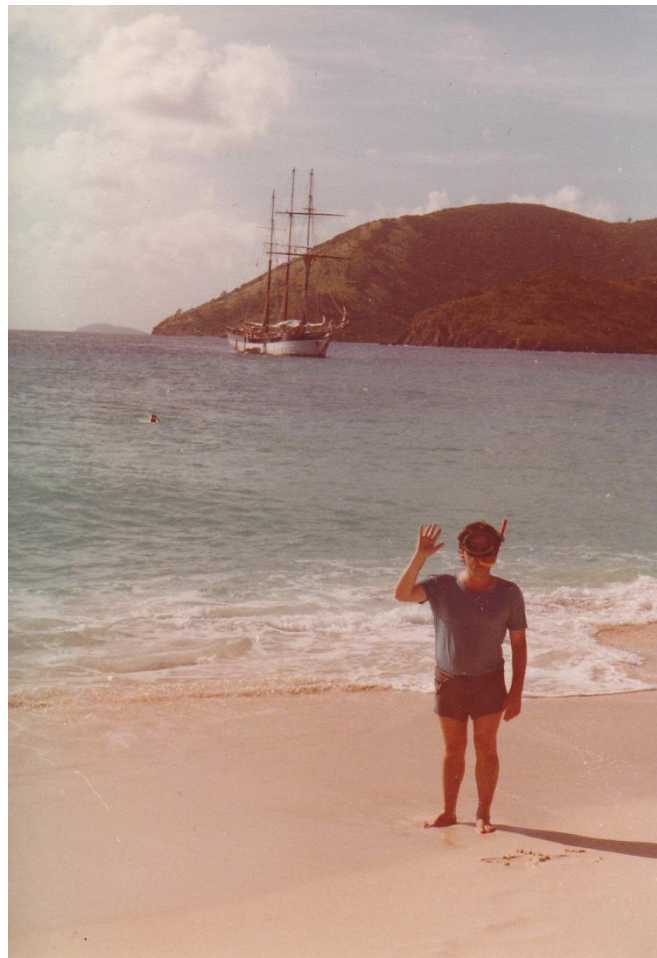
||  
is set of eq. points



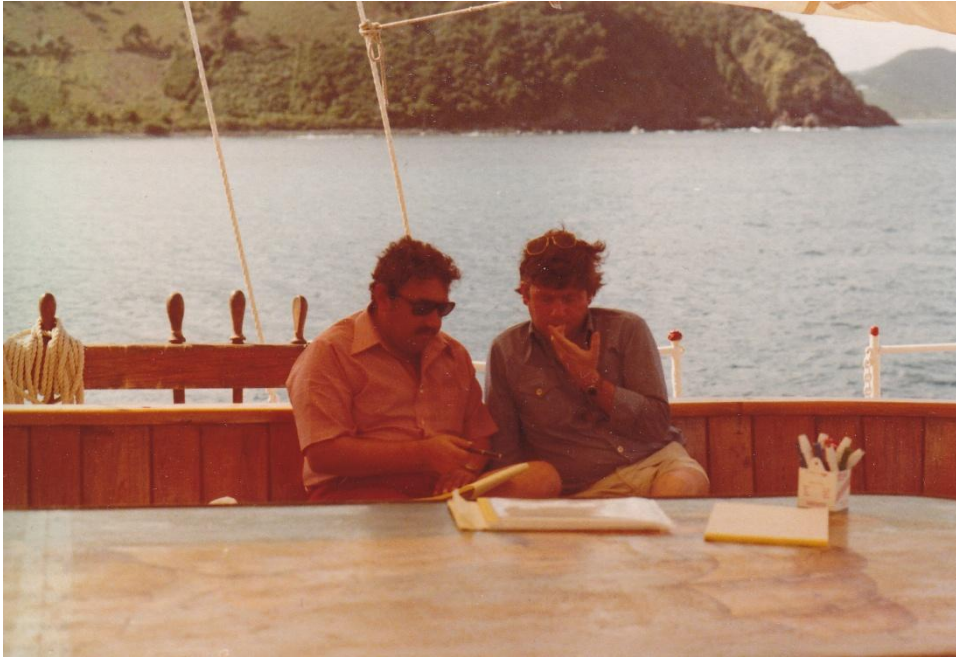




Jan jumping in the waters of the Carribean from the 'Flying Cloud' cruise ship, Dec. 1977



Jan at a beach in the Carribean with the 'Flying Cloud' in the background, Dec. 1977



Jan with Mike Athans on the 'Flying Cloud', Dec. 1977



Jan in Grenoble, May 1978

Pictures sent by Vincent Blondel



Liège, 1997



Leuven, 2004

Seven years between these two pictures. Notice how little Jan has changed !



Leuven, 2004



Oberwolfach, 2005



Hyderabad, 2008

Beste Jan,

Mijn beste herinneringen aan jou dateren van mijn eerste jaren in Groningen (1977+). De sfeer aan de universiteit en het Mathematisch Instituut was heel anders dan nu. Er was geen wiskunde, maar 3 aparte vakgroepen: Zuivere Wiskunde, Technische Wiskunde en ons samenraapsel van statistiek, systeemtheorie en informatica. Het jaarlijkse ritueel van de onderwijsverdeling was weinig verheffend. Het was de tijd van gelijkheid van hoogleraren, medewerkers, promovendi en studenten. Medewerkers die geen onderzoek deden moesten niet belast worden met meer onderwijs dan medewerkers die veel onderzoek deden en promovendi begeleidden. Studenten en promovendi uit eigen kweek zaten in commissies en mochten oordelen over de merites van internationaal vermaarde onderzoekers. Het was ook de tijd van lange vergaderingen en nota's; hier ging het voornamelijk om hoogdravende principes met weinig aandacht voor de implementatie hiervan. Men geloofde heilig in het onderwijs als het belangrijkste toekomst perspectief voor wiskundige afstudeerders en men geloofde niet dat informatica ooit groter kon worden dan wiskunde. De betrekkelijk nieuwe afstudeerrichting informatica kreeg weinig steun en weinig wetenschappelijk respect; het was geen wiskunde en systeemtheorie was ook een beetje verdacht. Het idee dat informatica zou uitgroeien tot een invloedrijke wetenschappelijke discipline met aanzien vond men absurd. In de landelijke kranten verschenen lange stukken over de negatieve consequenties van de dreigende informatisering van de maatschappij. Citaties vond men waardeloos en te veel publiceren en te veel conferentiebezoek waren verdacht. Jouw vele buitenlandse bezoekers werden meer als last dan plezier gezien en jij moest hun huisvesting zelf regelen (zoals je dat voor mij had gedaan). Internationalisering moest nog uitgevonden worden. Als angelsakische vond ik dit bizar en jij ook. Ik herinner me goed de vele malen die jij mijn kamer binnenviel om jouw frustraties af te blazen en ik deed hetzelfde in jouw kamer.

Maar over het algemeen houd ik hele fijne herinneringen aan deze tijd over; de vele gezellige diners bij jou en Margherita thuis, de grappige bijeenkomsten van het "Systeemclub" en onze Huis- Tuin- en Keukenbridgeclub. Jij leefde helemaal op met om je heen een groep mensen met wie jij kon discusseren en debateren over allerlei onderwerpen. Op het instituut trok jij vele slimme afstudeerders aan die geïnspireerd waren door jou om verder met systeemtheorie te gaan. Velen zijn later in Groningen en elders in het land gepromoveerd. Zij kregen vaste aanstellingen op verschillende universiteiten en sommigen zijn nu zelf hoogleraar. Jij inspireerde niet alleen met jouw enthousiaste colleges, maar ook door jouw manier van omgaan met studenten en promovendi. Jij verwachtte veel van de studenten, vaak met take-home tentamens die meer dan "challenging" waren. De studenten in de 70's en 80's konden dat aan, maar de latere studenten hadden minder begrip hiervoor; alles moest binnen een bepaalde tijd voor de mindere studenten maakbaar zijn. Jij had ook aandacht voor een ander aspect van de opleiding en jij organiseerde regelmatige borrels voor studenten en promovendi waarbij jij een energieke catalysator was voor intellectuele (en andere) discussies. Zij profiteerden veel hiervan, maar ik denk dat jij ook profiteerde; ze gaven jou iets terug waarbij je je emotioneel kon opladen. In de latere jaren was dat ook te zien bij de dagelijkse lunches in de kantine van het sportcentrum; met collega's, promovendi en buitenlandse bezoekers hield professor Willems een gezellig geanimeerd "hof". Ook mijn promovendi vonden het geweldig.

Gedurende de kwart eeuw die wij samen op het instituut werkten kwamen vele veranderingen, zowel in Groningen als landelijk. Naar mijn mening is het opzetten van het

Systeemtheorie Netwerk in 1987 en de bijbehorende landelijke colleges de belangrijkste ontwikkeling geweest voor systeemtheorie in Nederland. Voor ons die in de VS waren gepromoveerd waren de voordelen van landelijke colleges vanzelfsprekend. Door de oude garde werd het eerder gezien als een aanval op hun gezag en het kostte veel moeite en vele pittige vergaderingen om het idee aanvaard te krijgen. Jij nam het voortouw in dit experiment en jouw manier van vergaderingen voorzitten was een combinatie van grondige voorbereiding, overredingskracht en jesuitische strategieën. De tweede stap was om Groningen bereid te vinden om ons te steunen en dat was even moeilijk. De derde stap was de landelijke competitie te winnen. Het lukte allemaal en vele promovendi hebben van deze colleges en de jaarlijkse Benelux conferenties geprofiteerd. Zonder het netwerk was de onderzoekschool DISC nooit gekomen.

Er is veel meer, maar dat laat ik aan anderen over.

Ik wens jou een gelukkige 70 ste verjaardag en nog vele gelukkige jaren toe,

Ruth







Dear Jan,

In the last few years of my mathematics study at the University of Groningen something happened. The department got a quality impuls by recruiting people like Floris Takens, Erik Thomas and Jan Willems. I was curious and I still needed some credits, so I decided to sign up for the course on systems theory that you had introduced into the programme. At the time it was not clear what I was going to do after my studies. I had chosen a minor in economics and therefore I thought it was logical to choose statistics as a specialization: I entered the course on systems theory to learn something on the side and to get the final credits. But then I was caught by your enthusiasm and I saw the beauty of the conceptual framework. Suddenly I realized it was much more interesting to adopt that framework and use it in analysing economic issues than to just apply statistical methods to economic data. But something else happened. You showed me that research is fun: I had to change my programme to be able to specialize in systems and control theory and signed up for one of your other courses. You came to class with a new book by Murray Wonham on a geometric approach to linear multivariable control. The material was interesting but more importantly, the teaching opened up and you showed us what research is and that it is fun to do. At that point I decided to try to build a career in academia.

Essentially economics is a behavioural science. At the time I was also caught by the idea to use game theory to model strategic interaction between economic agents. Game theory was not popular in economics yet (but completely took over in a later stage). I thought that by combining the conceptual frameworks of systems theory and game theory I would have a powerful tool for analysing economic issues. Both the extension to game theory and the positioning in economics were not your main interests but I was privileged that you wanted to stay involved. Your inspiration, broad interest and research attitude have been very important for me in my first steps into academia. Although I was doing a PhD in the Faculty of Economics at Tilburg University, it was natural for me to ask you to be one of my promotors and I was glad that you accepted. You have probably missed some deep theorems in my thesis but you always supported me in what I was trying to do.

Now I am working in the field of environmental economics but I still benefit from what I have learned in the old days. Our contacts have become scarce but whenever we meet I value to be able to talk with you on whatever comes up. You turn 70 now but it looks like you are still alive and kicking. I hope you can keep up the good work. Jan, thank you for everything and cheers!

Tilburg, 20 August 2009

Aart de Zeeuw



I first met Jan at an IFAC Conference, I am rather sure that it was SYSID 1973, in The Hague. I think Jan is not aware of the fact that I was there. At this time, I was a young assistant at Bonn University, working in the area of time series econometrics and eager to learn from systems- and control theory. At a discussion at the conference, I mentioned a number of problems, which I thought were interesting and still unsolved, but I got the answer that these problems had been solved already by Jan Willems. Jan was regarded as a “young lion” in the community.

In 1988 and 1989 Jan invited me to visit him for one month in Groningen. Each of us was working on problems, which had certain aspects in common; Jan was working on the behavioral approach and I was interested in linear dynamic errors- in- variables- and factor models.

I have to say, that I extremely benefited from the discussions I had with Jan over several decades- and I also really enjoyed this exchange of ideas and opinions. Partly, the discussions with Jan opened new insights for me, partly he corroborated opinions I already had. Let me mention a few points in this respect:

-I find the concept of symmetric modelling as developed by Jan very important. In particular with a background in econometrics, where debates, whether a certain variable is an input or an output, are not uncommon, this concept seems to be quite natural.

