

***A Note to IFAC, Control and Communication in Human-Machine Systems – Societal and Cybernetic Perspectives by Professor Gunnar Johannsen***

On June 27, 2019, I (IPC Chair of IFAC HMS2019) and Dr Sven Nömm (NOC Chair of IFAC HMS2019), Tallinn University of Technology, invited via email Prof Gunnar Johannsen, University of Kassel, Germany, to give a banquet talk during the *14th IFAC Symposium on Human-Machine Systems (HMS2019)* in Tallinn in September 2019.

On July 01, 2019, Prof Johannsen confirmed his acceptance of our invitation and agreed graciously to deliver a talk of a review nature entitled '*IFAC, Control and Communication in Human-Machine Systems – Societal and Cybernetic Perspectives*' during the HMS2019 banquet on Sep. 18, 2019. Prof Frederic Vanderhaegen (Vice Chair of IFAC TC 4.5 on Human-Machine Systems), University of Valenciennes, France, kindly agreed to moderate Prof Johannsen's talk which turned out to be a very inspiring, informative and popular speech for the participants of IFAC HMS2019.

Prof Johannsen is a pioneer in HMS research field (refer to his brief bio. at the end of this Newsletter). He served as the first Chairman of IFAC Working Group on Man-Machine Systems (under TC on Systems Engineering then) in 1981 and served HMS community on that role for the next 9 years.

Due to Gunnar's sustained outstanding contributions to HMS community, I think that his expository speech would interest researchers and practitioners from all over the world in HMS community who are curious to know better the historical evolution of HMS field from perspective of control systems. Suggested by Prof Tetsuo Sawaragi (Vice Chair of IFAC TC 4.5 on Human-Machine Systems), I decided to publish Gunnar's invited talk (with his agreement) in our TC Newsletter online, in order to disseminate among wider audiences his insightful views on this exciting and fast-growing cross-disciplinary scientific field.

Prof Jianhua Zhang

*Chair, IFAC TC4.5 on Human-Machine Systems*

*Oslo Metropolitan University*

*Norway*

Nov. 15, 2019

14th IFAC/IFIP/IFORS/IEA Symposium on  
Analysis, Design, and Evaluation of Human-Machine Systems  
Tallinn, Estonia, September 16-19, 2019

Banquet Keynote Talk on Wednesday September 18, 2019

## **IFAC, Control and Communication in Human-Machine Systems – Societal and Cybernetic Perspectives –**

Gunnar Johansen

Dear Ladies and Gentlemen

Many thanks to both of you, Jianhua Zhang and Sven Nömm, for your kind invitation to this speech.

It is a great honor for me to share some contemplations with all of you:  
on the role of the IFAC family and on our HMS (Human-Machine Systems) community with  
a few historical reminiscences,  
as well as briefly on the remarkable evolution of our field, on highlights and challenges, and  
on possible futures.

First, I will refer to examples within my own historical IFAC experience,  
illuminating some societal perspectives of our IFAC activities and relating two previous IFAC  
events to this wonderful city of Tallinn.

My 15 years of activities in official IFAC functions started in 1981.

On my way to the IFAC World Congress in Kyoto, I attended the very first IFAC event in  
China, the 3rd IFAC Workshop on Distributed Computer Control Systems in Beijing in  
August 1981 with only 78 participants, including 22 from China.

Manfred Thoma, Vice-President of IFAC at that time and main supporter of the event,

presented an introductory overview paper with the topics hardware, software, network structure, and man-machine communication.

The following IFAC World Congress 1981 in Kyoto under the excellent leadership of the IFAC President, Yoshikazu Sawaragi – Tetsuo Sawaragi's father, became the birth place of our HMS community, with our first HMS sessions. I presented a paper on "Human-Computer Interaction in Decentralized Control and Fault Management of Dynamic Systems".

The major success for our HMS community in Kyoto 1981 was the foundation of the Working Group on Man-Machine Systems, with strong support from Alexander Levis as the chairman of the umbrella TC on Systems Engineering. I became the first chairman of that Working Group, and served HMS within that function for the next nine years.

