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1997 June

40th Anniversary

1957 – 1997

40 Years of IFAC

9 Presidents of IFAC: Y. Sawaragi, J.F. Coales, H. Chestnut (front row, left to right); B. Tamm, M. Thoma, T. Vamos, B.D.O. Anderson, Y.Z. Lu, S. Kahne (back row, left to right)

Anniversary Celebration in Conjunction with the IFAC Council- and Related Meetings and the IFAC Symposium on System Identification Fukuoka, Japan, 8 – 11 July, 1997

This year's Council- and Related Meeting in Fukuoka marks the 40th Anniversary of the International Federation of Automatic Control. 40 years ago, in September 1957 IFAC's constituent meeting was held in Paris.

To commemorate this event and to give an overview over the achievements, accomplishments and developments in the Federation over these past 40 years, but also to present an outlook into the future of the automatic control field, a Technical Session under the heading

"IFAC – Past, Present and Future"

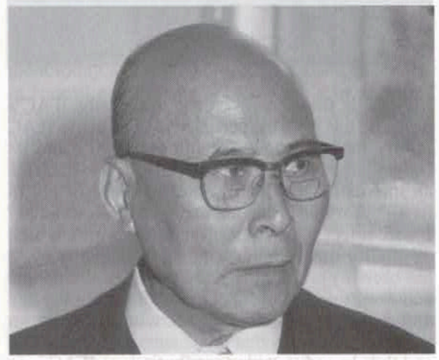
will be held in Fukuoka on Tuesday, 8 July 1997. We invite all of you to attend the IFAC Symposium and the Technical Session on IFAC. But if you are not in a position to come to Japan in person, we would like to use this issue of the Newsletter to give a summary of the lectures which will be held on that occasion.

The speakers at the Special Session are:

Prof. Y. Sawaragi	welcome address
Prof. S. Kahne	past of IFAC
Prof. Y.Z. Lu	present of IFAC
Prof. P. Albertos	future of IFAC
Prof. V. Kucera	theory
Prof. R. Isermann	applications
Prof. W. Schaufelberger	education
Prof. K. Furuta	control technology in Japan

Welcome to the 40th Anniversary Session

Yoshikazu Sawaragi*
Advisor



As a general chair of SYSID'97, we sincerely thank IFAC for organizing this special session in honour of the 40th anniversary of IFAC and for holding the Council Meeting in conjunction with SYSID'97. It is a great pleasure and honour for me to welcome you all at this special session on "IFAC-Past, Present and Future".

First of all, it is my sincere wish to celebrate the 40th anniversary of IFAC with all the participants as a member of the IFAC Family. It is most impressive for me to remember that I have attended each and every one of the IFAC Congresses including the Heidelberg Conference in 1956 and devoted myself to the development of IFAC with respect to research and management for 40 years.

Needless to say, the recent revolutionary development of computers and communication devices is bringing about a remarkable change in control theory and practice. The role of IFAC for the healthy development of human society, therefore, becomes increasingly important. Through the discussion of the activities of IFAC in Past, Present and Future, I hope that these valuable ideas will be beneficial for the future development of IFAC.

Taking advantage of this opportunity, I would like to mention a most important planning of our NMO Japan to establish the IFAC Japan Foundation; Professor Yong-Zai Lu, the President of IFAC is encouraging NMOs to establish such Foundations to support the activities of IFAC in all respects. The IFAC Japan Foundation is dedicated to improving communication of scientific results in the fields of IFAC, particularly in Asian Pacific Countries with NMOs. At present, the Japan IFAC Foundation is in its planning phase. I am a chairman of the preparatory committee and would like to do my best for the establishment of this foundation. I do hope that all participants will support us in this matter.

Finally I would like to extend my sincere gratitude to all the persons who have contributed with enormous efforts in the preparation of this meeting.
Thank you very much.

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IFAC's History is its People

Prof. Stephen Kahne*
Immediate Past President

My task in these few words is to describe IFAC's past. I do this from the perspective of an active IFAC family member since the middle 1960's and its Immediate Past President. How does one describe an international scientific professional society in its 40th year in a brief statement for its Newsletter? I will select a few people and activities which exemplify important aspects of IFAC's history. It has been my privilege to know each of those people and events personally - a possible result of my age and general good fortune. It would not be an exaggeration to say that IFAC was and is its people and thus knowing their contributions to IFAC is to know IFAC.

In the beginning there was Gerhart Ruppel. During World War II he was a leader of a German professional society on automatic control, the Vereinigung Deutscher Ingenieure (VDI) in Germany. His partner in the leadership of this group was Hermann Schmidt. This control group was one of very few at that time anywhere in the world. Control engineering publications were limited and during the war communicating in the open about any technology was unusual. At the end of the war, as industrial nations were rebuilt, there was renewed interest in many kinds of communication between countries. In July 1951 the first truly international conference on "Automatic and Manual Control" took place at the College of Aeronautics in Cranfield, UK. A second international conference on control was held in New York City in December 1953. The third one, in Heidelberg in 1956, was where IFAC was conceived. Rufus Oldenburger of the US used the occasion of this meeting to propose an international federation in the controls field. Attending this meeting in addition to Ruppel (FRG) were Victor Broida (France), Alex Letov (USSR), Pawel Novacki (Poland) and John Coales (UK), all of whom would become IFAC Presidents. These national leaders, plus several more, agreed to propose a suitable international federation in control. Broida and Oldenburger were particularly active. At a subsequent meeting in April 1957 each brought a proposed constitution for IFAC. Oldenburger's was simpler and less expensive to realise and was adopted by the group. The organisational meeting of IFAC occurred in September 1957 in Paris. There it was decided that an American (Harold Chestnut) would be the first President and the USSR would host the first Congress. Letov was elected First Vice-President and became President in 1959, starting a short lived cycle of leadership changes each two years. By 1961, the cycle was increased to three years to ensure that each President ended his term with an IFAC Congress in his home country.