-Jan has always had a critical attitude towards the use of stochastic models in system identification. I do not completely agree with Jan in this respect, but I admit that we should be careful in imposing assumptions e.g. on the noise and in drawing conclusions from stochastic “testbeds” when evaluating system identification procedures. The quality criteria used e.g. in asymptotic statistics are not “universally” useful.

-In statistics, questions concerning the underlying model class are partly neglected, or burrowed under general assumptions. In the systems- and control community, on the other hand, there is a strong emphasis on the analysis of the model classes and the properties of the relation between the external behaviour and the parameters to be estimated. This is a tradition going back- as many other things- to Rudy Kalman, I think. Jan has always emphasized this point.

Jan has not only made seminal and extraordinary contributions to systems- and control theory, he is, in my opinion, an indispensable voice, critically questioning and commenting developments in the field. Jan is the opposite of what the famous German economist Max Weber called “Fachmensch ohne Geist”. I consider this particularly important in times where there are no clear “driving paradigms” and where there is a certain tendency to get lost in “technology” and to re-invent things which have been developed in the past in neighbouring fields or even in systems and control.

Let me conclude with a few private words. I very much enjoyed the discussions about many topics, ranging from the development of our field to politics, which I had with Jan over the last decades; for instance, I still remember very well the discussions we had at breakfast every day at the University House, when we both were visiting the Australian National University. We know that the last year was very hard for Jan. Jan, I wish that you will completely recover and that you will enjoy a happy life on Doke’s side and that you will continue your work. We need you!

HAPPY BIRTHDAY, JAN

Manfred



## **Jan C. Willems, Designer, Builder and Teacher**

Some observations: Jan likes to work with young people and he shows that he enjoys doing that.

He has a strong drive to make his subject more than just some kind of math. Math is about math and nothing else. But the rigour of math is what Jan strongly promotes as the language for professional and strict formulations of engineering concepts and the tools to develop engineering constructs. By promoting this 'tool' as an inspiring teacher in an engineering environment in the Groningen "JCW Systems and Control School" students have learned to arrive at better and crispy formulations for complicated problems or areas, making them appreciate the sound formulation of Systems and Control concepts and problems in a mathematical setting.

When we met, shortly after Jan arrived in Groningen, I was a math student, rather close to the MSc (Drs) degree. After some initial observations I got a good picture of the state of affairs if I would choose to ask Jan as my supervisor. So I did. I got a room next to Jan's office which facilitated having very regular contacts. I was impressed by Jan and the field of Systems and Control as a part of the Math Department. Systems and Control, in my view, was a kind of math but it was different. There was a world behind Systems and Control which Jan often called the Physics part. For me, that strong link with 'reality' was (and still is) very attractive. I tried my best on a topic, which later on appeared to be a conjecture by Roger Brockett concerning the Circle Criterion (but Jan only told me that at the end of the adventure) but I was not able to solve it. Nevertheless it was big fun to work on that problem but it was even more fun and inspiring to work with Jan. Somewhat later, Malo Hautus and Jan were my PhD thesis advisors.

It is already 25 years ago that I left academia for industry (in 2006 I returned to the University of Twente) but we always kept contact. An important vehicle for that was DISC, of which Jan was the Principal Initiator. Jan also served as the first chairman of the board. I am proud to say that I was asked to be Jan's successor as chairman of the board of DISC. DISC is a beautiful example of a very fruitful cooperation of Engineering and Mathematics. It is this atmosphere that Jan brought to Groningen and stimulated to become a firm foundation for Systems and Control for which the Netherlands hold a strong position on a world scale.

Jan, we all owe you,

Rikus Eising

Beste Jan.

Zeventig jaar is eigenlijk best al wel een hele leeftijd en bij heel veel mensen die deze leeftijd bereiken, hebben de jaren vaak al duidelijke sporen achter gelaten. Bijna een jaar geleden - toen ik je voor het laatst ontmoette bij het officiële afscheid van Geert-Jan Olsder in Delft - was dit bij jou zeker niet het geval. Eigenlijk zag je er, in mijn herinnering althans, nog steeds zo uit als toen ik 30 jaar geleden voor het eerst in de collegebanken bij jou zat. Ongetwijfeld zal je ziekte het laatste jaar z'n sporen hebben achter gelaten, maar het zou me verbazen als ik tijdens deze happening ter gelegenheid van je zeventigste verjaardag niet meer dezelfde enthousiaste, ietwat Franse trekken vertonende Jan Willems zou ontmoeten.

Zo'n 30 jaar geleden, ik denk in het cursusjaar 78/79, heb ik voor het eerst college van je gehad. Het vak heette toen "inleiding in de systeemtheorie". Het was 'één van de oriëntatie vakken voor het doctoraal. Van tevoren had ik geen idee waarover het zou gaan. Het was een vak in de richting van de toegepaste wiskunde en daar het volgens de inhoudsbeschrijving niet over natuurkunde ging zou het misschien wel interessant kunnen zijn. Het eerste college begon behoorlijk abstract met de introductie van een systeem als zijnde een 8-tupel. Verder kwam je ook al vrij snel bij het toepassen van de concepten met voorbeelden uit de natuurkunde aandragen, zoals stroomcircuits, iets waar ik weer niet zo blij mee was. Gelukkig bleek dit echter niet essentieel te zijn om de rest van het college te volgen en na een aantal weken werd een en ander wat concreter en samen met de huiswerkopgaven gaf dat de burger moed om het college toch maar gewoon te blijven volgen. Ongetwijfeld heeft je enthousiasme voor het vak en je duidelijke uitleg hierbij ook een belangrijke rol gespeeld.

In het doctoraal heb ik vervolgens alle vakken in de richting systeemtheorie gevolgd. Hiervan herinner ik mij met name het voorval dat ik samen met Jan Schut en Rein Smedinga de "take-home" toets van het vak "Geometric Control Theory", waarin het gelijknamige boek van Wonham werd behandeld, had gemaakt. Officieel mocht dit niet van jou. De lineaire algebra die wij hadden gehad tijdens onze studie was echter dermate abstract geweest dat wij behoorlijk moeite hadden om te begrijpen wat er nu precies allemaal in het boek van Wonham gebeurde. Daar Jan Schut en ik geen zin hadden om te verbloemen dat we hadden samengewerkt (iets wat bij de andere vakken wel steeds was geoorloofd), hebben we weliswaar e.e.a. afzonderlijk opgeschreven, maar ongeveer hetzelfde ingeleverd. Dit feit was niet aan jouw arendsoog ontsnapt en we moesten bij jou op app`el komen om uitleg te geven. Nadat we hieromtrent uitleg aan jou hadden gegeven, was jouw oordeel dat we nog eens opnieuw, onafhankelijk van elkaar, het tentamen moesten maken. Daar we beiden echter de studiepunten toch niet nodig hadden, we voor onszelf het idee hadden dat we het vak toch goed gevolgd hadden en zeker niet de enigen waren die hadden samengewerkt om ons de stof eigen te maken, hebben we dit toen niet gedaan.

Na 5,5 jaar studie was het tijdstip aangebroken om na te gaan denken in welke richting ik wilde afstuderen. Daar ik alle vakken in de systeemtheorie met veel plezier had gevolgd en daarnaast ook de nodige economievakken, leek een combinatie van deze 2 richtingen ideaal. Vandaar dat ik bij Pieter Otter en jou terecht kwam om mijn afstudereerscriptie op het gebied van adaptief regelen van een simpel macro-economisch model te schrijven. Met name het knutselen aan wat Riccati vergelijkingen, die in dit onderzoek naar voren kwamen, vond ik leuk en het heeft mij er later toe geïnspireerd om het onderzoekswereldje in te gaan nadat ik mijn

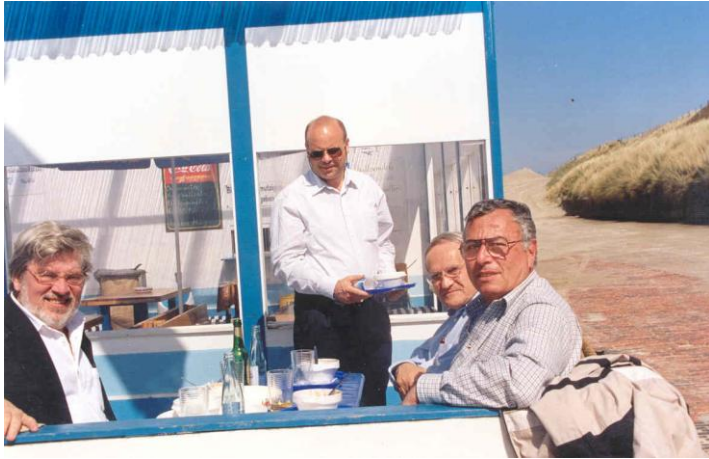
militaire dienstdiensttijd erop had zitten. Wat ik mij na die dienstdiensttijd pas realiseerde, was hoeveel ik eigenlijk wel niet van jou op het gebied van systeemtheorie had geleerd in de doctoraalfase van mijn studie en dat het eigenlijk achteraf jammer is geweest dat ik niet onmiddellijk na mijn afstuderen promotieonderzoek ben gaan doen. In die anderhalf jaar is er toch wel een hoop parate kennis verloren gegaan. Nadat ik in Eindhoven begonnen was met mijn promotieonderzoek, hebben we elkaar regelmatig gezien tijdens de Beneluxmeetings. Wat het onderzoeksgebeuren betreft, heb ik tijdens deze bijeenkomsten altijd genoten van jouw duidelijke probleemstellingen, de wiskundige formaliseringen en aangedragen oplossingen. Wat dat betreft vind ik dat ik met Malo Hautus en jou een ideaal stel ouders heb gehad die mij een uiterst gedegen opvoeding hebben gegeven, waarvoor dank!

Jan, ik hoop dat je je nog een tijdje aan je hobby en levenswerk mag kunnen wijden en dat je gezondheid hierbij geen al te grote parten zal spelen. Nogmaals dank voor je wetenschappelijke opvoeding en geniet van het "feestje" ter gelegenheid van je zeventigste verjaardag!

Jacob Engwerda

Dear Jan,

In accordance with the philosophy that “one picture is worth a thousand words”, I have put together a small collection of pictures. Unhappily, I could not find any trace of pictures from your memorable 1978 (?) visit to BGU and to our home in Omer. At that time you introduced me to the mysteries of geometric control, a topic that haunted me ever since.



I like the picture on the left, taken in Borkum, for the relaxed atmosphere that it projects.

The next two pictures, of Doke and yourself, are from Borkum too.



The picture with Roger is earlier and was taken at Kalman’s 60<sup>th</sup> birthday conference in Frascati.



This one I took in 1997, during my 60<sup>th</sup> birthday conference in Kaiserslautern. To the best of my memory the location was Speyer.



Finally, a sample from the Sde Boker workshops, which you helped to make a success, in nonchronological order. One with Joachim and me, the other at sunrise in Sde Boker.



Looking at pictures with Nilly.

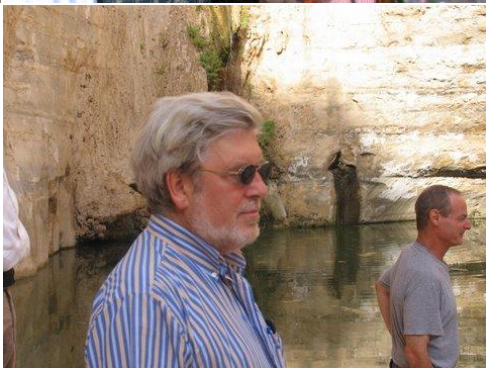
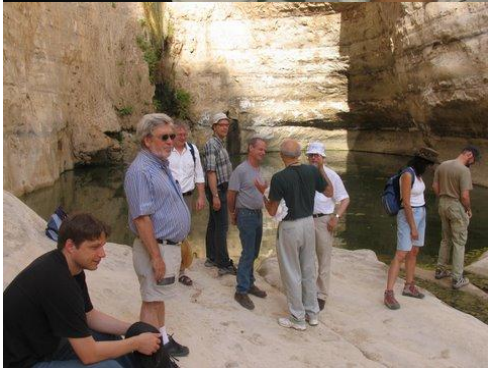
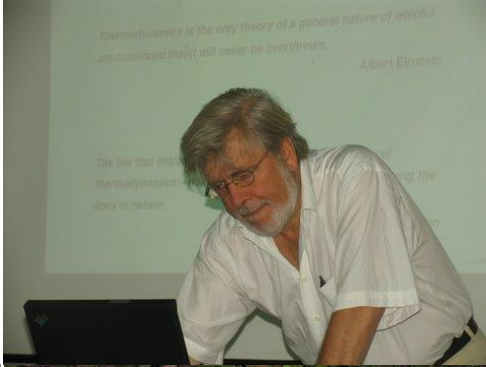


We wish Doke and yourself good health and all the very best.