The first IFAC/IFIP/IFORS/IEA Conference on Analysis, Design and Evaluation of Man-Machine Systems was held in September 1982 in Baden-Baden, Germany. As IPC Chairman, I was happy to jointly cooperate with the Co-Chairman John Rijnsdorp who has been chairman of the Committee on Social Effects of Automation, now Social Impact of Automation.

The multidisciplinary nature of our HMS field was considered by the appropriate choice of the cosponsors for this conference, and later symposium series in the Masterplan of IFAC. In addition to the IFAC sister organizations IFIP and IFORS, I invited also IEA, the International Ergonomics Association in order to represent the human sciences more strongly.

Strangely enough, the name Man-Machine Systems could be changed into Human-Machine Systems only after 1998 – after I could finally convince surprisingly an English colleague that human is also a substantive – and that only with the help of the Oxford Dictionary.

In the beginning, several IFAC officials asked questions whether two different committees, namely Social Effects of Automation and Man-Machine Systems, were necessary.

It was easier to counteract these questions after our two IFAC groups had settled their own internal disputes.

This was reached by means of a Delphi study, chaired by Tom Sheridan from MIT, between the IFAC World Congresses 1984 and 1987.

The results of this Delphi study on "Humanization of Technology Vs Human Engineering" are included in the Proceedings of the World Congress 1987.

A pragmatic consensus has been pursued since then with the belief that we are stronger and more convincing with two complementary groups within IFAC which are supporting each other.

With great enthusiasm, I chaired four of our HMS conferences. The heaviest challenge was the conference in Xi'an, China in September 1989. Everything was well prepared and ran normally, until the great shock of June 4, 1989 in Beijing occurred. With my main international responsibility for this conference, I contacted the China department of the German Ministry of Foreign Affairs, as well as the then IFAC President, Boris Tamm in Tallinn. Boris Tamm cultivated a well-balanced diplomatic style. Because of the enormous amount of preparation already invested and for the sake of the international support of our Chinese colleagues, he decided that I should continue with all activities as long as the safety of the conference participants would be guaranteed. I maintained a high rate of information exchange with all involved, particularly all potential participants. Ultimately, it seemed certain that the conference could be held without disturbances.

I did not expect to be confronted with so many different reactions and with so much extra work. At the same time, I experienced an astonishing amount of double morality.

A Swedish colleague scolded me for not canceling the conference completely. In France, all scientists were banned from participating. In Germany, the same was partly due to the instructions of university presidents.

At the end, the conference took place with a quite small number of participants, about 10% of that of the first HMS conference of 1982. More than 50% of the participants were Chinese. The circumstances were so enormous that my Chinese colleague Baosheng Hu as the main organizer, my Dutch colleague and friend Henk Stassen and I had to completely reschedule the conference program on the evening before the conference. Only three plenary lectures and

21 regular lectures were presented, without parallel sessions. Finally a small, very collegial conference happened in a friendly atmosphere.

Following the idea of Henk Stassen, the location of our HMS symposia rotates since 1989 between Asia, Europe and America.

One of the highlights at the IFAC World Congress in Tallinn in August 1990, under the leadership of the IFAC President Boris Tamm, was the plenary talk of Ülo Jaaksoo, Co-Chairman of the IPC. About 2000 people gathered in a completely dark hall, just with a spotlight on Jaaksoo. It was a kind of "I have a dream" speech. He spoke quietly and full of empathy and hope. The audience was completely silent and fascinated. Later a colleague from Moscow answered in a harsh manner. He was one of the first who accepted a professorship in the United States immediately after the Soviet Union was dissolved.

All the reported societal facets indicate that there is more than only science and technology in our lives as scientists and technology practitioners. That is our luck and our responsibility.

Second and finally, I like to briefly mention a few aspects of science and technology achievements in our HMS discipline.

I present this under a cybernetic perspective.

Aleksandr Lerner wrote his book "Nachala Kibernetiki" of 1967 (English edition "Fundamentals of Cybernetics" of 1972) in order to make the ideas of Norbert Wiener more accessible to a broader audience – Wiener's ideas in "Cybernetics: or Control and Communication in the Animal and the Machine" of 1948 and 1961.

Lerner's book contains a 10-page Chapter 18 on "Man and Machine". The following citation from this chapter presents a still actual view on our HMS objectives:

"The functions of automatic equipment and of the people who participate in the control are so intertwined that it becomes impossible to correctly formulate, let alone solve, many control problems by limiting oneself to the technical aspects of the problem, and ignoring the psychological and physiological factors associated with the participation of man in the control process.