Because of Cold War tensions, the Federal Republic of Germany did not join IFAC until 1971. In the meantime, to ensure West German involvement, even without being a member, Ruppel served as the Honorary Secretary of IFAC and Frau Lieselotte Schröder, a senior staff assistant of Ruppel's managed the actual secretarial functions. This team served until 1975 and started the important IFAC tradition of a stable, long term Secretariat.

The second figure whose contributions I would like to highlight is John Coales, participant in the formative meetings in the 1950's. John had been active in the UK during the War in radar development and was later a Professor at Cambridge. He was IFAC's fourth President and led the IFAC Congress in London in 1966. He is most closely associated with IFAC's publications program, an involvement which has spanned the active history of the Federation. It was John Coales' friendship with Robert Maxwell, Chairman of Pergamon Press which led, in 1976, to a unique publications agreement between Pergamon and IFAC, an agreement which, in a slightly modified form, now exists between IFAC and Elsevier Publications, the successor of Pergamon Press. This publications arrangement has provided IFAC authors with an important vehicle for publication of papers appearing at IFAC conferences, has relieved IFAC conference organisers of much of the publications burden of organising an IFAC meeting and has provided IFAC with a significant revenue stream for more than twenty years.

Following initiation of the IFAC-Pergamon program in 1976, John Coales continued his active leadership of the enterprise until the early 1990's at an age where most people have retired from all professional activities. John Coales' third major contribution to IFAC, after the Presidency and publications, was the creation of a new Constitution for IFAC in the early 1980's in response to a greatly expanded scope of activity by the Federation. A constitutional task force led by Coales and including Janos Gertler and me completely revised the IFAC Constitution to reflect the continued growth in importance of technical activities of IFAC including documentation of these activities through the publications program. One of the keys to the IFAC organisation is the essential role played by IFAC's National Member Organisations (NMO). From the moment of its birth, IFAC members have been NMOs - not individuals. This affected the earliest developments since several major potential IFAC countries did not have suitable NMOs - in particular, the USA and UK. After AACC and UKAC were formed to provide NMOs for IFAC, this model was periodically debated. The NMO concept has held up under rigorous scrutiny and, although discussed from time to time, even today, continues to be the well accepted basis for the Federation.

Still another IFAC luminary with a crucial role in IFAC was Fred Margulies, a long time IFAC supporter. After 1975, Ruppel decided that it was time to resign from the Secretary position. Replacing Ruppel and Schröder was harder than at first imagined. After interim arrangements were made with a consulting firm in Helsinki, home of IFAC's 8th President Uolevi Luoto (1975 - 78), Fred Margulies worked out a very important arrangement with the Austrian government to provide substantial secretariat facilities in the village of Laxenburg just south of Vienna. With the employment of Barbara Aumann in 1978, the second permanent home of the IFAC Secretariat was created. We are reminded of the stability of the IFAC Secretariat when we recall that 1997 is the 40th year of IFAC, and 1998 is the 20th year of the Laxenburg Secretariat. Following the retirement of Fred Margulies as IFAC Secretary in 1984, Gusztav Hencsey from Budapest has been the IFAC Secretary working out of the Laxenburg office supported by Barbara Aumann and Ernestine Rudas.

So, these are glimpses of IFAC's history with a focus on three of its leaders. There are so many others who could have been described as examples: Victor Broida, the French civil servant whose initial enthusiasm for IFAC was a real driver for its creation; Pawel Nowacki, IFAC's 5th President and leader of Polish R&D in control and a multi-lingual scientist/scholar whose care and diplomatic skills were important in keeping East/West politics from affecting the early years of IFAC's history; Bill Miller, the General Electric steel working control engineer who represented the American NMO on the IFAC Council or in technical leadership roles for more than 20 years; Yoshikazu Sawaragi, IFAC's 9th President, Japan's leading facilitator of Japanese co-operation between industries and academic programs in control. There are tens of others whose contributions could also be used to provide some insights to the history of IFAC. I apologise to those not mentioned in this note. Some of them appear in the articles accompanying this one in this Newsletter.

The success of IFAC over these 40 years is most importantly due to people such as those mentioned above. It is also due to tradition and practices developed by IFAC leaders during this period. No one deserves all the credit but all have contributed. I trust that when IFAC reaches its 50th and 75th years the list of contributors will be even longer and the accomplishments even more noteworthy.