Happy Birthday!! Nilly and Paul.









Dear Jan,

Four Decades of \_ \_ \_

My first sighting of you was on September 24th 1969, the week after your 30<sup>th</sup> birthday, when you gave the opening lecture in course 6.60 at MIT, Analysis of Dynamical Systems. I took this in spite of my graduate advisor saying it was an unnatural pre-occupation with the equation  $x = Ax$ . I was 'just' an engineer from industry who hadn't done any mathematics since graduating from Imperial a couple of years earlier and had not had homework graded since I was in secondary school. It was all a bit of a shock to my system, but a very rewarding one to see how stimulating and elegant the area of systems and control could be, and in all probability determined the course of my subsequent career.

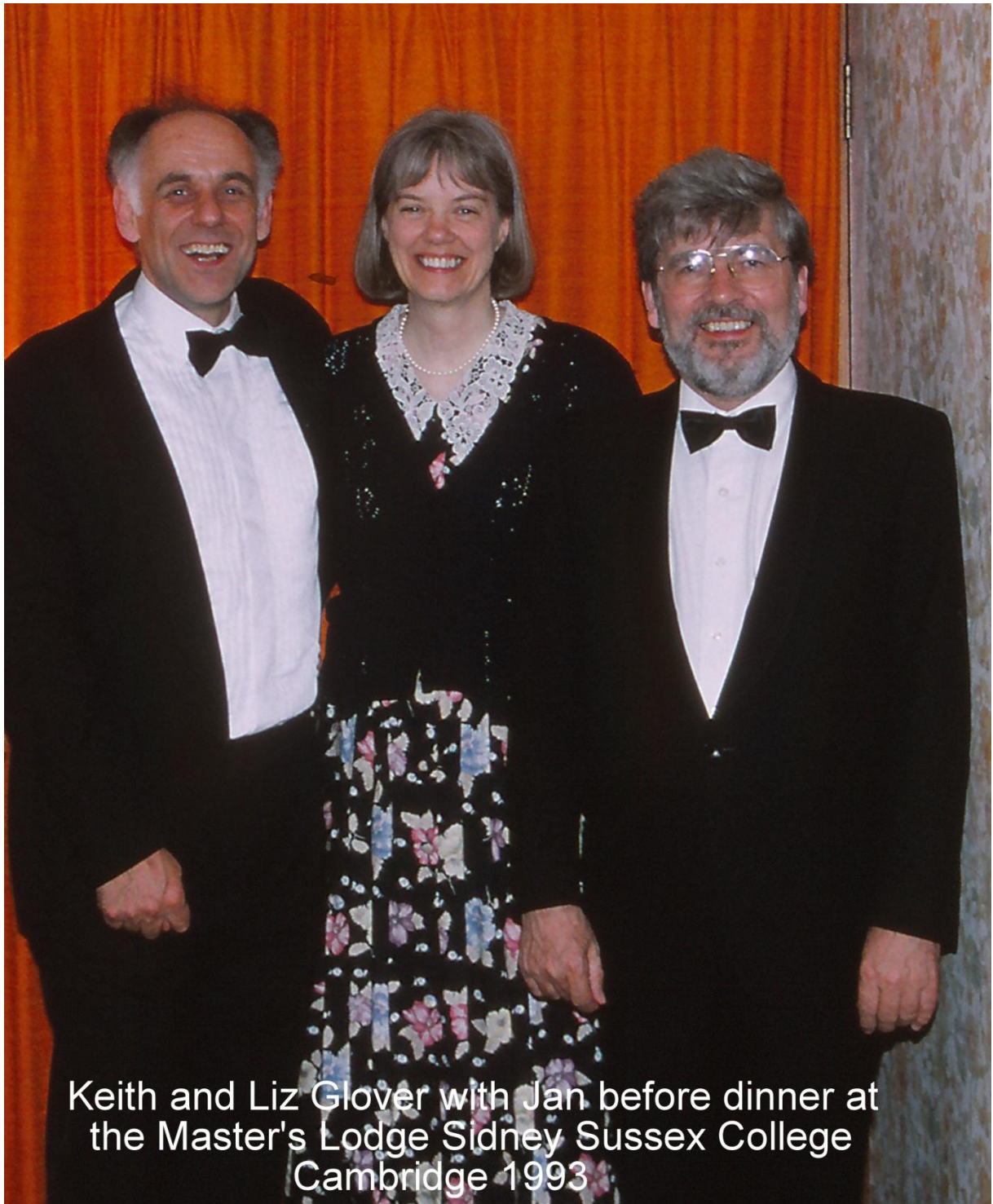
You then looked very young to be a professor and have remained looking so. I recall you returning from a visit to Stanford saying that you had been wearing an MIT sweatshirt there and an aging MIT alumnus approached you, enthusing about MIT, and asked if you were an undergraduate there, you were too embarrassed so said you were a grad student! Your boundless and youthful enthusiasm was always a delight. In spite of you abandoning me twice during my graduate studies, once for a year in this Cambridge and the other for Groningen, your influence on my education and thesis was critical.

In the decades that have followed, I don't recall anything special in 1979. In 1989 for your 50th John Doyle and I included a revised historical perspective on H1 which suggested we should just have thought of 'how Willems would do it' in the state-space and all would be straightforward, and this remains an entirely reasonable view.

In the following decade, I fondly recall in 1993 you putting on a tuxedo to join Liz and myself at a small celebratory dinner in the Master's Lodge in Sidney Sussex College (photo attached). In 1999 at your 60th I also reflected on your influence on me in *Early Behaviour* and concluded 'It was a genuine privilege for me to have been introduced to this field by such a gifted teacher and mentor'. Since then you were generous in helping Malcolm Smith to produce the Festschrift for my own 60th in 2006 and being one of the star-attractions at what was for me a most memorable event.

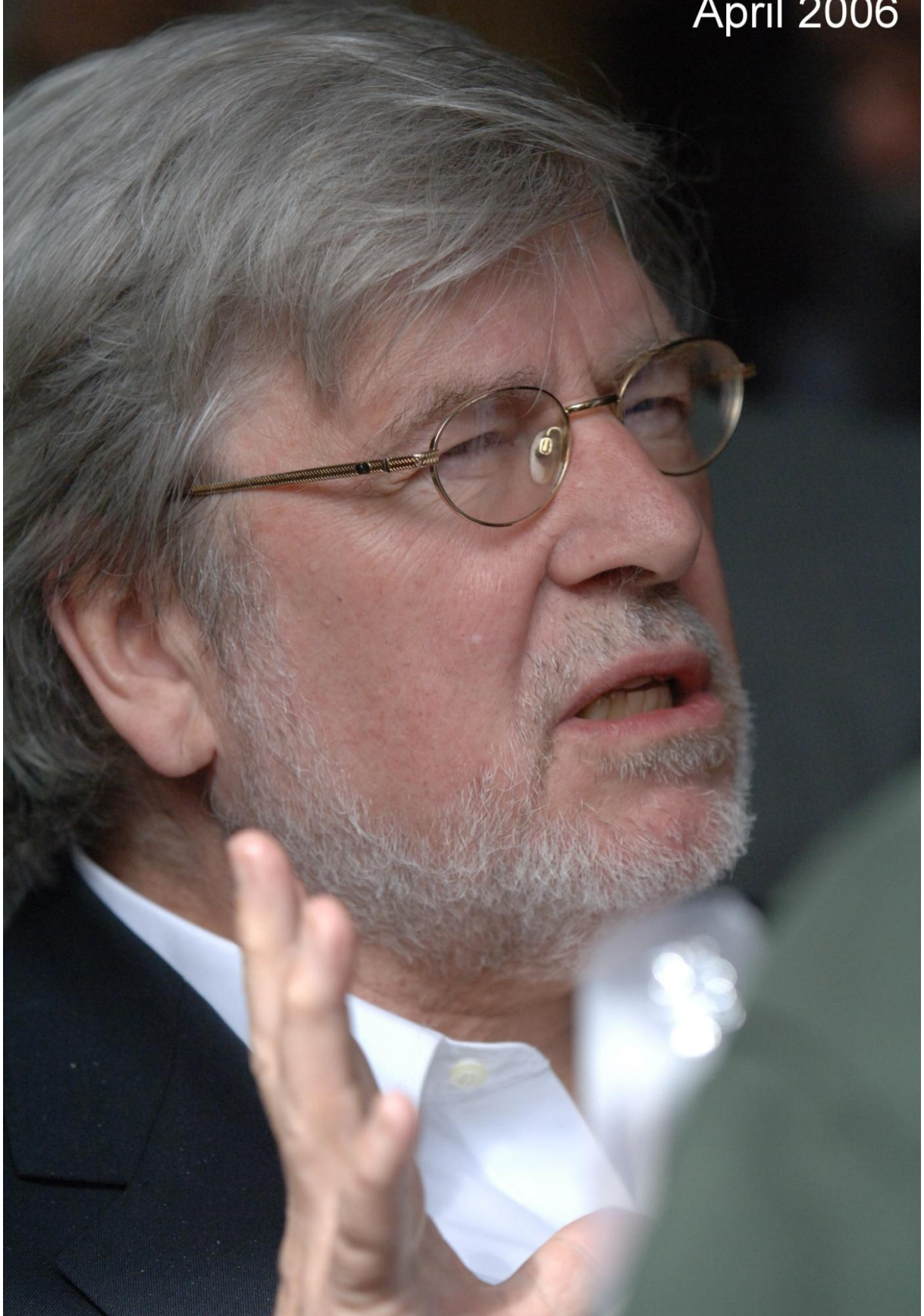
The last decade has mostly seen me attending University and Departmental meetings as Chair of School and then Head of Department, which has been challenging in very different dimensions! However September 2009 is not only your 70th but also when I step down as Head of Department to start a period of sabbatical leave and return to my research roots and hopefully branch out a little. I hope to rekindle in myself some of your youthful enthusiasm and impeccable sense of taste.

Thanks for everything,  
Keith Glover (your joint first PhD student, MIT 1969-73)



Keith and Liz Glover with Jan before dinner at  
the Master's Lodge Sidney Sussex College  
Cambridge 1993

Jan ever thoughtful at Keith Glover's 60th  
April 2006



## **Jan, for good taste!**

Jan, you know, I drifted away from system theory towards econometrics, and marketing is part of the game then. Well then, what do I see as the main selling point of your prime spiritual product, behaviors? My advertisement is the following. Though non-alcoholic, system behaviors do much excite the brain, and they have the best long-lasting flavor of all what is available in system modeling.

When, after a long period, we had a brief contact some time ago, you expressed your continuing discomfort with stochastic modeling, especially for time series data. This brings us back to the research questions on time series modeling to which you introduced me some twenty-five years ago and that formed the basis for my dissertation. We can safely say that these questions still remain far from being well understood. The recent financial crisis has opened the eyes of some financial economists that Brownian motion does not provide a model that is as trustworthy as it is in (some parts of) physics. If, nonetheless, we wish to compare stock prices to random movements of particles in a liquid substance, we should account for the fact that, sometimes and unexpectedly, the 'bottom drops out of the market'. These catastrophes are somewhat akin to volcanic eruptions, as clear signs of increasing stress in the market did not help in predicting the precise breaking point. As compared to financial markets, volcanoes are much more well-behaved, as they function free of purpose whereas people act driven by their own interests, which are not observed, varied, and conflicting.

Jan, your expressed discomfort with stochastics also made me remember various occasions where we witnessed Kalman expressing his conviction that only physics deserves to be called a science, and econometrics certainly not. I do agree, at least, if we define the essence of science as the formulation of universal laws, quite akin to the idea of deterministic behaviors described by laws restricting the possible configurations for the observed variables. Apart from this beautiful domain, there is another one dealing with human behavior, with all its lack of predictability, especially if outcomes depend on the interaction of large numbers of 'non-rational agents'. In such domains, what we know is often minor as compared to what we do not know, but still we need to act. Just think of financial planning for your retirement age, although I am sure that you do not worry for yourself about any of these two issues.

