WORKSHOP Human Cyber Physical System Interaction: Control for Human Welfare

September 22-23, 2014

Paris, Institut Henri Poincaré

http://h-cps-i.sciencesconf.org

IPC chairs: **Mariana Netto**, IFSTTAR & **Sarah Spurgeon**, UCL, UK **IPC vice-chair:** **Tariq Samad**, Honeywell, US
NOC chair: **Françoise Lamnabhi-Lagarrigue**, L2S-CNRS, EECI, France

IPC Members:

Anuradha Annaswamy, MIT, US
Corinne Brusque, IFSTTAR, France
Gilney Damm, University of Evry, France
Jack DiGiovanna, EPFL, Switzerland
Ronald Hess, University of California, Davis, US
Françoise Lamnabhi-Lagarrigue, L2S-CNRS, EECI, France
Naomi Leonard, Princeton University, US
Franck Mars, IRCCyN, CNRS & Ecole Centrale de Nantes, France
Wan Chul Yoon, KAIST, Korea
Berenice Mettler, University of Minnesota, US
Patrick Millot, University of Valenciennes, France
S. Narayanan, Wright State University, US
Joerg Raisch, Tech. Univ. Berlin, Germany
Stephen Robinson, University of California, Davis, US
Tetsuo Sawaragi, Kyoto University, Japan
Anand Tharanathan, Accenture, US
Wan Chul Yoon, KAIST, Korea

NOC Members:

Mariana Netto, IFSTTAR, France
Janan Zaytoon, SEE, GDR MACS, France

Workshop Report

Preface

The International Workshop on Human Cyber Physical System Interaction : Control for Human Welfare (H-CPS-I 2014) has been dedicated to stimulating cross-fertilization in the field of technology design for the welfare of human beings, with particular reference to control science and engineering. By opening the view to a large space of applications and domains dealt with by different approaches, the main goals of the workshop have been to highlight new challenges in Human-CPS-systems design, discuss their social impact and identify research problems to address and resolve the challenges. H-CPS-I 2014 has been held at the Institut Henri Poincaré in Paris, France on September 22-23, 2014.

The workshop idea has received immediatelly and from its very first begining attention and support from the IEEE CSS Outreach Chair Prof. Gary Balas. Thanks infinitely Gary! The IEEE CSS Outreach Support has been indeed fundamental for constructing the first Stone for this event creation and for the success or this new action. The workshop has also received key precious support from the International Federation of Automatic Control (IFAC) and from the important organisations and groups as the French Institute of Science and Technology for Transports, Development and Networks (IFSTTAR), the Highly Complex and Networked Control Systems (HYCON2) European Network of Excellence, the European Embedded Control Institute (EECI), the French National Center for Scientific Research (CNRS), the French Research Group Modeling, Analyses and Control of Complex Systems (GDR MACS), the French Society of Electricity, Electronics and Science for Information and Telecommunications (SEE), the French Institute of Carbon-free, Communicating Vehicle and its Mobility (VeDeCom), and the Institute for Decision and Control of Paris Saclay (iCODE).

Contents

I - MOTIVATION

The origin of the motivation for constructing this event is the computing and internet revolutions that have opened recently an enormous set of new possibilities in control. These changes have impacted citizens' lives allowing new health treatments, new transportation means, new services, new energy management (smart grids), as well as many other services. Anoher consequence has also been the increased complexity of the systems (systems of systems, hybrid, networked,…), that are now called cyber-physical systems having become one of the ICT priorities, with human interactions representing a central aspect in them. Major current questions concern how to best consider human factors in the control loop because of the increased number of sophisticated systems, that often cooperate closely with humans or that need to be operated directly by a human operator. This consideration is relevant across the control space, including modeling, algorithm design, implementation, commissioning, operation, and maintenance. For these tasks and others, the human element needs to be more formally and rigorously understood, analyzed, and modeled than is the practice currently.

II - MAIN GOALS, KEY TOPICS, AND WORKSHOP DESCRIPTION

Following this motivation, the workshop main goal has been to brainstorm and exchange on the new challenges in Human Cyber Physical Systems and to discuss their social impact. For this, the approach has been to break the barriers among the different associated disciplines and application domains where Human-CPS interactions studies are necessary. The talks included experts from the United States, Europe, and South America in the three selected application domains, medicine, transportation and smart grids and on the disciplines control, computer sciences, psychology and sociology. To guide a potential multidisciplinary audience, the organizers have defined four levels of interaction between the Cyber Physical System and the Human: human-machine symbiosis, humans as operators of complex systems, humans as agents in multi-agent systems and the human as a part of a controlled system. Two tutorials offering a transversal vision across different domains on the modelling and control of Human-CPS Systems have also been given to begin each day of the event. The workshop featured 22 presentations by proeminent researchers besides the two tutorials to cover a large spectrum of challenges in Human-CPS Systems according to the defined structure. An open panel on Prospectives and Social Impacts of the Human-CPS Nexus, chaired by Prof. Anuradha Annaswamy and Dr. Tariq Samad closed the event. Since the workshop goal was to provide multidisciplinary exchanges between the participants from different fields, the structure of one section gathering all the audience together in an amphitheatre was chosen to allow all participants to listen to all talks.