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The Position and Challenge of IFAC

Yong-Zai Lu*
President

Historically IFAC as an international professional society has made remarkable progress in the course of the last four decades. The foundation of IFAC's success was laid by the IFAC Constitution, its continued achievements by the common efforts and contributions of many distinguished control experts from many NMO countries generation after generation. To promote control technology and provide better services to our NMOs and control engineers, IFAC has made a series of strategic movements in the Technical Board structure, publications, finance and membership aspects in the past few years.

The new structure of the Technical Board has now been in operation for the second triennium. It is functioning very well. We now have 47 Technical Committees organised under 9 Coordinating Committees. A complete list of outlooks of all TCs has been prepared. This results in providing us with a clear picture of IFAC technical activities. To maximise our services to global control engineers, we will continue to make our technical activities and TC structure more dynamic and multidisciplinary.

The current TB and TC structures cover wide areas and disciplines from control theories, methodologies to applications. A number of emerging fields, such as neural networks, fuzzy logic and rule based AI techniques are also included in the relevant TCs. Because of the overlap among the TCs, the joint sponsorship for IFAC events is highly demanding in order to make our academic activities multidisciplinary. On the other hand, the co-sponsorship with other societies is also very beneficial to IFAC. Technically, we need to investigate more emerging and interdisciplinary areas, for example

- The applications of control concept and methodology in enterprise reengineering and business systems;
- Applications of data mining and knowledge discovery in the design of control systems;
- Applications of control technology in data communication and computer networking systems;
- Exploring the challenges and potential applications of internet and intranet technologies for automatic control.

A new five year Contract with Elsevier Science Ltd. has been signed by the IFAC Treasurer and myself in March, 1997. The contract gives IFAC a guaranteed income from the Proceedings, Automatica and CEP, and is one of the financial pillars of our Federation. Considering the uncertain publication environment we see today, this kind of contract makes our financial status more stable. Great efforts have been made to further develop the IFAC Affiliated Journals. Now we have six Affiliated Journals. Publications in general are one of IFAC's most important businesses and services. The investigation of new opportunities and challenges, such as electronic publications and electronic conferences in IFAC activities will be highly demanding in the future.

IFAC's financial status in general is in good shape. Our financial goal is to meet the objective of having three times of the budget in reserve. Our major income is from NMOs' fees and publications. However, due to the uncertainty of future publication incomes, it will be challenging to maintain IFAC's financial health in the coming century.

The Articles of the IFAC Foundation have now been available to all NMOs and I am pleased to tell you that so far we have received Articles of the local Chapters from the NMOs of China, P.R. and Romania. To my knowledge the US NMO and the Japanese NMO are in the process of setting up IFAC Foundations as well. Besides, the Cuénod Fund is also going well. While the IFAC Foundation is established, the Cuénod Fund will be placed under the IFAC Foundation's category.

The IFAC Affiliate Program has increased IFAC's strength even more by providing NMOs and organizers of IFAC events with data concerning the interest profiles of IFAC Newsletter readers. By making a Newsletter survey every three years, IFAC can be sure to reach those persons interested in automatic control and its specific areas.

I am delighted to note that the number of 'no-show' authors has been significantly reduced, particularly for the San Francisco Congress. The U.S. NMO and NOC made excellent contributions to support students and authors from developing countries. I hope while we establish more local chapters of the IFAC Foundation, the 'no-show' author problem will be further lessened. We will continue to support the control engineers of developing countries to help them join IFAC events.

The positions of the concept, principle, theory and technology of automatic control in human life and society will be significantly enlarging while we are entering the next century. The strategic goal of IFAC is to promote control technology and its applications through various IFAC activities and services.

The last IFAC World Congress of this century will be held from July 5-9, 1999, in Beijing, China. We are warmly welcoming world-wide control experts to Beijing for the IFAC '99 Congress.

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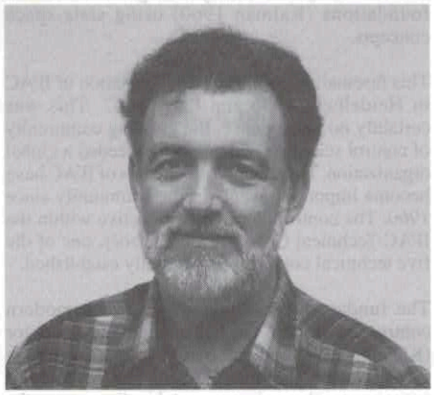
Some Thoughts About the Future of IFAC

Pedro Albertos*
President Elect



After looking at the past and the present of IFAC, as the world-wide federation involved in Control Theory, Engineering and Applications, it is indicated to say something about the future. But we all know that the future is difficult to predict as we are mainly dealing with a field which is in continuous development, with an association which is growing, in a scenario which is strongly influencing any activity through links to many other fields, and in a quickly evolving society where the uses and values change with the time.
Let us try to be predictive with respect to the subjects mentioned above

1) About the field.

- Linear systems theory and control are well developed but ... they are so fascinating that a lot of effort will be devoted to it also in the future, and new results will surely make the clarity and understandability of the resulting controllers even more fascinating. The extensive use of computers in the control loop will require a sound analysis of sampling process signals with a more flexible pattern.