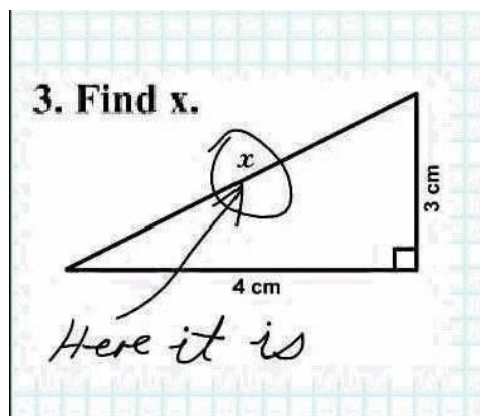
This is how I see econometrics, and more in general, statistics in its many fields of application. It helps us in providing a map, even though highly incomplete, of various possibilities with varying probabilities, and we try to get as accurate a map as possible. Progress is made by formulating good mapping instruments, that is, modeling procedures that work well in well-defined circumstances. Two examples of such (as viewed by many) successful stochastic models are the following. Logit models of McFadden (and its various extensions) help in modeling discrete choice behavior of economic agents, and models for conditional heteroskedasticity of Engle (and various extensions) help in modeling future stock price uncertainties. These models are not 'true' in any well-defined sense, but they help in understanding economic behavior and in making decisions. This is a much more modest objective than the level of understanding aspired for in physics. Nonetheless, it is a valuable kind of mental endeavor, even if it does not fully satisfy our real taste of understanding that we can experience in 'hard' science.

Well, Jan, the above does not offer much in the spirit of bringing up old and funny anecdotes, but it is about what stays most dear to me, that is, your wish to discuss and understand. I wish you all the best in your further advancement towards an ever more respectable age, and in your continuing interests in and contributions to our field of knowledge. And, a good life in good health and with lots of love and joy as well.

Christiaan



Me (just after finding X)



X (math isn't that hard after all)



## Jan C. Willems and the Bremen control systems group

Diederich Hinrichsen

I believe I first met Jan in Bremen 1976 when we invited him to give a talk in our colloquium series. At that time we were just beginning to introduce ourselves to systems theory. Germany was a sort of waste land in that area and we were looking with envy to the Netherlands where this field of applied mathematics was blossoming. While we were novices in the field, Jan was already a prominent international figure. In the evening we were dining in a Greek restaurant and I remember that scribbling on the back of a serviette he explained to me something about Wonham's (A,B)-invariant subspaces which was new to me, although I thought that we had studied Wonham's "geometric theory" quite carefully. It was a very pleasant first contact. He treated us as equal partners even though we were just beginners. In his explanations there was an enthusiasm for the field and a passion to get the basic concepts right which made a big impression on me. Ever since then, although we have been working on different topics and in separate frameworks, I have felt an intellectual affinity both to Jan as a person and to his work.

Jan has supported the Bremen Center of Dynamical Systems from its very beginnings in 1977. He was one of the three foreign experts who were asked to examine our initial research plans and advise the university as to whether or not a Center of Dynamical Systems should be established at the University of Bremen. Then three years later he was again on the board of experts deciding about the continuation of the center. His support was essential, since at that time mathematical systems theory was hardly recognized as a part of applied mathematics in Germany. After the center had been consolidated, Jan continued to be our most consistent supporter. He furthered the career of several members of our group by giving his expert opinion about their scientific achievements. He contributed to nearly every scientific meeting which we organized. He gave the opening lecture at our Joint Workshop on Linear and Nonlinear Feedback Theory, held at Bielefeld and Rome 1981, he was coorganizer of the workshop on Parametrization Problems in Systems Theory in Bremen 1985, he gave the opening lecture at the EEC workshop on Control of Uncertain Systems in Bremen 1989 and in the same year he was one of the four speakers invited to give keynote lectures at the Festcolloquium of the Center of Dynamical Systems on the occasion of its 10th anniversary. After this first decade, further workshops and conferences grew out of the research cooperation between the universities of Bremen, Groningen and Warwick, and Jan was a key figure in all of them.

Through his scientific work and in countless conversations Jan has deeply influenced the scientific development of many members of our group. I first came into contact with his work in 1975 when I supervised a diploma thesis on feedback systems from an operator theoretic input output point of view. Jan's PhD thesis was one of the main references. It is still one of the best references in this area. In 1982, when the behavioural approach was still in the pipeline, he visited us as guest professor for a week and we discussed Rosenbrock's work and the solution modules which D. Prätzel-Wolters and I had recently introduced to characterize system equivalence. Unfortunately, we were too much locked into a technical mathematical problem which we could not solve, so that we did not recognize the system theoretic potential of the approach. So we missed an opportunity to collaborate with Jan in the development of the first steps of the behavioural theory. Later, about the middle of the eighties, our interest shifted to the

control of uncertain systems. Then Tony Pritchard and I learnt a lot from Roger Brockett's book and Jan's IEEE-paper on Least squares optimal control and the algebraic Riccati equation (1971) which helped us in our investigation of stability radii. Jan's seminal work with Chris Byrnes on global adaptive stabilization was a starting point for the research of Dieter Prätzel-Wolters, Uwe Helmke, and, in particular, Achim Ilchmann on universal stabilizers and adaptive control. Jan's suggestion of the topic "delay-differential systems in the behavioural approach" motivated Heide Gluesing-Luerssen to develop her algebraic theory of linear systems with commensurate delays, which incorporated these delay systems into the behavioural framework. The theory of behaviours has also provided a very suitable framework for Ilchmann's early work on the algebraic theory of time-varying linear systems and this has recently triggered further developments in the area. There are more examples of this kind, but let me mention another type of example. We all admired the doctoral studies program of the Dutch Systems and Control Network which was initiated in 1986 with Jan as the prime mover. It was not possible to copy such a graduate program in Germany, because the distances between universities are too large, but the Dutch program has acted as a model for the recently initiated 'Elgersburg School of Mathematical Systems Theory' financed by the VolkswagenStiftung and addressed to doctoral students of mathematics and engineering. Jan is supporting this initiative and will give a five lecture course on the behavioural approach to systems theory in Elgersburg next year.

Especially from the early meetings, when we still were young, some memories come to my mind which are rather of an anecdotal nature. I remember the first evening of our first EEC funded workshop at The Burns in Scotland. We were already sitting after dinner at the fireplace of the old mansion when finally Malo Hautus and Michael Heymann arrived. They had come by a small plane from the continent, and when they entered the hall, both of them looked serious and a bit pale. Was it Malo or was it Michael who first discovered, when the plane started to rock and roll, that one of the two propellers had stopped moving? This was a scary experience and in that situation stability analysis did not really help. Fortunately, they landed safe and sound, but our evening conversation returned again and again to the anxious moments on board of that plane.

Later during this workshop there was a memorable football match between the Dutch and the Germans, with some English players on each side. Fortunately, Tony Pritchard was on our side. I conjecture that the participants of this workshop are the only system theorists worldwide who have seen Jan Willems playing soccer. We played on a rather rough surface which was a sort of meadow for grazing cows littered with thistles, tufts of grass and cow dung. I remember that we had a lot of fun, Jan was in the forward line of the Dutch team and once he came dangerously close to our goal. But I do not remember who won the game.

Another workshop which was important to us was the Joint Workshop of Linear and Nonlinear Systems which was held at the universities of Bielefeld and Rome in 1981. As mentioned above, Jan gave the opening lecture at this conference. During the memorable transfer by train from Bielefeld to Rome he was one of the happy few who remained sober in the midst of chaos with red wine dripping from the luggage compartments onto happily sleeping participants while others nearly missed the train because they insisted in buying Frankfurter Würstchen at Frankfurt railway station in spite of a tight train schedule.

In the late eighties and early nineties, Jan cooperated together with Ruth Curtain, Tony Pritchard and myself in joint European research projects on the control of uncertain systems.

Following the model of our workshops in Scotland we met for a week each year in summer time in a nice and quiet hotel in the Dutch countryside. The idea was that the young scientists of our groups should present their work to a small auditorium of 20 to 30 participants and have enough time outside of the workshop program to exchange ideas in a leisurely atmosphere. Jan participated in each of these workshops and helped to make them successful by his contributions and his presence in the discussions after lunch and dinner, during walks and at the bar in the evening. He likes not only scientific discussions, he is a true intellectual, with deep knowledge and broad interests not only in science but also in culture, history and politics. He has a clear and at the same time engaging way of presenting his points of view and a special skill of drawing everybody including the beginning student researcher into the conversation. Coming home the doctoral students from Bremen always felt encouraged and motivated by these encounters. They felt they had become members of a scientific community.

To conclude these notes I would like to say a few personal words of thanks and congratulation to Jan.

*Dear Jan,*

*In the above remembrances, sketchy, subjective and loosely connected as they are, I have tried to portray the prominent role which you have played for the development of our systems theory group and the Institute of Dynamical Systems. The Bremen systems theory group owes you a lot, and we thank you for your kind support during more than 30 years, your interest in our work and the many pleasant encounters and stimulating conversations we had with you.*

*Since your return from the United States you have been a driving motor of inter-European scientific cooperation in systems theory. By your charisma and the consistency of your work you have influenced the research of many people in many European countries and beyond. On the occasion of your 70th birthday we congratulate you for your impressive scientific achievements during the past 40 years and honour you as Europe's leading systems theorist.*

*In the name of all the former members of the Bremen control systems group I wish you a speedy and complete recovery from your kidney operation, many more years of scientific activity, personal happiness and enjoyment of your work.*

*Didi Hinrichsen*



Jan at the EEC-workshop in The Burns, Edzell, Scotland, 1980



Jan at Oberwolfach 1992 (?)



Jan at my 60th birthday, Borkum island 1999



Jan in the Negev desert, Israel 2008



Jan with Doke and Paul Fuhrmann, Israel 2008



Jan at the Fuhrmann's, Israel 2008



Get well soon! Elgersburg, April 2009



Jürgen Ackermann's home,  
IFAC Congress Munich 1987



Oberwolfach, March 1992

Jan Willems'  
70th birthday  
September 2009

In grateful recollection  
of times and events shared

Huibert Kwakernaak



Workshop RUG June 1995



Huibert Kwakernaak's retirement, Enschede, 12 April 2002





Beste Jan,

In 1978 maakte ik voor het eerst kennis met jou: Ik had net een proefschrift afgerond over dualiteitsresultaten op het gebied van mathematisch programmeren , en mijn promotor, Jaap Ponstein, zocht binnen de subfaculteit wiskunde een coreferent, anders had ik niet binnen de faculteit FWN kunnen promoveren, Jaap en ik werkten immers bij de subfaculteit der actuariele wetenschappen en econometrie, en bovendien had ik mijn opleiding genoten als kwantitatief econoom, en niet als wiskundige. Jij zegde toe, en ook Ruth stelde tijdens mijn verdediging vragen. Ik raakte al snel geboeid door jullie vakgebied, en verdiepte mij een beetje in niet-negatieve systemen, maar veel belangrijker voor mij was het totaal andere klimaat bij jullie: open, breed en internationaal, ik was gevangen!

Ik zal geen historisch overzicht geven van onze samenwerking, ook al was die aangenaam. Veel belangrijker is het om te vermelden, wat ik nu nog de moeite waard vind : dat is natuurlijk het contact met jou, jij was in veel geïnteresseerd, en werk en niet-werk waren amper gescheiden, per slot van rekening kun je niet part-time intellectueel zijn! Mijn blik op de wiskunde werd zeer verbreed, op een gegeven moment zo breed, dat ik de systeemtheorie heb verlaten, maar over dat onderwerp zal ik het nu niet hebben!

Via jou heb ik twee vrouwen ontmoet, die mij zeer dierbaar zijn, en, via jou heb ik nog steeds een goed contact, ook al zien wij elkaar niet zo vaak, met Jozef, onze toenmalige "gastarbeider" uit het oostblok. Wij treffen elkaar zo nu en dan, ofwel in Bratislava of in Wenen.

Via jou kwam ik ook in Laxenburg, de prachtige Habsburg-residentie, vlak onder Wenen, en Wenen is een soort passie voor mij geworden. Ook daarvoor dank.

En, natuurlijk, denkend aan jou, denk ik met plezier aan de vele gasten, de vele aios.

En ook al ben ik geen systeemtheoreticus meer, ik had tot voor kort regelmatig contact met "Twente", en dus ook met enkele oud-aios, omdat, hoe een toeval ( wat is dat: toeval ? ) mijn naaste collega gedurende de laatste jaren Michel Vellekoop was!

Je zult het zonder foto's van mij moeten doen, ik vind ze niets toevoegen aan het voorgaande.

