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The IFAC TC SWIIS
Past, Present, Future

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Abstract: The IFAC TC on "Supplemental Ways for Improving International Stability – SWIIS" is one of the longest situated in IFAC. According to first ideas during the IFAC World Congress in Kyoto 1981 this IFAC – at that time - Working Group organised in 1983 the first Workshop in this highly interdisciplinary field in Austria. Meanwhile a Technical Committee in IFAC, SWIIS was always a bridge between (control) engineers and various other disciplines to open IFAC to other related fields.

It`s a tradition to present on nearly each IFAC World Congress an update of this dynamic TC. Therefore in this contribution the role of process and manufacturing automation especially control engineering will be presented and discussed based on previous papers. In addition Ethics and Diversity are shortly discussed.

As an indicator selected Keywords of the main sponsored events of this TC were used. This contribution is based on Kopacek,P, L.Stapleton, M.Dimirovski (2017).

Keywords:Conflict and Post conflict, Developing Regions, Ethics; Systems Theory.

1. PAST

1.1 The roots (Kopacek, 2008)

First ideas to install a IFAC Working Group on "Supplemental Ways for Improving International Stability - SWIIS" cames up in 1981 during the IFAC World Congress in Kyoto initiated by Hal Chestnut. As result the first IFAC SWIIS Workshop was held in Laxenburg, Austria, Sept. 13 – 15, 1983 (Chestnut et.al. 1984)

1.2 Control engineering approaches

One of the classical approaches in SWIIS in the eightiees was modelling a conflict situation as a stability problem of one or between more dynamic systems.

At that time there were in conflict resolution only verbal approaches with less theoretical background, without any applications as well as mathematical and control engineering background were available.

Therefore it was absolutely necessary to introduce cybernetical and system theoretical concepts especially control theoretical methods as role of a direct connection to the reality.

Dynamics of nations and the interactions between nations are highly non-linear and also strongly coupled. From the view point of control theory this is a non-linear, time varying, multi variable System.

For such complex systems it was necessary to deal with states space approaches. The main problem was to determine optimal control parameters probably by adaptive control.

One of the classical approaches in SWIIS was modelling a conflict situation as a stability problem of one or between more dynamic systems. In that case persons, groups of persons, nations and groups of nations

For this we have first to define some similarities between Control Engineering and conflict solution. (Tab 1), (Tab 2).

From the point of view of theoretical and engineering systems, SWIIS had focussed on the application of continuous time approaches which are well known from the field of process automation (Kopacek et. al., 1990).

Table 1 Corresponding terms in control engineering and conflict solution (Kopacek et.al, 1990)

Control Engineering	Conflict solution
SISO System	Organisation (State) with one goal.
MIMO System	Organisation (State) with more goals.
Controller	Authority or government.
Command variable w	Goal of the authority (government).
Control deviation xd	Execution organ – Goal from the organistion.
Controller gain Kp (Xp)	Power of an organisation (State).
Subsystems	Internal groups or Societies
Disturbance variables z	External: Influences from neighbour systems.
	Internal: Influences from subsystems.
Negative feedback	Damping, Stability.
Positive feedback	Aggression, Instability.
Efficiency	Measure for the “System Intelligence”.
Stability margin	Critical state of the system.

Table 2 Possible disturbance variables (Erbe, Kopacek, 2006)

Geographical	Boarder problems, Invasions.
Religious	Prosecution, Discrimination, Conflicts, Fights……
Economic	Price limitations, Embargos.
Environment	Acid rain, Water pollution, global warming.
Raw materials	Resources, Prices, Monopoles.
Political	Ideologies, Human rights, Minorities.
Military	Aggression, Government with no power.
Various	

These approaches have been particularly important in SWIIS work on a sustainable future. However, the fields of production automation and systems engineering were introduced over the years, giving rise to new methods which SWIIS could usefully include in their approaches.