- Something similar is going on with particular classes of nonlinear systems and their control. But, the extensive use of AI-based techniques, like artificial neural networks, fuzzy logic controllers and neuro-fuzzy controllers, will result in control schemes more applicable in industrial environments, losing some of the rigidity generally imposed in nonlinear controllers by their dependency on the process model.
- New directions of control engineering developments will involve the consideration of the control and the process as a whole, with a number of issues:

  - To focus on the study of global system properties more than on the local ones;
  - To improve the controlled system operation in the full range of conditions, involving adaptation, supervision, and learning;
  - To integrate different control design methodologies and provide general control solutions.
- The availability of new technologies for the implementation of the control components, like mechatronics, optics, integrated circuits, to mention some of them, will allow the development of new and more powerful control strategies for a variety of fields, from micro-biosystems to aerospace.

2) About IFAC.

- IFAC is proud of the meetings organised under its sponsorship. They provide high quality forums for discussions, exchanges of opinion, meetings, convergence of ideas about the different topics in Automatic Control. And this should be an activity to pursue, with the appropriate actions to keep and improve their interest and quality.
- One of the objectives of IFAC is to allow a world-wide cooperation in this field. Everybody interested in these topics should be able to participate, at his/her level of competence, within IFAC. Some imaginative actions should be considered to avoid any obstacles for this global interaction.

- IFAC, as a body, is not static and has learned about system dynamics. Recently, some steps to change its structure have been taken on the technical side. In the transient period, information is collected about the suitability of these changes and minor corrections can lead to a stable and more flexible technical organisation. It is probably the time to think about other structural features, such as membership, finance or communication links.

- New fields of interest, as previously mentioned, are becoming relevant and IFAC should be aware of promoting activities in these fields, creating appropriate technical groups and sponsoring related meetings.

3) About the scenario

- We are living in the Age of Information. Communication facilities, the breakdown of artificial barriers, and feverish activity in many fields of science and technology offer to the interested people a huge amount of data. But we know that data in themselves may be meaningless without some kind of data validation, filtering and synthesis. This is necessary to get valid information.
- Lots of (meaningless) electronic mails, unreviewed papers, misleading information reach our PCs or our working places. There is a role for federations such as IFAC to provide the channels to gain access to validated information through well recognised journals (on electronic or hardware support), high class meetings, or reputed reports.
- Every system, in almost every operating condition requires increasingly higher performance levels, which leads to new fields of control applications.
- New issues should be considered in the implementation of the control, in an integrated way, interacting with the process designer.

4) About the society

- The wide and constant participation of qualified people from everywhere gives IFAC a privileged position to:
  - Propose standards. A lot of new results appear almost every year and IFAC, as a leading society in the automatic control field, has the faculty to contrast what is really important, avoiding the noise and uncertainty in these results.
  - Spread control milestone developments through the IFAC journals, publications and reports.
  - Make easy the fruitful exchange of ideas, sponsoring more than thirty world-wide meetings per year and a Master-meeting, the IFAC World Congress, once every three years.
  - Try to build a bridge between theory and applications, a wish more than a strong reality in this technologically leading field.
  - Improve the education tools and resources, thus promoting the technology transfer among researchers, teachers, developers and users from different countries and societies.
  - With a wider perspective, science and technology borders are becoming fuzzier and there is a tendency to a global integration of all (many) of the issues. Automatic control, a classical horizontal field, plays a relevant role in this new approach.

IFAC will follow the tale of the past 40 years, with new energy, new tools, and new ideas, but with the old friendly spirit, providing an open framework for everybody interested in Automatic Control.

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Control Theory and Forty Years of IFAC: A Personal View

Vladimir Kučera*
Vice-President

Control theory is a key ingredient in the progress of engineering and, in fact, of industrialised societies. Since its founding, IFAC has paid due attention to the developments of control theory. Now, when IFAC celebrates its 40th anniversary, it is tempting to review these fascinating developments as well as the role of IFAC.

Automatic control systems were first developed over two thousand years ago. The first feedback control device is thought to be the ancient water clock of Ktesibos in Alexandria, Egypt. Milestones among automatic control devices include the temperature regulator of a furnace (Drebbel 1620) and the centrifugal flyball governor (Watt 1785) used for regulating the speed of steam engines.

Most control systems of that time were based on devices that appeared during the industrial revolution and the governor mechanism was an integral part of these devices. Conditions for their stable operation were the main issue. Maxwell (1868) used differential equations to study the dynamics of control systems. Stability conditions were obtained by Routh (1874) and Hurwitz (1895). This demonstrated the importance of mathematical models and signaled the beginning of control theory.

The variety of control systems became extensive and feedback controllers were designed as separate or multi-purpose devices. Minorsky (1922) formulated the three term or PID control law. The major step in implementing these laws was the invention of electronic (Black 1927) and pneumatic (Mason 1928) negative feedback amplifiers. Field adjustable PID controllers became available (Ziegler-Nichols 1942) soon thereafter.

The aiming of anti-aircraft guns was at the advent of the theory of servomechanisms (James-Nichols-Phillips 1947) and in fact of the "systems" approach to the design of complex control systems. The importance of communication in control systems was emphasized by Wiener (1949) by drawing analogies to living organisms.

The design methodologies of the classical era were for linear single input, single output systems and were based on the frequency response techniques or the Laplace transform solution of the differential equations. The advent of computers and need to control ballistic objects for which physical models could be constructed led to the state-space approach, which replaces the general differential equation by a system of first order differential equations.