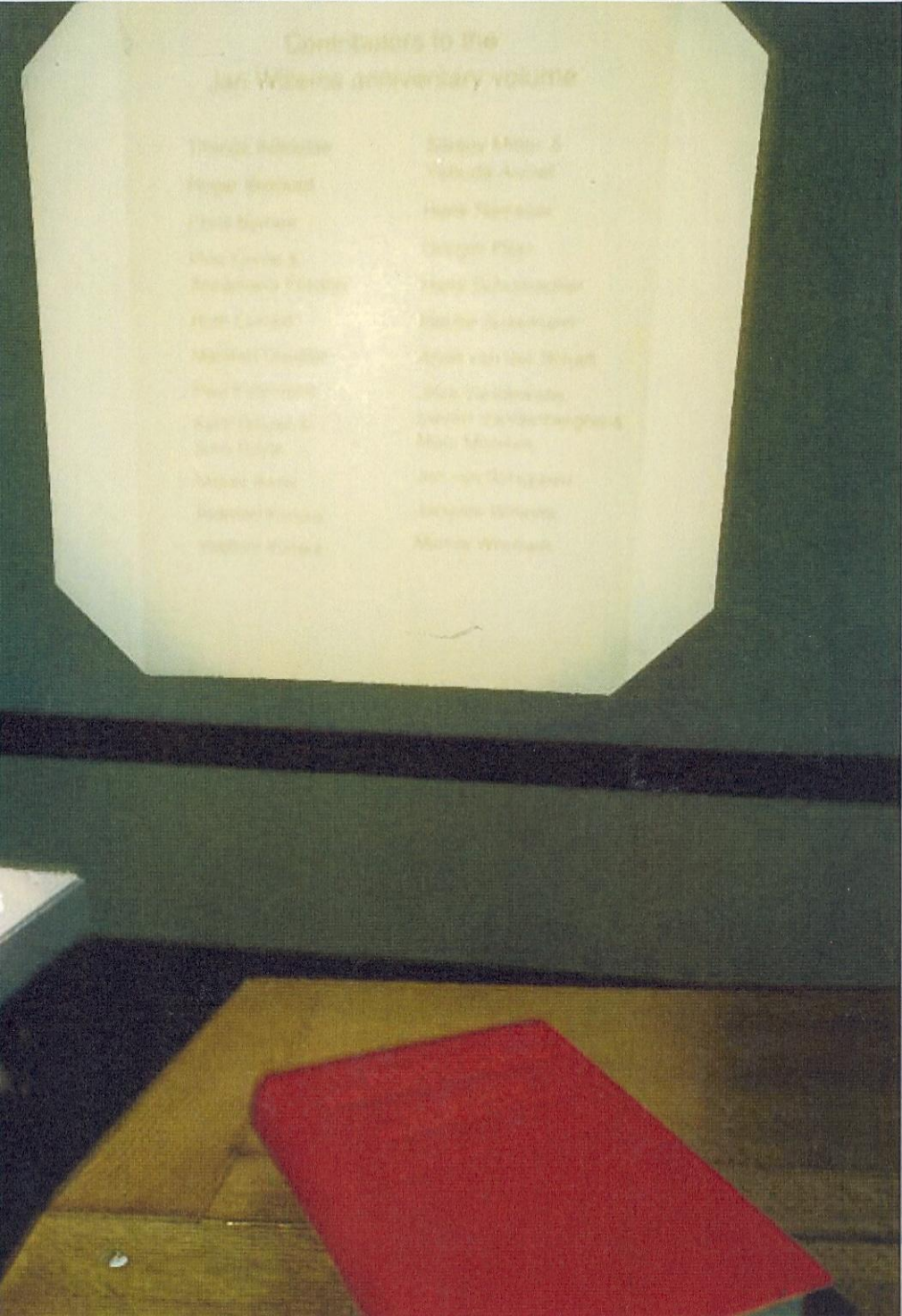
Ik wens je sterkte bij een moeilijke strijd.

Hans

J.W. ( Hans ) Nieuwenhuis.

Contribution by Henk Nijmeijer

Jan's 50th birthday : Hans Schumacher as editor of a book (Springer-Verlag, 3 decades of mathematical systems theory) with contributions of Jan's Network (3 photographs)







Jan at an informal EU (EG-workshop in Edzell, Schotland) 1980 or 1981.

Beste Jan,

We hebben elkaar leren kennen in de herfst van 1991 bij een borrel van de afdeling Wiskunde en Informatica van de Rijksuniversiteit Groningen. Ik was net bij Informatica begonnen en kende nog weinig mensen. Mijn eerste indruk van jou bleek juist te zijn: ongedwongen vriendelijk, charmant en vol van energie en humor.

Later heb ik bij colloquia het volgende meegemaakt: als een spreker zijn werk niet duidelijk kon uitleggen, begon je onrustig te bewegen op je plaats, de volgende fase was dat je naar je buurman boog en vroeg of hij iets begreep van wat daar verteld werd, later kwam je met vragen. Na afloop van het colloquium verraste je echter de spreker door hem oprecht lovend en vriendelijk met zijn werk te complimenteren.



Je was de eerste wetenschappelijk directeur (1992-1998) van het Instituut voor Wiskunde en Informatica (IWI). Je beleid was op hoge wetenschappelijke kwaliteit gericht en je hebt het instituut op het goede spoor gezet. Je grote inzet voor het IWI blijkt o.a. uit de energie en tijd die je hebt gestopt in de cultuurverandering die in dit verband nodig was, uit het wezenlijke aantal AIO-plaatsen die je in onderhandelingen met het College van Bestuur voor het IWI wist te verwerven en uit het werk dat je hebt gedaan om personeelskortingen en foute conclusies van het Faculteitsbestuur i.v.m. disciplineoverschrijdende citatieanalyses te voorkomen.

Naar aanleiding van de gesprekken met jou heb ik mijn persoonlijke publicatiebeleid aangepast, van boeken en conferentiebijdragen naar vooral artikelen in vooraanstaande tijdschriften, en ik blijf jou voor je aanbevelingen in deze richting zeer dankbaar. Ook andere

stellingen van jou, zoals de overproductie als groot probleem van de huidige beoefening van de wetenschap, hebben mij als wetenschapper en bestuurder gevormd.

Je directeurschap van het IWI viel in een tijd waar de bestuurlijke verhoudingen en verdeling van verantwoordelijkheden nog niet helemaal uitgekristalliseerd waren. Je kon zeer humorvol daarover vertellen en bleef die functie met grote inzet vervullen. Tot mijn herinneringen aan jou als IWI-directeur hoort ook de dag waarop een kunstwerk, geïnspireerd door de brachystochron van Johan Bernoulli (zie de door mij 'kunstzinnig' bewerkte foto hierboven), in de buurt van het IWI-gebouw ingewijd werd – uit de bewondering waarmee je over het werk van Bernoulli en zijn tijdgenoten sprak werd mij je liefde voor de wetenschap duidelijk.

Bijzonder graag denk ik terug aan de persoonlijke contacten met jou en Doke: een keer voor een glaasje wijn in jullie voormalige woning in het centrum van Groningen na een voorstelling in de Stadschouwburg, een diner in het Feithhuis, een verjaardag bij mij thuis, mijn bezoek en verblijf bij jullie in Antwerpen in november 2004 toen we samen naar een voorstelling van La Bayardere door het Ballet van Vlaanderen gingen.



Ik wens je goede gezondheid en een lang en gelukkig leven!

Nicolai Petkov

september 2009

My first encounters with Jan date back to the early eighties of the previous century. I was finishing my MSc thesis on a topic in number theory. The encounters were purely social. We had coffee in the WSN canteen with Harry Trentelman and Kees Praagman and had discussions about all kinds of subjects including the big problems of the world, the Tour de France, science in general, politics and what have you. Needless to say that Jan was never short of strong opinions about no matter which topic. Although I had no scientific or professional connection with Jan, already during that period I noticed his inspiring drive to stimulate students to study behind and between the lines. At that time my goal in life was to become a high school teacher in mathematics and it never crossed my mind that there could be alternative options. Until Jan suggested that I could continue my studies with a PhD project in Adaptive Control. He explained in about one hour what that topic was about and he did not want to listen to my objections that I had never taken a single course in Systems Theory. I decided to give it a try and started a few months later under the guidance of both Jan C. and Jan van Schuppen at the Center of Computer Science and Mathematics in Amsterdam. I had a great time. During my PhD studies I met with Jan every two months or so. I found it totally normal that he would reserve almost the whole day for discussions with me at those occasions. Indeed, I did not quite understand what Christiaan Heij, a fellow PhD student of Jan in Groningen, was complaining about when I was around. Little did I realize that I sometimes borrowed his supervision time. It was an inspiring period. Jan was a great supervisor. He was never interested in complicated formulas. It were the underlying ideas and the relevance that he insisted to focus on. It happened more than once that he tested my initial attempts full of lengthy and complex computations, he sometimes called that pointless formula manipulation, against simple examples, friendly putting me back on my feet. One particular meeting appeared to be crucial. I traveled to Groningen in a mood of despair. I had gotten totally stuck in my research and I had little hope that there was a way out of what felt like a deadlock. As I hoped that Jan would guide me out of this dark tunnel I was a little disappointed that he appeared somewhat absent minded. He was only half listening and we were frequently interrupted by colleagues so that I had restart over and over again. At the point where I came to the inevitable conclusion that my research direction was totally hopeless Jan looked bored, checked some unrelated paperwork prepared to make a phone call, waved to some people on the corridor, then looked at me and mumbled 'But what about pole placement?' It took me only a few seconds to realize that this innocent remark opened up a whole new perspective. And so it worked out. Until today I am still not sure whether or not Jan realized the impact of this single remark, but needless to say I am still grateful for it.

After my PhD graduation we kept close contact and we had many discussion about the behavioral approach that Jan was developing. In the early nineties we took up the plan to write lecture notes for an introductory course in mathematical systems theory that we both were teaching at our respective universities. What started as a modest project of writing some one hundred pages for local use only, grew out to an almost five hundred page effort to be published by Springer a few years later. It goes without saying that the project of writing a book with Jan was an experience in its own right. We both had strong opinions and at times progress went all but smooth. The book was published in 1998 and found wide recognition. I believe that we are both proud of the result.

On a more personal, though work related, level, a very nice experience was the CDC in Sydney in 2000. Jan, Harry Trentelman and I shared an apartment in Darling Harbor, close to the conference site. Jan had brought a pleasant bottle of Single Malt to share among the three of us. It

turned out to be a very pleasant week where Jan showed himself a good friend. He did, however, not so much participate in helping us to finish the bottle so that Harry and I had some headache related problems during at least a few of the morning sessions.

Jan is a true academic leader and teacher. I consider it a privilege that I could study under his guidance and I owe him a great deal for having shared so many of his ideas with me. Jan, I wish you the very best, in good health, for many years to come.

Jan Willem Polderman





## Some of the things I learned from Jan

P. Rapisarda<sup>1</sup>

Aujourd'hui, je suis au moins sûr que le plaisir existe sinon de voir,  
du moins d'avoir vu une belle chose avec une certaine personne.

(M. Proust, *Albertine disparue, A la recherche du temps perdu*)

Jan has made me see many beautiful things: new mathematical frameworks being forged, and new results and ideas in technology, engineering, economics, science, or politics- it did not matter where they came from, as long as they were original, innovative, thought-provoking, and as long as they could feed conversations in which logic and reason could be put to strenuous use.

His enthusiasm about beautiful intellectual things can sometimes be alarming in the abruptness and in the intensity of its revelation- for example during a seminar or a talk, when his wiggling on the chair impatient to put the next question to the speaker can impair one's concentration. However, there is what I would call a childish quality to his passion that makes it refreshing, endearing, and valuable. Much like playing for a while with a child leaves one feel less fatigued by the usual aggravations and the everyday irritations, after having talked or worked with Jan one's mental step is quicker and bouncier, the horizons of one's thoughts seem to have extended further than the routine drab environment, one's intellectual breathing seems to be deeper and more secure.

Jan is like a beauty farm for the mind.

Watching him work, discuss science, organize scientific events, hosting visitors from all over the world, writing papers, preparing seminars, and so forth has been, outside of my own parents' example, the most formative experience of my personal and intellectual life, even if it begun alas only at a rather ripe age. These are some of the things that I learned from him- many more I am forgetting. I must also own that although I try hard I am often not able to follow his example due to the shortcomings of my intellect and of my character.

Jan has taught me never to be cynical. He sometimes poses at being one, and his black humour jokes are often terribly funny; but the pose soon wears off, his idealistic attitude returns, and with it his questioning and anguishing about sloppiness, intellectual dishonesty, unfairness, exclusion. I have seen him going for what must have been the twentieth time over a sentence in a paper, trying to get it right; prodding a speaker, well beyond that level of unintelligibility that brings the average listener to look through the window of the seminar room in search of evasion, to explain once more, to make himself clear; patiently correcting a Ph.D. student about a point of notation, or about a logical step in a proof; getting himself together quickly after the last in a long series of disappointments with bureaucracy. These things are all important: letting the inaccuracy or the questionable statement pass unchallenged because of tiredness or superficiality, or giving in to discouragement in the face of administrative silliness does not do a good service to the scientific community and in the end to our own life, which is so much related to it.