Therefore in cybernetics the scientific man-machine discipline has developed, which investigates the two basic problems:

- (1) symbiosis between man and machine;
- (2) distribution of functions between man and the automaton."

At the second of our IFAC HMS conferences in 1985, Tom Sheridan presented a plenary talk on "Forty-five Years of Man-Machine Systems: History and Trends" in which he introduced three 15-year eras.

I like to continue with succeeding eras in the same manner until today and into the future – also based on my overview plenary paper "25 Years of Human-Machine Systems in IFAC" at our 10th HMS symposium in 2007.

There is a seamless continuation between the different eras, not indicating a change between topics but a broadening and deepening of the HMS discipline with more and more additional topics.

Era A: Acuity, Anthropometry and Activity Analysis (1940-1955)  
human factors engineering; empirical studies

Era B: Borrowed Engineering Models (1955-1970)  
manual control; systems engineering and systems theory;  
use of control, communication, decision and signal detection theories

Era C: Computers and Cognition (1970-1985)  
supervisory control; cognitive engineering; artificial intelligence;  
human-computer interaction (largest session at our first HMS conference in 1982 – very important subarea of HMS besides being a main area in computer science);  
Ironies of Automation (1982/1983) – Lisanne Bainbridge  
– one of the most important papers ever (still actual)  
– example: deskilled people have to take over in case of incapable automation

Era D: Graphics, Multi-, Tele- and Aiding (1985-2000)  
graphics technology push; interaction design;  
multimodality (visual, auditory, haptic);

virtual reality; multi-user and team performance; telemanipulation;  
knowledge engineering; cognitive systems engineering;  
decision and knowledge support; human reliability;  
mental model and workload; usability engineering

Era E: Human-Centered Computing, Smart Interfaces, Enterprise Systems  
and Biomedical Engineering (2000-2015)

multi-agent systems; human-centered automation;  
human-robot collaborative control; model-based design;  
display and decision support; cultural issues;  
situation awareness; risk and safety; wearable computing;  
personalization of user interfaces; work organization in enterprises;  
resilience engineering

Era F: Neurocognitive Systems Engineering, Human-CyberPhysical Systems (H-CPS)  
and Embodied Interaction (2015-future)

goal-directed control; brain-machine interfaces; partly autonomous vehicles;  
symbiotic and cooperative automation; virtual and augmented reality

Just to select only one hot topic of today: H-CPS and here particularly autonomous driving.  
Even some of our HMS colleagues advocate completely autonomous car driving.  
However, human perception, cognition and intuition cannot be fully replaced by sensor fusion  
and artificial intelligence.

With any technical system, there is always somewhere a systems border and interface to the  
human. Thus, finally every complicated or complex technical system is a human-machine  
system. This concerns serious design but also legal aspects.

Should at the end designers and managers or even politicians be responsible in case of  
accidents ?

I don't want to see the possible horror scenarios with hundreds of cars stuck in immobile  
highway jams (or even gigantic accidents caused by mismatches in task allocation between  
human and machine).

To cite Lerner of 1967/1972 again:

" . . . man was, is and will always be the decisive link in a complicated chain of interaction between man and nature; he will always be in command of any system created by him and for him."

This humanistic view of 1967 has to be our guiding objective and principle value – also today and in the future.

It should be an important guideline for the whole Automatic Control community.

As researchers and practitioners of the HMS community, we sometimes still need to remind some of the pure technologists and theorists among our colleagues of this very basic truth.

The Ironies of Automation have always to be overcome with intelligent HMS solutions. And sometimes, we still have to fight for the freedom and ideas of our global commitment.

Good luck and much success with all your dedicated work.

Many thanks for your support and enthusiasm in our HMS field.

. . . . and many thanks for your kind attention.