The stage was set for a tremendous development of systems and control theory, known as the modern control period. The emphasis was on the mathematical formulation of the control objective. The maximum principle (Pontryagin 1956) and the dynamic programming (Bellman 1957) laid the foundations of optimal control theory. Accordingly, the control system theory was given axiomatic foundations (Kalman 1960) using state-space concepts.

This fascinating period saw the formation of IFAC in Heidelberg 1956 and Paris 1957. This was certainly no coincidence: the growing community of control scientists and engineers needed a global organization. The triennial congresses of IFAC have become important events of the community since 1960. The control theorists were active within the IFAC Technical Committee on Theory, one of the five technical committees originally established.

The fundamental achievements of the modern control era include the linear quadratic regulator (Kalman 1959) and the optimal state estimation given noisy observations (Kalman 1960). The state-space approach was instrumental in discovering the role of Riccati equations and Kalman (1960) showed that a deep and exact duality existed between these two problems. A culmination of these efforts was the LQG problem, which is an optimal state-estimate feedback control. The linear-quadratic synthesis has found wide application, especially for multivariable systems.

A geometrical approach to state-space analysis and design was developed by Basile and Marro (1969) and Wonham (1970). By using the abstract geometric concepts of linear spaces, a compact and coordinate-free formulation was obtained for many problems of interest. These include model matching, disturbance rejection, reference tracking, decoupling, and pole placement. The geometrical formulation proved to be a vehicle for extending the concepts of linear systems theory to nonlinear systems (Brockett 1983, Isidori 1989), with manifolds replacing linear spaces. Modern non-linear control is no longer about particular problems but it is applicable to important classes of systems.

The success of state-space approach renewed the interest in input-output or transfer-function methods (Rosenbrock 1970). The key tool for the study of linear multivariable systems proved to be the concept of matrix-fraction-description (Wolovich 1974). These achievements paved the way to the parametrization of all stabilizing controllers for a given system (Kučera 1975, Youla 1976). This seminal result launched a new line of research in feedback system design. Optimal control problems were formulated as norm-minimization problems in Hardy spaces of transfer functions (Zames 1981). The underlying abstract-algebraic ideas facilitated extensions to more general classes of systems (Vidyasagar 1986).

A dramatic observation (Doyle 1978) that the separation property of state feedback is lost for perturbed systems renewed the interest in robust control design. Most attention was given to the problem of robust stabilization. The case of norm-bounded uncertainty was reduced to a norm-minimization problem (Kimura 1984). Robust stabilization under parametric uncertainty was made tractable using the appealing result of Kharitonov (1978) on the stability of interval polynomial families. The design for robust performance integrates the classical and modern approaches (Anderson-Moore 1990) and remains the subject of intensive research.

The absence of accurate and simple models on the one hand and the presence of large disturbances and variations on the other hand are typical in some industries, especially in process control. This has given rise to adaptive control systems. Various mechanisms are used for parameter adjustment: model reference control (Whitaker 1958), self tuning control (Kalman 1958, Peterka 1970, Aström 1973), gain scheduling (Shamma-Athans 1990), and backstepping (Kokotovic 1991). This is an active research area with many applications.

The increasing availability of vast computing power at low cost, and the advances in computer science and engineering, are influencing developments in control. Recursive algorithmic solution of control problems is possible as opposed to the search for closed-form solutions. Control systems can be seen as decision-making systems. This leads to interdisciplinary research and cross-fertilization. Emerging control areas include hybrid control systems (systems with continuous dynamics controlled by sequential machines), fuzzy logic control, parallel processing, neural networks and learning. On the other hand, control systems theory benefits other areas, such as signal processing, communications, numerical analysis, transport, and economics.

IFAC was born with modern control theory. The control problems which were important at that time included the launching, manoeuvring, guidance, and tracking of missiles and space vehicles. Now, forty years later, the challenges include better understanding and controlling manufacturing processes, with an eye on safety and the environment. Control education should provide a broad view of automatic control. Application areas are increasingly more diverse. Accordingly, the original technical committee on theory has evolved into several specialized technical committees in order to promote any and all aspects of contemporary control theory. IFAC involves the best control theorists and continues to be on the cutting edge of progress in our fascinating field. The interaction with control engineers remains essential; this is the key role of IFAC today.

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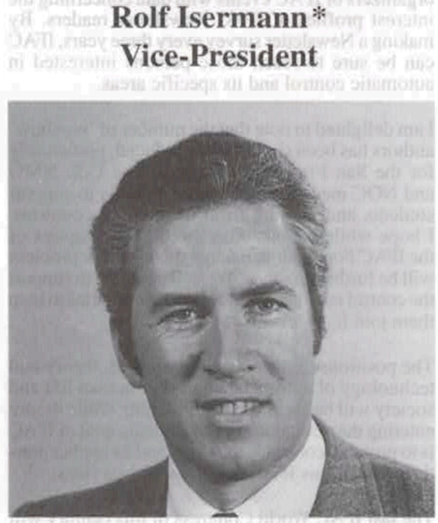
From Analog to Intelligent Control 40 Years Control Applications in IFAC

Rolf Isermann*
Vice-President



One of the goals of the conference on Regelungstechnik in Heidelberg 1956, organised by VDI and VDE was to bring theory and applications together. At that time, and also at the 1st IFAC-Congress in Moscow 1960, the majority of applications-oriented contributions considered controllers with valve and magnetic amplifiers, pneumatic and electrohydraulic amplifiers and corresponding actuators. The tools for the theoretical understanding of control systems were mainly the frequency response, describing functions, correlation functions and analog computer simulations. New control principles were proposed or investigated like special dead-time controllers, dither signals for friction compensation, sampled-data control and state control. Many of the theory-oriented papers considered practical control problems.