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<sup>1</sup> Information: Signals, Images, Systems group, School of Electronics and Computer Science, University of Southampton, SO171BJ Southampton, United Kingdom, fax: +44- (023)-80594498; e-mail: pr3@ecs.soton.ac.uk

Jan has taught me to be modest. I often see him discussing heartily about mathematics with newly arrived Ph.D. students, expressing genuine interest in their work, always bolstering their courage in investigating further, always ready to approve or, if necessary, dispute their ideas. There is no condescension in his actions or words: his demeanour is exactly the same he would have in a conversation with established scientists. One tells him something new, something he does not know, and suddenly one gains a friend and a listener as attentive as one could hope for. Jan is trying to learn. He is always trying.

Jan has taught me to be inclusive and generous, to bring concern, loyalty and charm to friendships, and to keep them in good repair. An e-mail, never superficial or hurried, is all that it takes for one to feel unique; a quick sentence at the end of a talk at a conference, to know that he is still thinking about that problem discussed long ago. His unflinching humanity always shines through.

Jan has taught me the importance of honesty- he makes clear with his own example that honesty is not only important per se, but that it has a social and scientific function, and that it is important to exercise it dutifully. He has taught me that questioning and criticism is not only helpful to the well-meaning ones who are genuinely interested in making of themselves and of their work the most they can, but it is a due sign of respect for ideas, even for those one does not completely agree with.

When I proofread one of my papers and I realize the effects of my sloppiness, or that what looked like a good idea is in reality a less-than-exciting result, I always wonder what would Jan think of that, and I mentally blush. Actually often I do even worse than that: I sulk, sometimes for days, and my despondent mood is less caused by the understanding of my own limitations than the embarrassment of thinking that I would disappoint Jan. Is the mark of a great teacher his constant, unyielding presence in the mind of his students? Surely it is evidence of the importance of his example on how to conduct oneself in scientific and for that matter also non-scientific issues.

Thank you, Jan, for having had me as a student, and for providing such a lofty model to follow. I try and will always try my best- and whatever I will be able to do will owe much to your teachings.

Dear Jan,

It is amazing how the human mind can adapt to the way time goes by!

I remember that, as small child, my daughter used to ask for a celebration of every half year of her life... And now here we are celebrating decades.

I must confess that I felt a bit lost when I was asked to contribute for this "liber amicorum" on the occasion of your 70<sup>th</sup> birthday. What else could I say that I hadn't already said on your Festschrift ten years ago?

I have dug for funny episodes in my memory – found quite a few, believe me – I have reread the correspondence that we exchanged when I first contacted you – yes, I have religiously kept those letters -, but everything seemed so irrelevant at this stage of our lives...

So, instead, I decided to dig in my heart and, beyond the scientist and the master, celebrate the man. Everybody can make theorems, some can even develop nice theories, but only very few like you have the gift of allying this with a profound humanism, great sensibility and a (sometimes well disguised) deep understanding for the others.

This was patent in the way you received me as your PhD student over twenty years ago, in a time where Europe ended in the Pyrenees and my country was so enormously distant from the Netherlands – which I only completely realized when someone once asked me if we also had bread and bakers back in Portugal... More than your precious help with all the practical details of my settling in Groningen - I can never forget the day you came to Neptunusstraat driving a mini-bus filled with furniture for my student room - I value the way you considered it natural to accept someone from an obscure country like me to come to work with you; I value the way you never let me feel an outsider in those times when the world hadn't yet become this big village.

I bet you will protest – “The woman is crazy, what is she speaking about? What's the big deal about that?” – while reading these lines. But that's precisely what makes you so special.

I can't help letting my “Zuidse vrouwenziel” speak to thank you for being like that.

Your favorite “promovenda”\*

Paula



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\* I think I may continue to use this attribute you once gave me, since to my knowledge I am still the only one...

Contribution by Hans Schumacher



During a workshop in Scotland, probably 1979 or 1980. Of course Peter Crouch and the late Tony Pritchard are recognized on the front row together with Hans Schumacher and Uwe Helmke; on the second row Henk Nijmeijer, Arjan van der Schaft, Ruth Curtain, and Dietmar Salamon are seen. At the side, looking a bit sleepy perhaps, is Jan...

Hereby a copy of some notes of Jan for the course that he and I taught in the Dutch national network of systems and control, nowadays known as DISC. I think the note is from 1986; remarkably the word "behavior" does not appear...  
Note the book reference !

nieuwe  
blz

## Koncept

### Mathematische systeemtheorie en Lineaire systemen

#### Doelstelling:

In dit college zal een kader worden geschetst dat kan dienen als wiskundige basis voor de analyse en synthese van dynamische systemen. Dit college vervult een brugfunctie: enerzijds worden begrippen die <sup>enigzins</sup> <sup>zullen</sup> bekend zijn uit de eerste fase in een axiomatisch en formeel wiskundig kader geplaatst en anderzijds worden ~~model~~ problemen aangesneden die in een later stadium <sup>van</sup> het tweede fase curriculum zullen worden uitgediept.

#### Specifieke onderwerpen:

1. Dynamische systemen. Algemene definities. ~~Toe~~ De toestand van een systeem. Veel voorbeelden
2. Lineaire systemen: externe variabelen, input, output, en toestand. Hun interplay.
3. Wiskundige  $\mathbb{R}$  digressie ~~over~~ over polynoommatrices
4. Polynoombeschrijvingen van systemen. Regelbaarheid en waarneembaarheid. De transfer functie
5. Toestandsmodellen. Realisatietheorie. Gendwarsigheid van toestandsmodellen voor lineaire systemen. De Hankel matrix.
6. Exact modelleren. Klassieke realisatiealgoritmen via de Hankel matrix
7. Wiskundige digressie over  $L_p$ , Fourier, en Laplace
8. Modelreductie: probleemstelling. Uitwerking van de basisideeën van de algoritmen van gebalanceerde realisaties.

9. Storingsontkoppelen: DDP, LQG en  $H_{\infty}$ . Uitwerking van de basisalgoritmen voor exact storingsontkoppelen.
10. Approximatief modelleren: recursieve kleinste kwadraten identificatie van (AR) systemen.
11. Kontrolécodes als voorbeeld van een inversieprobleem.
12. Passieve systemen. Minimum fase systemen. Toepassingen in elektrische netwerken en electrotechniek.
13. Ze zijn ook  $\infty$ -dimensionale systemen! Een glimpje van semigruppen.

Ditboek of Tekst: "Linear System Theory"

Tekst: A.B. Cee en F.G. Hasj: "Linear System Theory"  
 Unwritten books Publishing Co., Groningen, The Netherlands, 2001.

Vereiste voorkennis: ~~Enige voorkennis van bekendheid met toestandsbeschrijving van lineaire systemen~~

Voor dit college is geen specifieke voorkennis vereist. Wel is ~~er~~ vertrouwdheid met lineaire algebra, en ~~de~~ toestands- en frequentiebeschrijving van systemen aan te berekenen.

Dear Jan,

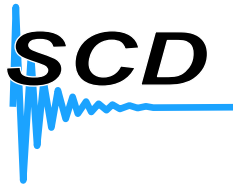
When I first got to know you as a Ph.D. student when I followed your course in the Dutch Institute System and Control program on behavioral system theory.

You have always been inspiring, but I have to admit there has been an anecdote during which I was a bit upset, and that is for an Italian an understatement. In one of the take home exams there was a question which took me two nights to solve. I cannot remember the details, but I do remember that you got me really frustrated in those two nights. Finally, I managed to solve it, but the morning after an email arrived in which you simply said that that specific problem was harder than expected and the students did not need to solve it. I remember that my physiological state changed getting that email and I got a bit red and steamy. But you recognized the effort explicitly well during the grading and that was greatly appreciated.

You always have challenged people and that is one of the ways you have inspired and pushed many young and senior scientists in the beautiful field of System Theory. Since then we met regularly and have had many discussions related to common views and differences, and these discussions are still going on regularly, especially when we start talking about terminals, ports and interconnections like a long dinner and discussion having with you and Arjan in Groningen which is still very fresh in my memory.

As everybody knows and acknowledges you have been a pillar in system and control and an inspiration for me as for many others, I have had the pleasure to learn from you a lot, to work with you, but last and not least to learn how to drink good Belgium beer together and that is also an important achievement for a young Italian coming to the Netherlands.

Happy birthday Jan and thank you for all! Stefano



*Seminars*

Persistency of excitation:  
a real-life anecdote

*Dear Jan,*

*From all members of our research group you surely have been attending the largest number of SISTA seminars. From these many occasions I will never forget the following memorable event. It happened on a day when a new PhD candidate was giving a talk. The presentation was very fancy, full of nice colors and good looking layout with powerpoint slides. Arriving around the tenth slide, some first equations were showing up in the presentation. The person felt embarrassed and said: "Apologies for the equations that I am showing". Your reaction at that moment was a mixture of anger and words of wisdom, resulting into the historical words "You never have to apologize for being more mathematical!".*

*This little anecdote is only illustrative for the numerous interesting and stimulating questions you have been asking during the seminars. It helps us all better thinking about the deeper essence and developing a good understanding of the subject! In other words, it brings persistency of excitation in practice!*

*Many congratulations with your 70th Birthday!!*

*with warm regards,  
Johan Suykens*



Most sincere congratulations for Jan's 70th birthday.

I spent 10 months with my wife in Groningen as a visiting researcher in Systems and Control Group of University of Groningen from April 2000 to February 2001. It was my first long stay in Europe. Jan was my host. I would like to express my sincere gratitude for his kind hospitality during my stay. I could enjoy my stay and research there in a very nice environment. I could also make many friends in the community of the behavioral system theory. This visit was the starting point of my research on behaviors. The picture below was taken in University of Groningen on February 14, 2001, the day before I went back to Japan.

Jan also visited Kyoto several times invited by Prof. Yamamoto. We also had discussions during his visits. Every time I had discussion with him, I was struck with wonder by his deep thinking and enthusiasm for his researches. The discussions with him were very valuable for me, and I have much to learn from him.

I wish his health may continue, and look forward to seeing him again in Japan in the near future.

Kiyotsugu Takaba

Kyoto University



It must have been in 1977 that I took the introductory course on linear systems given by Jan Willems from his handwritten lecture notes. It dealt with introductory state space theory, but above all, an input output system was defined as an octuple of mappings and sets. I remember that, as a third year student of mathematics, I was fascinated by this set theoretic frivolity. In the last phase of my studies in Groningen I decided to choose Jan as supervisor for my master's project. This project was on infinite zeros and root loci. At that time, I was convinced of the fact that infinite zeros and root loci was the central theme in systems and control, and I admired the authors of papers on these subjects (published very often in the International Journal of Control) as famous pop stars. I actually met these famous people myself at a conference in Bielefeld, Germany, in June 1981: Jan forced me to give a talk there on the results of my master dissertation. I remember Leonard Silverman during one of the talks at the conference raising his hand and saying: "this reminds me of something I did 10 years ago". Science appeared a cruel world to me.

In the fall of 1981 I started my PhD project, supervised by Jan. At that time, Jan's main research interest was the so-called geometric approach, dealing with problems of disturbance decoupling, tracking and regulation, pole placement, and observer design. In fact, in the spring of 1979 I had participated in a working group organized by Jan to read, study and understand (in that order) the book Linear Multivariable Control, a Geometric Approach, by W.M. Wonham. Around that time, Jan himself must already have worked on his famous paper "Almost invariant subspaces: an approach to high gain feedback design - Part 1", in which he developed a theory of approximate disturbance decoupling by state feedback, using the concept of "almost controlled invariant subspace". Anyway, the geometric approach was very much into fashion those days, and I soon decided to spend all my time on trying to understand almost invariant subspaces. That was not an easy task, since many of the proofs in Jan's paper were very short. In fact, some of the proofs were not even written out in full detail: Jan's experience and intuition had told him that the results were true anyway, so why bother about the details. I remember the frustration that I felt when I had to struggle to fill in these details. Anyway, it is fair to say that part of my doctoral dissertation dealt with filling in the missing details in Jan's almost invariant subspaces paper.

After finishing my doctoral dissertation in 1985, I joined the Faculty of Mathematics and Computer Science of the University of Eindhoven as an assistant professor to work in the group of Malo Hautus. During the six year period that I worked in Eindhoven, I kept meeting Jan at conferences regularly. One of the nicest events that I remember is the workshop on the Riccati equation, organized by Sergio Bittanti in the beautiful town of Como, it must have been in the summer of 1990. My participation in this conference was really low budget: my family and I were on a camping ground somewhere along the shore of Lake Como. During the workshop, Jan told me about a position that was going to be available in his group in Groningen. After a successful job application, I returned to Groningen on January 1, 1991 to become an associate professor in the Systems and Control Group.