## SHORT BIOGRAPHY and Awards

### Gunnar Johannsen

- 1940 born and raised in Hamburg, Germany (two twin sisters, father missing)
- 1960 studies of communication engineering, control theory, and information processing (later called Informatik, computer science) at the Technical University (TU) Berlin (1967 Dipl.-Ing.) as well as music in the Sound Engineering curriculum at the University College of Music Berlin (until the end of 1963)
- 1966 marriage with Gisela Johannsen, b. Hentze (two daughters)
- 1971 Doctorate (Dr.-Ing.) in Guidance and Control at the TU Berlin
- 1980 Habilitation, RWTH Aachen University, teaching area Human-Machine Systems of Aeronautics and Astronautics
- 1971 – 1982 Division Head at the Research Institute for Human Engineering, near Bonn
- 1982 – 2006 University Professor of Systems Engineering and Human-Machine Systems at the University of Kassel  
Supervision of 16 doctoral dissertations in Kassel  
and participation in many other doctoral committees as evaluator or examiner in Kassel, Braunschweig, Delft, Enschede, Valenciennes, Stockholm, and Johannesburg
- longer research stays in the USA (Urbana-Champaign, Illinois), Japan (Kyoto), Austria (Vienna), and Canada (Vancouver)
- 1981 – 1996 chairman of several committees of IFAC (International Federation of Automatic Control) and of four of its Human-Machine Systems Symposia in 1982, 1985, 1989, and 2001 as well as of the Integrated Systems Engineering conference in 1994 (proceedings editor of all of these except 1989)
- 1993 textbook "Mensch-Maschine-Systeme" (588 pp.) with Springer-Verlag, Berlin, Heidelberg  
several years part-time studies in orchestral conducting in Hamburg, Vienna and Kassel
- 2001 conception and direction of the International Workshop on "Human Supervision and Control in Engineering and Music" with integrated orchestral concert (see publications);  
there, conductor of Takemitsu's November Steps (for Biwa, Shakuhachi and Orchestra) with the Extended Youth Symphony Orchestra of the state of Hesse – Further conducting
- 2006 – today freelance scientific activities and consulting  
in human-machine-systems science, human-computer interaction, human-centered computing, human-centered automation and design, human-cyberphysical systems, cognitive systems engineering, visual and auditory displays, gestural control, knowledge engineering, evaluation methods, usability engineering, computer science applications (traffic informatics, computer graphics, artificial intelligence), cybernetics and musicology as well as literary activity
- 2009 cancer death of my wife Gisela Johannsen, b. Hentze
- 2011 marriage with Christa Janke-Johannsen, b. Boltz (5 children and 9 grandchildren in total)

## Awards

- 1995 Japanese-German Research Award  
of the Japan Society for the Promotion of Science (JSPS)
- 2001 Life Fellow of the IEEE (Institute of Electrical and Electronics Engineers), USA  
"for contributions to human-machine systems engineering, cognitive ergonomics, human-computer interface design, and human-centered automation"
- 2005 Honorary Doctorate (Dr. h.c. – Docteur Honoris Causa)  
from the Université de Valenciennes et du Hainaut-Cambrésis, France
- 2007 Nominee for the Bower Award and Prize for Achievement in Science  
on Human-Centered Computing, of The Franklin Institute in Philadelphia, USA  
"for achievements in human-centered computing, including human-machine systems analysis and design, human-centered information presentation, and cognitive systems engineering"
- 2016 Recipient of the Hal W. Hendrick Distinguished International Colleague Award  
of the Human Factors and Ergonomics Society (HFES), USA – Excerpt from the laudation :  
"Gunnar Johannsen has consistently been a leading figure in human-machine systems in Europe. He has made pioneering contributions to mathematical modeling of human behavior and performance in manual control tasks as well as supervisory control. Dr. Johannsen has been a tireless contributor to the international human-machine systems community. . . . .  
. . . . he is an outstanding example of a person who successfully bridges the disciplines of engineering and ergonomics, and is probably the most highly qualified person in Europe in high-technology human factors"
- Biography listed for years in Marquis Who's Who in the World (the Top 3%)
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## Gunnar Johannsen

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More extended Biography and List of Publications :

[www.gunnar-johannsen.de/johhome.html](http://www.gunnar-johannsen.de/johhome.html) (not completely up-to-date)

[en.wikipedia.org/wiki/Gunnar\\_Johannsen](http://en.wikipedia.org/wiki/Gunnar_Johannsen) (not very complete)

[www.EngineeringAndMusic.de](http://www.EngineeringAndMusic.de)

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