With regard to the application in real processes the time period from 1960 to 1970 can be characterised by the use of transistor amplifiers, binary machine tool sequence control with transistor logic devices, use of digital computers for simulation and first process computers for direct digital control. Beside the triennial World Congresses IFAC organised the following application oriented symposia for the first time: Digital Computer Applications to Process Control (Stockholm, 1964), Micro-miniaturisation (Munich, 1965), Systems Engineering (Tokyo, 1965), Automatic Control in Space (Vienna, 1965), Identification (Prague, 1967), Fluidics (London, 1968), Multivariable Control (Düsseldorf, 1968), Automatic Control in Basic Industries (Sydney, 1969) and in Biological Systems (Yerevan, 1969), Programming Languages for Machine Tools (1969).

The advent of the microprocessor in 1971 then opened the era for a broad development of digital control. First stand-alone digital controllers and sequence controllers appeared 1973 and decentralised programmable digital automation systems became standard for process automation. Around 1980 the first self-tuning controllers were offered on the market, merging identification and parameter estimation algorithms with digital control algorithms. Major contributions for this development were published during the IFAC-Symposia on Identification in Prague 1967, 1970 and The Hague 1973. Between 1970 and 1980 many new digital control methods were proposed and applied like internal model control, predictive control, sliding mode control, and fuzzy control. Examples of IFAC-Symposia which witnessed this important development for automatic control are: Digital Simulation (Györ, 1971), Interfaces with Process Computers (Lafayette, 1971), Stochastic Control (Budapest, 1974), Power Electronics (Düsseldorf, 1974) and Software for Computer Control (Tallinn, 1976). Several Symposia were dedicated to special application areas, like Traffic Control (Versailles, 1970), Mining, Mineral and Metal Processing (Sydney, 1973), Ship Operation (Oslo, 1973), Agriculture (Saskatoon, 1975), Offshore Oil Fields (Bergen, 1976), Manufacturing (Tokyo, 1977) and El. Power systems (Melbourne, 1978).

The time-span from 1980-1990 shows further development of distributed digital control, the solution of real-time computing problems and the expansion into higher levels of automation like optimisation, scheduling and general management as well for continuous as for discrete event processes. This broadened development of automatic control is reflected in the following IFAC-Symposia and Workshops organised by IFAC the first time: Large Scale Systems (Toulouse, 1980), Distributed Computer Control (St. Adele, 1980), Real-Time Programming (Graz, 1980), Safety of Computer Control (West-Lafayette, 1982), Man-Machine-Systems (Baden-Baden, 1982), Fuzzy Information (Marseille, 1983), Artificial Intelligence (Leningrad, 1983), Components for Low Cost Automation (Valencia, 1986), Reliability, Availability, Maintainability (Bruges, 1988). New application areas turned out to be Rubber, Plastics (Ghent, 1980), Biotechnical Processes (Helsinki, 1982), Industrial Robots (Madrid, 1982), Transportation Systems (Baden-Baden, 1983), Petroleum Industries (Kuwait, 1985), Aquaculture (Trondheim, 1986), Fault Detection and Safety in Chemical Plants (Kyoto, 1986).

Around 1990 the components become smart by embedded microcomputers and new sensor and actuation principles including micro-mechanical devices. The role of artificial intelligence for control increases with abilities for decision-making, learning and merging of quantitative and qualitative based methods, resulting in autonomous or intelligent control systems. Fly-by-wire and drive-by-wire systems with high reliability are further milestones in control technology. The control systems are more and more integrated with the processes, e.g. demonstrated in the development of mechatronic systems. First IFAC Symposia and Workshops along this line are for example Artificial Intelligence in Real Time Control (Swansea, 1988), Fault Detection, Supervision and Safety (Baden-Baden, 1991), Discrete Event Systems (Shenyang, 1991), Intelligent Components (Malaga, 1992), Motion Control (Perugia, 1992), Computer Aided Manufacturing (Helsinki, 1992), Intelligent Autonomous Vehicles (Southampton, 1993) and Automotive Control (Ascona, 1995).

For the development and application of these automatic control methods in all technical areas like process industries, manufacturing, mechanical and electrical engineering, transportation systems and vehicles, aero-space systems, components and instruments, biomedical systems, the continuous and focused international exchange of knowledge and cross fertilisation is very important. It is one of IFAC's goals to support these developments by its workshops, symposia, congresses and its publications and to do this also in the future.