It was only after five or six years that Jan inicted on me his interest in the behavioral approach. Our first joint paper on the behavioral theory of dissipative systems appeared in 1997. In the period from 1997 to 2002 Jan and I spent several long periods of time developing a theory of control in a behavioral framework. During these periods we would have very long sessions, sitting together in front of the large white board in Jan's office, brainstorming. On many

occasions these sessions would last the whole day, sometimes for several weeks in a row. For me the most striking thing of these sessions was that Jan never seemed to run out of energy. He never seemed to be tired and always wanted to give it another try. Clearly, Jan has a natural and effortless ability to concentrate and to do research. It goes without saying that I learned a lot from our joint research sessions and that they brought me an enormous amount of pleasure and inspiration.

In 1999 we worked on a behavioral formulation of the H1 control problem. The paper was becoming bigger and bigger, and after a while it had become 120 pages. We were extremely happy with our results, and Jan's idea was to submit it to the IEEE Transactions on Automatic Control. I suggested that it would probably be a little bit too long for this journal. Jan (no compromises!) however insisted that the results should be published as a whole, in one single paper. Of course, after three weeks the manuscript was sent back by the editor: two papers resulted from this, Part 1 and Part 2 of "Synthesis of dissipative systems using quadratic differential forms".

It seemed unavoidable that Jan and Doke left Groningen in 2004 to live in Antwerpen. For me, their departure to Belgium marked the end of a very intense period of collaboration. Since then, Jan (and Doke) and I of course have met regularly. A very nice period was the time we spent together in Kyoto in November 2006, and our visit inside the emperor's palace there.

Jan, I expect to meet you soon again in Kyoto for Hanami in April next year!

Harry Trentelman



## **Just "Thank you"**

Maria Elena Valcher

Working in the Academia is an experience quite unique. That's why the verb "to work" sounds quite inadequate (no, I am not confirming unfair gossips claiming that we do little!) to describe an experience which involves not only professional, but also personal, aspects. It is not just a matter of learning a job, but also of growing as a person, and I feel that in this context, much more than in others, everyone meets, at the beginning of the career, persons who play a model role.

Jan had that role in my early years as Assistant Professors. His brilliant mind, energy, commitment, and broad perspective, as well as his specific research interests, captured my attention first, and my respect and admiration immediately after.

Over the years, as our friendship and our scientific collaboration evolved, Jan never ceased to represent for me not only a friend and a colleague, but also a reference and a source of inspiration. That's why I am not only happy, but really proud, to be part of the group of friends celebrating Jan's 70th birthday. Cheers, Jan!

Beste Jan,

Een paar weken geleden, bij het verplaatsen van een paar archiefdozen in mijn kamer, kwam ik een map tegen met de slides die ik gebruikt had voor een presentatie in de Eindhovense meet- en regeltechniekgroep van Pieter Eykhoff, waarschijnlijk ergens rond 1985. De titel was

*“An Anthology on the Behavioural Approach of Jan C. Willems”.*

Het was in de tijd dat ik vanuit mijn interesse in de systeemidentificatie, naarstig op zoek was naar meer helderheid, ordening en structuur in de “bag of tricks” die regelmatig door Pieter gepresenteerd werd voor het beschrijven van alle keuzeopties die de gebruiker tot zijn beschikking had (of moest hebben) in de systeemidentificatie van die tijd. Ik herinner me de regelmatige bezoeken die ik bracht aan Groningen waar we ons samen met Christiaan Heij en Hans Nieuwenhuis rond het bord schaarden en discussies hadden die mij gaandeweg helderheid verschaften hoe de systeemtheoretische concepten mij konden helpen in mijn identificatieproblematiek. Het was nog voor de tijd van het landelijke netwerk, en voor mij was dit contact met de wiskundige systeemtheorie uitermate boeiend en stimulerend, en duidelijk aanvullend op de opleiding die ik in Eindhoven had gehad. Het was ook de tijd van de systeemtheoriedagen in Groningen met na afloop pizza eten bij jouw thuis.

Ik presenteerde de resultaten en mijn inzichten vol verve in Eindhoven, maar naast enig begrip was er toch wel een sterk beeld van “moet het nu allemaal zo moeilijk....?”

(Toen ik voor de gelegenheid van het schrijven van dit stukje opnieuw op zoek ging naar die slides van bovengenoemde presentatie, bleken ze natuurlijk volstrekt onvindbaar...).



Fotomateriaal uit die periode heb ik niet kunnen vinden, behalve dan de ene foto van mijn promotie op 3 maart 1989 in Eindhoven (zie hiernaast)

Van jou ontving ik indertijd een uitnodiging om deel te nemen aan een systeemtheoretische workshop van een internationaal netwerk in Maastricht. Jij zult je dit wellicht niet meer herinneren, maar het waren voor mij belangrijke stappen in het vormen en richtinggeven van mijn academische loopbaan.

Overigens speel jij ook –wellicht zonder het te weten- een rol in het mechanisme dat er uiteindelijk toe heeft geleid dat ik een positie vond als universitair docent. In het midden van de jaren tachtig zaten de universiteiten potdicht, en was het vinden van een positie uiterst moeilijk, zeker aan de engineeringkant. Het verhaal dat ik nog regelmatig aan studenten vertel over de start van mijn academische loopbaan, begint bij het moment dat Ad Damen, Andrzej Hajdasinski en ik in Eindhoven een lucifertje trokken om te bepalen wie onze gezamenlijke bijdrage zou “moeten” presenteren tijdens de Benelux Meeting. Ik “verloor” en moest presenteren, maar de presentatie (over minimale partiële realisaties) wekte jouw interesse, en de opmerking die jij daarover maakte tegenover Okko, was voor hem enige tijd later mede aanleiding om mij te polsen voor een docentpositie in Delft. Zo zie je maar.....! Wat je nodig hebt is de ondersteuning van Jan en een doosje lucifers.....



Tijdens een van de meer recente Benelux Meetings on Systems and Control, met Stefano Stramigioli

Beste Jan, wat we in Nederland (en België) hebben opgebouwd in nationale netwerken, onderlinge samenhang, en sterkte in het vakgebied hebben we te danken aan jouw visie en leiderschap. Ik ben er trots op om op dit moment leiding te mogen geven aan het nationale netwerk dat voortkomt uit jouw initiatieven en hoop daarmee de onderlinge samenhang en de sterkte binnen ons vakgebied verder te ondersteunen....



25-jaar Benelux Meeting, Heeze, 2006  
(die rechter foto is wel heel ernstig.....)

Jan, van harte gefeliciteerd met je zeventigste verjaardag!!

Ik wens , mede namens Irma, jou en Doke alle goeds toe voor de toekomst. Ik hoop dat je de komende tijd de tegenslagen achter je kunt laten en vol enthousiasme en energie aan de volgende fase van je jeugd kunt beginnen.....

(En voor IFAC 2017 in Amsterdam (?) reken ik op je....!)

Paul Van den Hof  
10 september 2009

## Five Decades of Mathematical System Theory

*at the occasion of Jan's seventieth birthday*

Looking back in time is an interesting activity with all kinds of opportunities to 'rewrite' history, or at least to interpret it in a(ny) desired manner.

In 1989, at the occasion of Jan's fiftieth birthday, a Festschrift was edited by Henk Nijmeijer and Hans Schumacher with the magnificent title 'Three Decades of Mathematical System Theory'<sup>2</sup>, thus fixing the start of mathematical system theory to 1959, twenty years after Jan's birthday<sup>3</sup>. In 1999, almost unavoidably, another magnificent Festschrift was edited, at the occasion of Jan's sixtieth birthday, this time edited by Jan Willem Polderman and Harry Trentelman<sup>4</sup>. The somewhat threatening title of this second Festschrift was 'The Mathematics of Systems and Control: From Intelligent Control to Behavioral Systems', although the editors of the first Festschrift tried to stick to their interpretation of history by calling their own (joint) contribution 'Four Decades of Mathematical System Theory'. I will now take the opportunity to call my small contribution to the present Liber Amicorum, at the occasion of Jan's seventieth birthday, 'Five Decades of Mathematical System Theory'<sup>5</sup>.

Looking forward in the future is a much more risky adventure. I think it is without doubt that Jan has had an astonishing impact on the area of mathematical systems and control theory, and that this influence is remaining. His contributions to the theory of dissipative systems, to geometric control theory, to identification theory, and to the foundations of mathematical system theory, including behavioral system theory, are truly tremendous. Personally I am very much convinced that his work on interconnection of physical systems and on the concept of control by interconnection will be very fruitful for future developments, and I am sure we will hear more about this at the workshop celebrating his seventieth birthday. But, at least if I speak for myself, Jan's personal influence has been equally large, as can be already seen by re-reading the contributions to the Festschriften mentioned above.

Looking back at the sentences I wrote for the previous two birthday celebrations, which still had a very serious undertone, I would this time rather like to emphasize the enormous joy of doing research with Jan. The thrill and excitement of trying to dig deep and understand the essence of the problem and its solution is still very much resonating. Thus, leaving history and future aside at this very moment, I would very much like to wish Jan a very happy celebration of his seventieth birthday, among all his scientific colleagues.

*Contributed by Arjan van der Schaft*

*Institute of Mathematics and Computing Science, University of Groningen, the Netherlands.*

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<sup>2</sup> H. Nijmeijer, J.M. Schumacher, editors, *Three Decades of Mathematical System Theory, A Collection of Surveys at the Occasion of the 50th Birthday of Jan C. Willems*, Lect. Notes Contr. Inform. Sci. 135, Springer, Berlin, 1989

<sup>3</sup> The editors also realized the arbitrariness of the year 1959 as the starting point of mathematical system theory, but in defense they quoted George Axelby, who had claimed that 1959 was a revolutionary year for systems theory, preludeing the first IFAC World Congress in Moskou in 1960, with the presentation of the groundbreaking contributions of Kalman, Pontryagin, and Kalman

<sup>4</sup> J.W. Polderman, H.L. Trentelman, *The Mathematics of Systems and Control: From Intelligent Control to Behavioral Systems*, University of Groningen, ISBN 90-367-1112-6, 1999.

<sup>5</sup> In the spirit of the first sentence: I have also good memories about the year 1979, 'Two Decades of Mathematical System Theory', since in this year I was able to start my PhD studies with Jan.



PhD defense in 1983





1996 Kansai Airport, after the CDC in Kyoto



1999 Groningen 60th birthday

Somewhere in May 1974 in a national paper an advertisement appeared in which a PhD student was asked for. He or she should do research on a problem in mathematical system theory at the Mathematical Institute of the University of Groningen. It was at the time that the level of the education at the Dutch high schools still was aligned with the entrance requirements of the University.

The planning was that I should finish my study in mathematics at the Technical University of Delft by the end of 1974. During my study in Delft I discovered that somehow I preferred to be involved with problems which were not easy to solve. I wanted to continue that kind of work after my study and I decided to apply to the position in Groningen. The result was that I was invited for an interview. I must confess that I was a little bit excited and uncertain. Eventually I had the feeling that I hardly had any experience with mathematical systems theory.

We arrived at the central station of Groningen. By leaving the station certainly a quite other feeling did attack you than when leaving the central station at Rotterdam. By the way this still is so but in a positive sense. Bus line number 5 seemed to go into the direction of "Paddepoel" (Toad pond, frogger) where the WSN building should be. Not quite a name that was inviting to go to. We needed to go till the end point of that line that was somewhere at the beginning of a pasture. In the distance on your left and right a small number of buildings could be observed. To the left a narrow nine floors high building should be the WSN-Building where professor J.C. Willems has his room according to the invitation letter. There at the fourth floor I met Jan for the first time. In Delft the distance between student and professor was big and the relation rather formal. What a relief. The reception was very friendly and of an open character. The soft southern Belgium pronunciation of Jan strengthened this nice atmosphere.

The exact detailed content of our conversation I do not remember any more. The research that Jan had on mind should have something to do with the relation between stochastic control and information theory. However something deterministic was ok too. After the discussion with Jan I also met the three other members of the system group at that time. One of which is still a friend. Finally I left Groningen with more questions than I arrived with and my uncertainty was increased instead of decreased. Yet soon I received a letter from him in which he told me that the choice was fallen on me. To be honest I did not expect that. I immediately called him to tell him about my uncertainty. Could I really do the job? His immediate reaction was that he would regret it if I should decide not to take the job. Especially the way he talked to me on the phone gave me trust and in that same talk I said to him that I wished to accept the job. The final result of our conversation was that at the end of 1974 I started to work as a PhD student with Jan.