Usually mathematical models have a distinct structure and parameters. While in technical systems the model parameters the constants in the equations are well determined by physical laws in non technical systems the model parameters have to be estimated from mostly statistical data. Models for the dynamic behaviour assume that the whole system may be disaggregated into more subsystems described by simpler dynamic models. There are two principal types of models which are used in systems engineering. Either input-output (external) or stat space (internal) models. While input-output models are suitable for simple linear systems with one input and one output (SISO - Systems), state space models give a deeper insight in the inner relations of a system and therefore they will be commonly used for more complicated systems with multiple inputs and outputs (MIMO-Systems).

A usual way in systems engineering is to simplify complicated models. In most cases successive simplification finally yields to models of linear time invariant MIMO – systems. The dynamic behaviour of such systems might be described e.g. by a set differential equations of first order (state space equations) or one differential equation of higher order. By means of these models all well known methods of linear system theory (e.g. controller design, stability theory) can be used. That was one of the main goals of SWIIS. A good example was the influence of the conflict factor “Energy” on stability studied by (Erbe, Kopacek, 2006).

These new approaches (Kopacek,2001) include “Multi Agent Systems” (MAS). Such systems have been very well known in software engineering for more than 20 years. A multi agent system consists of a number of intelligent, co-operative and communicative hard- and software agents, like robots, which are working on a common task.They can use their intelligence to divide the whole task into subtasks, as long as each subtask can be carried out by at least one of the agents. This procedure can be repeated to solve the common task. The most recent research is focussing on MMAS – Multiple Multi Agent Systems, in which different multi agent systems are used to solve different aspects of a complex task.

SWIIS models for the dynamic behavior have similarities to multi agent systems (MAS). The actors are people, nations with a distinct degree of intelligence and the ability to communicate and cooperate with others. A conflict could be defined as a competition between two or more multi agent systems, or as a multi multi agent system without co-operation between the different multi agent systems.

This is very different from the case of production engineering, where the different multi agent systems co-operate with each other rather than acting counterproductively. Thus, the new approach of MMAS was a useful tool for the work of SWIIS in the past.

In Table 3 some of the keywords from this period are collected. Application of control principles to international stability and Modelling of stability are continuing from 1986 until now.

Techno-Economic Conditions for International stability, Negotiation and Mediation in Conflict Resolution, Decision-Making Processes, stability, sustainable development, East/West/North/South relationships, Negotiation and Mediation in Conflict had only a lifetime of one triennium.

Table 3: Early keywords of SWIIS adapted from (Kopacek et. al, 2017)

	1983	1986	1989	1992	1995	1998
Techno-Economic Conditions for Internat. Stability						
Analytical Approaches to Internat. Stability Systems						
Negotiation and Mediation in Conflict Resolution						
Decision-Making Processes						
Modelling of stability.						
Methodological analysis						
Development: stability, sustainable development						
Application of control principles to internat. stability						
International policy co-operation						
Cultural and educational aspects in internat. stability						
East/West/North/South relationships						
Global development: regional impact						
Negotiation and Mediation in Conflict						
Social Aspects of Technology						

Cybernetics and especially control theory and engineering including the related fields of research indicate that there may be alternative supplemental methods employed for improving the solution of various conflict situations.

2. CONSOLIDATION (Table 4).

Meanwhile the working group SWIIS was a Technical Committee (TC) in IFAC and the triennial workshops were appointed as regular conferences. The trend, inclusion of more economical and historical topics was continued.

It was decided to co-operate closer with the the IFAC TC`s on “ Social Effects of Automation” and “ Developping countries”. This requires removement of of the conflict oriented and adding of new technological Keywords in the Scope of SWIIS. Examples are listed in Tab.4

3. PRESENT (Tab.5).

On a TC meeting the scope of the TC SWIIS was revised. *“To identify, define, and improve factors that significantly influence international stability. To outline ways in which IFAC can use its own systems and control capabilities to enhance international stability and build a more peaceful world. To interact with other organisations having similar goals. To cooperate with other IFAC TCs regarding SWIIS activities”.*

Furthermore two new Working Groups were created: Working group on “ Ethics in Control Engineering” chaired by M. Hersh (Scotland) and a Working group on “Automation and End of Life (EoL)Management” chaired by B. Kopacek (Austria).