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Control Engineering Education and 40 Years of IFAC

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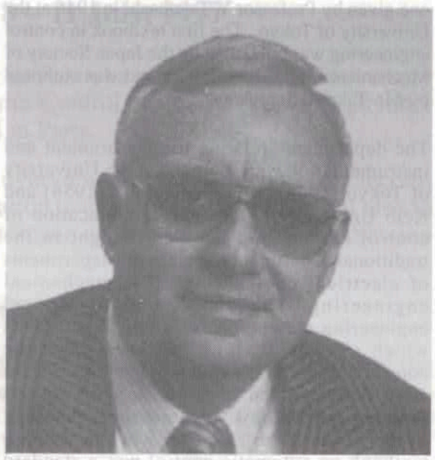
Treasurer



Control is one of the traditional fields in almost every engineering degree education. In some universities there are special degrees in control engineering, in others there are not. Control has developed from beginnings in what is now called classical control (frequency domain techniques, Bode, Nyquist, Root Loci) through modern control (state variable feedback, observers, filters, optimal control) to sequencing, nonlinear, adaptive, robust, learning and intelligent control. Every engineer graduating today is expected to have a solid foundation in at least classical and modern control.

As organisation, IFAC has from its beginnings shown an interest in research, applications and also to a smaller extent in education in control engineering. Only a brief summary of the history and the current state of education in control can be given here, for more details see a recent report in the IFAC Journal Automatica [1]. Much of the material that forms the core education in control engineering today was either already available in textbook form when IFAC was founded (classical control) or introduced shortly afterwards (modern control, optimisation, sampled data systems). A list of more than 50 textbooks that appeared from 1940 to 1955 is contained in a paper by St. Bennett in [2], where several other interesting papers on the history of control may also be found. A list of almost 100 recent textbooks is included as appendix in [1].

Education at universities is driven by research. Therefore almost all new developments are introduced into the teaching process at advanced undergraduate or graduate level. As time is limited in the curriculum for an introduction to control engineering, it is interesting to see, how the basic content has changed over the years. There is a general agreement today about the content of a basic education in control engineering [1], consisting of an introduction to the concepts of dynamic systems, stability, optimality, feedback and dynamic compensation. Transfer function and state space methods should be introduced as well as continuous and discrete time techniques. The treatment is mainly linear and time-invariant, only very brief introductions to more advanced methods are given in this basic education. Over many years this fundamental content has changed very little, new views including a more precise definition of control under uncertainty (robust performance) are only now making their way into introductory textbooks. Whereas the content has remained fairly static, the widespread availability of computers and the corresponding software (i. e. Matlab/Simulink) have changed both the exercises and laboratory assignments considerably. Much more realistic examples can be handled in computer based exercises and many advanced experiments have been introduced in laboratory sessions. Complete assignments where students go through the entire design cycle of modelling, identification, controller design, implementation and testing can be handled in a time frame of a few hours with appropriate CACE and real time implementation tools.

In which ways is IFAC contributing to this development? Most of the activities in education within IFAC are co-ordinated by the former Education Committee (EDCOM), now Technical Committee on Control Education with leading roles by its chairmen, which since 1972 have been: V. V. Petrov, P. M. Larsen, W. Schaufelberger, D. P. Atherton, M. J. Rabins, K. H. Fasol. EDCOM is responsible for sessions on education in many IFAC events, especially at the World Congresses. EDCOM has also been instrumental in setting up the successful series of conferences in Advances in Control Education (ACE) in Swansea, UK (D. Atherton, 1988, TRICMED), Boston, USA (M. J. Rabins 1991), Tokyo, J. (G. Ichikawa, 1994), Istanbul, T. (A. T. Dinibütün, 1997). The proceedings of these events provide much valuable information on almost all questions concerning control education, i. e. curriculum, courses, exercises, laboratory assignments, projects etc. A well established and long standing relation exists with the activities for developing countries within IFAC, where many joint events and special courses have been organised.

Much of the discussion on the future development of engineering education in general is going on in the corresponding societies such as the American Society for Engineering Education ASEE and the European Society for Engineering Education SEFI. It is important for IFAC to keep an active EDCOM for the discussion on the development of education in control engineering based on first hand knowledge of the advances in the field. Universities will have to reconsider their role in undergraduate, graduate and continuing education in the near future and the EDCOM of IFAC must play an important role in this ongoing discussion in the area of control systems engineering education.

[1] Kheir N. A., Aström K. J., Auslander D., Cheok K. C., Franklin G. F., Masten M., Rabins M.: Control Systems Engineering Education, Automatica, Vol. 32, No. 2, pp. 147-166, 1966.

[2] IEEE Control Systems, Special Issue on the Evolving History of Control, Vol. 16, No. 3, June 1996.

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Development of Control Technology in Japan

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Council Member

Introduction

Japan has been a member of IFAC since its foundation and hosted many IFAC events. In 1981 the 8th Triennial World Congress was held in Kyoto with Prof. Yoshikazu Sawaragi as the President.

Japanese industries have used control technology not only for the factory and process automation but also in its products such as automobiles and electronic appliances. This has been achieved based on its long history of academic societies in control and control education at the universities.

This presentation will introduce these historical development and Japanese academic structures and the position of the IFAC NMO Japan and typical research projects relating to control engineering.

History

The systematic study of automatic control started at the end of the Second World War. After the war, Professor Kankuro Kaneshige of The University of Tokyo organized the Society of Automatic Control in 1947 with Professor Yasundo Takahashi, which started to publish its journal in 1954.