*I never did regret!*

With respect to the field of systems theory and scientific thinking in general I enjoyed Jan's strong abstract and conceptual thinking. Beautiful. The way we finally did define the notion of the "certainty equivalence principle" is an example of this conceptual thinking. The atmosphere we worked in was open, inviting and full of trust. For our students too! The open book and home examinations were examples of this trust. On a regular basis our group of four had discussion meetings. Jan did give one of us an international journal paper to present and to discuss with the group. I'll never forget the first paper I did have to present. It was a paper of Akaike concerning stochastic realization theory (Stochastic theory of minimal realization). What

a hell of a job. But finally I succeeded in understanding the paper in full detail. After my presentation Jan looked at me and said to all three of us: "How glad I am that I finally exactly understand the content of that paper".

Jan could not have given me a nicer compliment!

Besides our scientific work it also was sociable. Jan did not smoke (Now a day's none of us do). Yet at regular times he entered my room with the question if it was allowed to role a cigarette from me. Most of the time you then know that Jan needed to talk with you mainly to express some new ideas and to hear what your thoughts were about it. On Friday afternoon we often meet at five at the "Paddepoel bar" to end the working week and start the weekend and to say "till Monday" (together with some beer and meatballs). The international researchers Jan did invite to Groningen were an experience on their own. Some of them despite of a lot of sheets with a lot of text you did not understand at all. With others we had dinner with fried cauliflower. All of them were nice and good people to meet.

There are two things in my life where Jan played a really important role:

- Love and feeling for abstract and conceptual thinking.
- Two lovely children Anand and Tara.

Jan,

***Thanks***

Hen.

(H. van de Water)

Jan ... a **REMARKABLE** scientist

Dear Jan,

It was a great honor and pleasure for us when you decided to become part of our SCD team during the last part of your career. I will always remember your active presence and vivid interactions in seminars and workshops we organized in SCD: always eager to learn, always asking interesting questions, always stimulating the audience to think deeper, to understand better. Science was your life, and in particular I appreciated your willingness to share your knowledge with our young PhD students in an open enjoyable atmosphere. Especially Ivan Markovsky was the right student at the right moment who succeeded to capture your "remarkable" theory on behavioral modeling and to link it to total least squares concepts and algorithms, as studied in our group. This nice cooperation resulted in our joint book:

Ivan Markovsky, Jan C. Willems, Sabine Van Huffel and Bart De Moor, *Exact and Approximate Modeling of Linear Systems: A Behavioral Approach*. Monographs on Mathematical Modeling and Computation series, SIAM, Philadelphia, 2006, 206 p.

We were proud of you, Jan, and therefore Ivan wanted to express his gratitude in the preface of the book. However, you reacted as follows by email from Japan on January 28, 2005:

*"Over the coming holidays here (tomorrow, the former emperor Hirohito's birthday, a holiday, believe it or not, and next week Children's day and Constitution day, with a 'bridge' in between), I will take a last look at the book. Superficially, not in detail. I already spotted one correction. Please tone down the first sentence of the Preface, and certainly do not call my 3-part paper 'remarkable'. Reason: I am a co-author, and I do not feel comfortable calling my papers 'remarkable' (do not worry, this is not false modesty, if I was not a co-author, I would - vanitas vanitorum, et omnia vanitas - have asked you to capitalize and boldface 'remarkable')."*

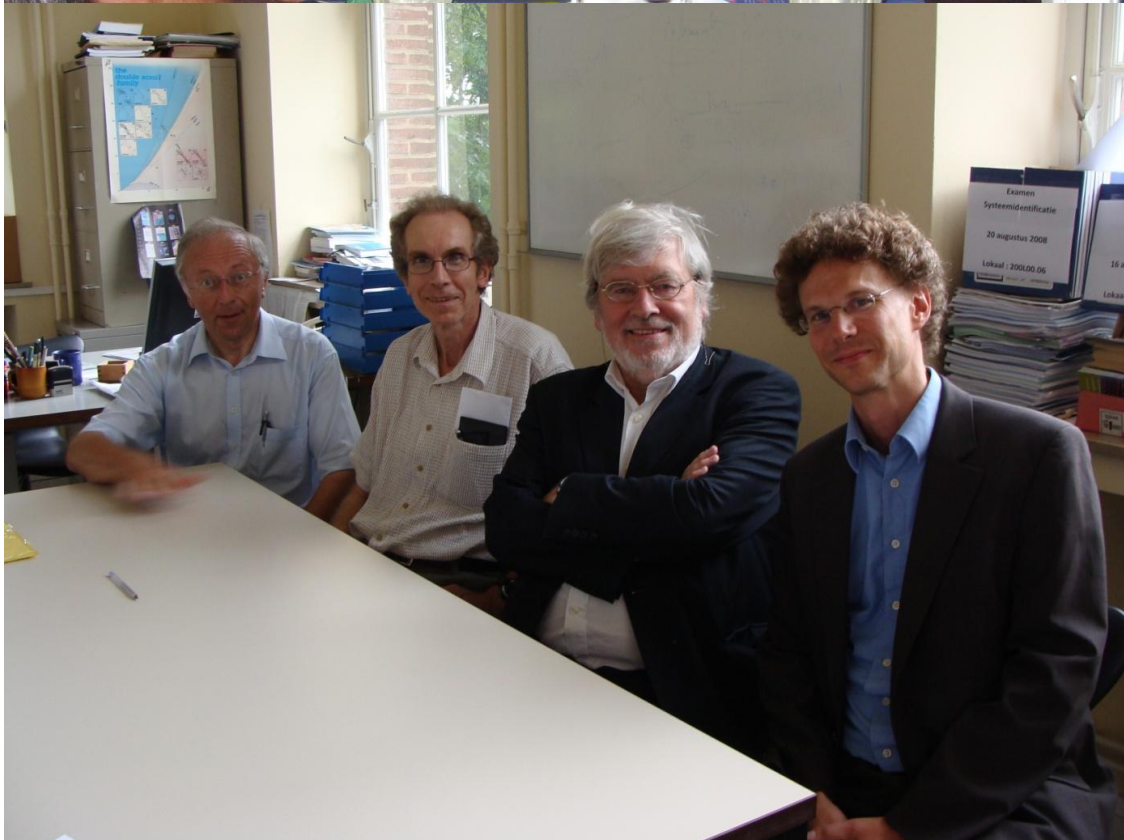
This "remarkable" reaction characterizes your personality, your way of life and dealing with science. Thank you for your warm friendship during many years at ESAT. I wish you all the best for the future and hope you will enjoy life from day to day with your lovely wife Doke.

My sincere congratulations with your 70<sup>th</sup> birthday!

My warmest regards,

Sabine Van Huffel

Pictures sent by J. Vandewalle



























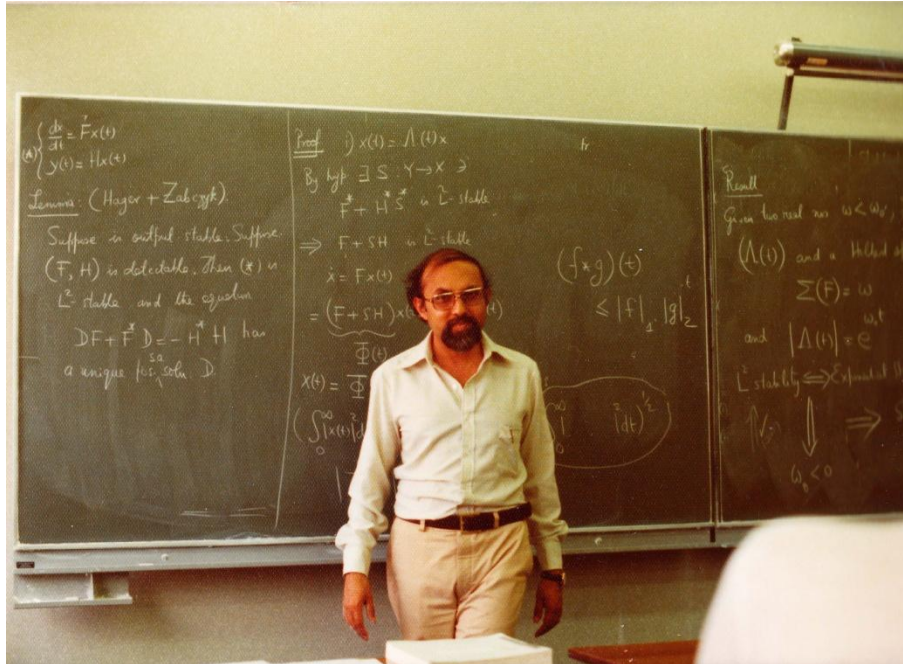








Pictures sent by A. van Swieten



## A Tribute to Jan Willems

Yutaka Yamamoto

### 1. First Encounter

My first encounter with Jan was at the famous conference held in a British Virgin island called Tortola. It was winter of 1977, more than 30 years ago; I was then a Ph. D. student of Rudolph Kalman at the University of Florida, about to finish my doctoral study. Rudolf proposed this idea of running a conference “on the boat” which appeared to be a superb idea, attracting many top control theorists and even some mathematicians (including Steve Smale and Morris Hirsh). I (and my fellow student Fumio Hamano also) was under the mission of bringing two sets of easels from the University of Florida to the site so that people can give a talk with pieces of white paper on these easels. This conference seemed to be fabulous one indeed, except somewhat unexpected sea sickness that some people had to suffer from. There are more to the story about the mysterious case of “missing easels,” but let’s not delve into details which are quite irrelevant here.

In any event, it was a very precious occasion for a young Ph. D. student to have an acquaintance with celebrated scholars. This is the first time I met Jan, and could listen to his talk.

I remember Jan’s talk to some extent. He spoke about almost invariant subspaces, I think. But the statement I still recall with definitive clarity was the following. “We often encounter a difficulty in solving our problem. However, it is naive to stop there. When we cannot solve the problem, we change the problem.” Frankly, I must confess that, while we have a freedom in modifying problems, this statement appeared to be a bit easy-going, to an inexperienced researcher as me at the time. I was dumb not to fully appreciate the correctness and importance that the message suggests. My stance at the time may have been still a bit inclined to a more mathematical interest.

This was my first encounter with Jan. So, he is one of the first, along with my advisor Rudolf Kalman, to give me a strong impression that it is imperative that one should give a “right” formulation of a problem<sup>6</sup>.

### 2. Years Later

Years later in 1983 he visited Japan as a JSPS fellow and also came to Kyoto. I had an occasion of discussing realization theory of infinite-dimensional systems, and we had a nice interaction of ideas about canonicity, reachability and observability. Jan found that my style of presentation inherited much of my mentour, Rudolf Kalman, and he appraised it positively.

Since then, he visited Japan several times; particularly, five times since 2003, once for 3 months as a visiting professor of Kyoto University, and again as a JSPS fellow for 40 days in Kyoto.

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<sup>6</sup> To be a little kinder to myself then, one may argue that I did understand the importance of this, but maybe failed to appreciate fully the true difficulty of choosing the right track between real world and its idealization via mathematics.

We have spent many days and hours discussing many different subjects. System theory, particularly behavioral theory, of course, but also other subjects, ranging from science, technology to philosophy, mathematics, arts, politics, religion, jokes, etc. Jan has this incredible talent of being able to tell nifty short stories and jokes with very touch of humor. And this extra touch of humor indeed penetrates through all discussions with him, and makes them so enjoyable and fruitful. Even when we discuss serious subjects, there is almost always a touch of humor and relaxation, which works as a magical catalyst that makes his opinion even more convincing.

Jan has greatly influenced me in my scientific taste and thinking. Rudolf Kalman, who was my Ph. D. advisor, naturally influenced me most in my early training as a researcher. However, Jan influenced me perhaps with the same degree in that we share various similar ways in thinking. Of all, we had established a more intimate relationship as to the extent of discussing many, sometimes personal, subjects. This is very different from my relationship with Rudolf where it still carries the shadow of a mentor-student relationship.

In the last 5 to 6 years, Jan visited Japan several times with Doke, and we have shared lots of fine memories together. Mamiko showed a good deal of Kyoto to Doke while Jan and I were busy discussing science. I pride myself in introducing part of Japanese culture to Jan and Doke, in guiding lots of interesting Japanese temples, gardens, shrines, Buddhist statues. Katsura and Shugakuin villas are superb examples of the height what the Japanese artistic tradition can accomplish. To my knowledge, there is no such style in any other countries that has succeeded in transcribing nature as a somewhat abstracted concept. The nature represented in these Japanese gardens is not a bare copy of nature itself. It is an artistic representation of nature. I was truly pleased and impressed to see how Jan could grasp the essence of such expressions of Japanese culture.

### **3 His Cancer and Recovery**

It was a great shock to hear that he had a serious case of cancer in his left kidney in February, 2009. After 6 months since then, at the time of my writing here, I am pleased to say that the whole picture is much brighter than it was 6 months ago.

I wish him good health and a high-quality life in many years to come.



2003



2005



2005



2005





2005



2005



2006



2007