New Keywords like social aspects of technology transfer, managing the introduction of technological change, ethical aspects, technology and environmental stability, and anticipating secondary and tertiary effects of technological development were introduced.

Control strategies for a sustainable future need considerable attention and this should include consideration of open systems models and the identification of feedforward paths. The systems models will need to be highly dynamic and focus upon navigation paths rather than solely predictive and deterministic mechanisms. The systems involved are emergent and holistic in nature and futures methods might be useful.

Nowadays system engineering methods, based on well known principles of control engineering, mathematics, statistics are applied to such problems. One of the main problems arising is the description of the static and dynamic behaviour of conflict partners or systems in form of mathematical methods. Such models are determined either in a theoretical or experimental way. Theoretical model building yields to complicated models difficult to handle. Therefore simple models are mostly used determined in a heuristic way. Erbe and Kopacek described a new method for model building and as an example a simple linear time invariant model is used to describe gas or oil supply and consumption of several countries.(Kopacek, (2008)

Table 4: Keywords of SWIIS adapted from (Kopacek et. al, 2017)

	2001	2003	2006	2009	2010	2012	2013
Analytical Approaches to Internat. Stability Systems	■						
Modelling of stability.	■	■	■	■	■	■	■
Methodological analysis	■						
Development: stability, sustainable development	■				■		
Application of control principles to internat. stability	■	■	■	■	■	■	■
International policy co-operation	■						
Social Aspects of Technology	■	■	■	■	■	■	■
Managing the Introduction of Technological Change		■	■	■	■	■	■
Engineering Ethics		■	■	■	■	■	■
Case Stud. of Technology Transfer and Social Change		■	■	■	■	■	■
Technology and Environmental Stability		■	■	■	■	■	■
Knowledge Management					■	■	■
Globalization impact on International Stability					■	■	■
International System Complexity				■	■	■	■
Collaborative and Social Networks						■	■
Cross Cultural Aspects of Engineering					■		■
Enterprise Integration Technologies, CIM, Robotics					■	■	■
Health Informatics and Tele-Medicine Applications					■		■
Environmental Systems					■	■	■
Terrorism							■
Engineering Education							■
Technological Factors in unstable regions					■		■
Technology Innovation and Knowledge Networks							■
Technological Appl. in Post-conflict Regions					■		
End of life Management - EoL					■	■	■
Mechatronic Systems						■	■
						■	■

Automation and control systems such as integrated enterprise information technologies and distributed telemedical system architectures require highly secure information processing environments to ensure that costly (and even fatal) errors do not occur emphasised. However, research into systems development methodologies shows significant gaps in the treatment of systems security. Many methodologies do not specifically include security and privacy considerations within their frame of reference. As a consequence, recent studies of information control and management systems have shown that, in a global context, many organisations are at a significant security risk.

These new topics requires new Keywords like:

- Social Aspects of Technology
- Managing the Introduction on Technological Changes
- Ethical Aspects of Technological Proliferation
- Technology and Environmental Stability
- Modelling of Social and Economic System
- Knowledge Management
- Globalization impact on International Stability
- Complex Adaptive Systems
- Complexity modelling
- International System Complexity

Table 5: Keywords of SWIIS adapted from (Kopacek et. al, 2017)