Lateron many societies relating to automatic control started their activities in Japan. The Japan Association of Automatic Control Engineers (JAACE) was founded in Kyoto, which became the Institute of Systems, Control and Information Engineers (ISCIE). In the Kyushu and Nagoya area, societies of automatic control were also founded.

In 1957, after the preparatory meeting of IFAC, The Committee of Automatic Control was established in the Science Council of Japan by the efforts of Prof. K. Kaneshige and has played the role of the IFAC NMO Japan. The first Japanese Joint Automatic Control Conference was organized in 1958.

In 1960, the first IFAC Congress was held and 18 papers presented from Japan.

In September 1961 the Society of Instrument and Control Engineers (SICE) was founded by the merger of The Society of Measurement and Instrumentation, The Society of Automatic Control and research groups in various areas in Japan. SICE has now about 10,000 members. 60% are from industries. JAACE has continued its activities.

In addition to these two societies, many other traditional societies have had research activities in control science and technology, such as
The Japan Society of Precision Engineering
The Society of Chemical Engineers, Japan
The Institute of Electrical Engineers of Japan
The Institute of Electronics, Information and Communication Engineers
Japan Society of Mechanical Engineers
Japanese Society of High Technology in Agriculture
The Remote Sensing Society of Japan
The Robotics Society of Japan

The representatives of these societies are the members of the IFAC NMO Japan. For the Japanese NMO, the IFAC membership fee presented a problem and in 1969, Professor Y. Sawaragi, Chair of The Committee, succeeded in obtaining government support. Since then the membership fee has been paid from the government budget. This was an unusual form of support for the academic societies by the government.

Education of Control Engineering

The first lecture on automatic control might be the one given by Professor Y. Takahashi in 1946 at the University of Tokyo. The first textbook in control engineering was published by the Japan Society of Mechanical Engineers in 1948, and was authored by Mr. Takeshi Samukawa.

The departments relating to measurement and instrumentation were founded at the University of Tokyo (1945), Kobe University (1958) and Keio University (1954) and the education of control engineering has been taught in the traditional departments, such as the departments of electrical engineering or of mechanical engineering. The department of control engineering may be one of a few departments which aims at teaching engineers from the control science and engineering viewpoint. In 1959, the department of control engineering was founded at the Tokyo Institute of Technology by the efforts of Professor Keisuke Izawa whose textbook on automatic control was a standard textbook in Japan for a long time. Osaka University (1962) and the Kyusyu Institute of Technology (1960) lateron founded the respective departments. Unfortunately these departments are either to change their name or to merge into the other department.

In 1972, the Department of Systems Engineering was established at Kobe University.

The professors of control engineering are organized in an association which has 500 members and a meeting every year on the occasion of the Japanese Joint Automatic Control Conference.

Research on Control Engineering

The research on control engineering is undertaken by the universities, governmental research institutes and industries.

Funding of the research for universities is mainly from the Ministry of Education and Sciences. The total budget for research was 92.4 billion yen in 1995 and 101.8 billion yen in 1996. About 42 percent is distributed to research projects in science and engineering. The number of accepted projects was 35,000 in 1996, and the acceptance ratio is about 37 percent. There are several research areas with priority. The Environmental Pollution Control Project lasted from 1972 to 1974, and was organized by Prof. Y. Sawaragi as a first special research program relating to control engineering. Continuing this project, Autonomous Decentralized Systems was organized by Prof. A. Ichikawa, and now three projects, namely Virtual Reality (Prof. S. Tachi), Intelligent Robots (Prof. H. Inoue) and Emergent Systems (Prof. S. Kitamura), are relating to control engineering.

The Ministry of International Trade and Industry and the Science and Technology Agency support research projects for their institutes and industries.

In MITI sponsored projects, the Industrial Science and Technology Frontier Program had a budget of 26 billion yen in 1995. Relating to control technology, Micromachine Technology (1991-2000) has about 2.5 billion yen. Two projects of Proficient Machine Technology and Smart Structure System are being studied.

MITI has several research laboratories for research. Electrical Technical Lab., Mechanical Engineering Lab. are the main laboratories for control related projects.

Control Related Industries

The Japanese GNP is said to be about 500,000 billion yen. (Kuramae Journal no. 922, 4 21-29, 1997) which is known to be earned mainly by the industries. It is difficult to estimate the contribution made by control technology. In this section the scale of electric instrumentation and robotic industries will be presented.

The 1995/96 report of the Japan Electric Measuring Instruments Manufacturer's indicates total sales of the instrumentation industry of about 651.6 billion yen in 1995. If we consider the general automation-related business, a company like OMRON has sales close to 600 billion a year. The production of robots was about 69,500 units and the sales volume 479.4 billion yen in 1995. Most of these robots are used for assembling and welding

In the past, about 20 IFAC events have been held in Japan and SICE has co-sponsored many IEEE events with the Industrial Electronic Society, the Control Systems Society and Robotics and Automation Society. SICE itself started the international sessions in its annual conference by the efforts of Prof. F.Harashima in 1985. Mita Publishing Co. published the control journal "Control - Theory and Advanced Technology-", but it discontinued in 1996. The trend towards internationalization is now very obvious.

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