	2015	2016	2017	2018	2019
Modelling of stability.	■	■	■	■	
Application of control principles to internat. stability	■	■	■	■	■
Social Aspects of Technology	■	■	■	■	■
Managing the Introduction of Technological Change	■	■			■
Engineering Ethics	■	■	■	■	■
Case Stud. of Technology Transfer and Social Change	■				
Technology and Environmental Stability	■		■	■	
Knowledge Management	■				
Collaborative and Social Networks	■	■	■	■	
Cross Cultural Aspects of Engineering	■		■	■	■
Enterprise Integration Technologies, CIM, Robotics	■	■	■	■	■
Health Informatics and Tele-Medicine Applications	■	■	■	■	
Environmental Systems	■	■	■	■	
Engineering Education	■	■	■	■	
Technological Appl. in Post-conflict Regions	■	■	■	■	■
Software Tools for Enterprise Integr. and Networking	■	■	■	■	
Cost Oriented Automation	■	■	■	■	■
SME-oriented Automation. Decision Support Syst	■	■	■	■	■
End of life Management - EoL	■	■	■	■	
Efficient Use of Intelligent Machinery	■	■			■
Cost Effective Operation and Maintenance	■	■			■
Mechatronic Systems	■	■	■	■	■
Retrofitting of Automation Devices	■	■	■	■	■
Intelligent Systems and Applications		■	■	■	
Innovation Management				■	
Sustainable Design & Control				■	
Young Engineers in Control				■	■
Biomedical Systems			■	■	■
Archit.and. Softw. Tools Enterprise Integration					■
Cost reduction with Emaintenance Systems					■
Advances in embedded Contr. Systems					■
Efficient control of Hybrid. Energy Systems					■
Ecological Systems					■

Meanwhile the TC was renamed to TECIS.

According to the scope of TECIS the topics of the technical papers of the following events were very heterogenous. For example one block of papers dealt with complex adaptive systems. Such systems are more and more introduced not only for modelling and control of networks offer the possibility to design an umbrella for different applications. Further topics adressed were fuzzy methods, ethics in IT, collaborative software platforms, …….

4. FUTURE

TECIS 2018 and 2019 marked a major step forward for the community as it engages with a difficult international situation.

New developments requires new Keywords. Selected are:

- Architecture and Software tools for Enterprise Integation
- Cost reduction with E-maintenance Systems.

- Advances in embedded Control Systems
- Efficient Control of Hybrid Energy Systems
- Ecological Systems

Key developments during this triennium included the additional focus on "diversity and inclusion", traditionally an area within the ethics working group but now expanded following the establishment of an IFAC task force. The new Working Group in "Diversity and Inclusion" began formally with great energy in Sozopol (TECIS 2019) and is now chaired by Mary Doyle-Kent. The WG has established an inter-disciplinary forum involving researchers in social systems and social policy (e.g. in relation to migration studies), political science, economics, gender studies, LGBTQ+ and digital humanties, as well as control science-related disciplines.

For IFAC 2020 the committee has proposed new sessions addressing complex ethical issues relating to the applicaiotn of automation and control solutions, and which explore new methodologies for designing, developing and delivering these technologies. The session also offers a new manifesto for control and automation engineering and revisits the SWIIS proposal from IFAC World Congress 2005 in Prague where a Hippocratic oath for socially responsible engineering was offered. This work emerged from the Working Group on ethical Engineering and was a response to various earlier international initiatives which drew attention to the need for a global ethic for technology development. Around that time the WG was also exploring issues in relation to emerging digital technologies such as privacy which later proved to be central to any ethics of technology The revisinting of this topic is urgently needed right now. Into the 2020s a new wave of intelligent automation and control technologies promise to reshape the working lives of millions of people, with all the opportunities and challenges this brings for humanity.

5. SUMMARY and OUTLOOK

As pointed out earlier one of the original ideas of SWIIS was to contribute with system theoretical and systems engineering methods to conflict solution. The SWIIS community started with the classical approaches of control engineering especially control of time continuos systems like theory of linear or some times non-linear systems, modelling, stability, optimisation. In the history of SWIIS there were some new approaches presented on several events for application of new methods from control engineering to SWIIS problems. Examples are multivariable and timevarying systems as well as fuzzy and neuro methods.

Another new approach to the SWIIS problems is the use of methods from manufacturing automation time discrete systems as well as the improvement of the interdisciplinarity.

Furthermore ethics becomes more and more interest in control engineering, the classical IFAC topic on social effects is moving more and more to human machine cooperation, new automation technologies requires more interdisciplinary educated people. In addition developing countries need the newest technology for an efficient improving of the industry.

The influence of the conflict factor "energy" on stability will be studied by a new approach. Furthermore ethics as well as social aspects and diversity are the tasks for the future.

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