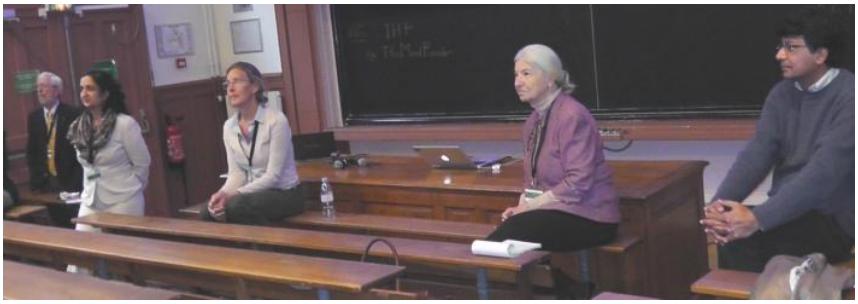

Figure 1 : The open panel Prospectives and Social Impact of the Human-CPS Nexus has closed the event. From right to left, Dr. Tariq Samad, Prof. Ruzena Bajcsy, Prof. Berenice Mettler, Prof. Anuradha Annaswamy and Prof. Ronald Hess.

The International Program Committee has been chaired by Dr. Mariana Netto from IFSTTAR (France) and Prof. Sarah Spurgeon of University of Kent (UK) and vice-chaired by Dr. Tariq Samad, Honeywell (US). The National Organizing Committee has been chaired by Dr. Françoise Lamnabhi-Lagarrigue from CNRS-L2S/EECI (France). The workshop attracted participants from 9 countries, the United States of America, India, Germany, the Netherlands, Switzerland, UK, Brazil, Japan and France. Industry participation included 2 invited talks, from Renault, France and from Accenture, US and the extremely active participation of Dr. Tariq Samad, Honeywell, supporting the event construction from the very begining.

III - PARTICIPATION

Participants	Total Number	Host nation	From industry	Women
Paying regular fee	**39**	**18**		**13**
Paying industry fee	**4**	**2**	**6**	**0**
Paying student fee	**4**	**2**		**1**
Free registration	**2**	**2**		**0**
Total	**49**	**24**		**14**

with 9 countries represented (France , USA, Germany, UK, the Netherlands , India, Brazil, Switzland, Japan). The top countries in terms of participation have been France (22), USA (9), Germany (7), UK (5), the Netherlands (2).

Industrial Involvement:
Honeywell - IPC Vice chair Dr. Tariq Samad from Honeywell.
RENAULT - Invited talk by Dr. Xavier Chalandon, Renault, expert HMI.
LAB - Joint RENAULT-PSA Laboratory (*laboratoire d'accidentologie et bio-mechanique des chocs*).
Presence of Dr. Nicolas BERTHOLON, deputy director of the LAB.

IV - SUMMARY OF THE WORKSHOP CONTENTS

The organization of the workshop has been along the two days, to begin with strong human-CPS interaction (red in the table below) to achieve soft H-CPS-I (green in the table below) in the end of the second day. The open panel 'Social Impact of the Human-CPS Nexus' closed the event.

MODELLING				
eg *the body motion modeling*: human instrumentation with sensors in the day-to-day life for detection of fatigue-related indicators after a VCA [PhD thesis of Tong Lu, Garches hospital, France, 2015]; *models of the human being action/cognitive activity level* : cybernetic driver model in [Saleh et al, 2013]; *models of the motion of groups of human beings* (work on flocky logic from N. Leonard and S. Marshall); *modeling the human-decision making* [Reverdy, Leonard, 2014]; *models of the creativity processes*.				
DECISION and CONTROL				
	HUMAN-CENTERED CONTROL	MACHINE-CENTERED CONTROL		
	Human-machine symbiosis	**Humans as 'operators' of complex eng. systems**	**Humans as agents in multi-agent teams**	**Humans as elements in controlled systems**
MEDICAL APPLICATIONS	Individualized neuroprosthetics: Overlaps with the Modelling and Control domains, here specifically tailoring the therapy to the specific patient [Borton, et al., Science Trans Med, 2013]	robots for cancer surgery		
TRANSPORTATION AND INDUSTRY		aircraft pilots, train driver, car drivers, process plant operators	coordination of UAVs and piloted aircraft in commercial airspace; Traffic control	
SMART GRIDS				comfort control in homes & buildings.
PHILOSOPHICAL AND ETHICAL ISSUES: man and technology, the limits of technology, etc.				
1) Which are the limits on what only the technology can do? What can (should) only a human being do? 2) At what point is the computer taking over key experiences of being human? How to take then all benefits from technology avoiding its possible negative effects?				

Table 2 : modeling, decision and control in H-M systems. The colors in the table are a tentative "measure" of "how near of the human being" the study - model, decision, control - is (red : very near; orange: near; green: far).

The workshop was opened by the Prof. Janan Zaytoon, by Dr. Lamnabhi-Lagarrigue and by Dr. Mariana Netto as the NOC chair and IPC co-chair, to give a short address on the conference main objectives and topics. Prof Wilfrid Perruquetti talked about the workshop follow-ups on the topic of the Social Impact of Automation, in the afternoon of the first day. The first tutorial on *Cooperative cyber-physical systems with human in the loop*, was given by Prof. Ruzena Bajcsy, University of California, Berkeley, and director of CITRIS, US, to open the first day presentations. Prof. David Abbink, TU Delft, The Netherlands, opened the second day with the tutorial *Human-centered haptic shared control: one design philosophy across different applications*. Twenty-two talks including invited and submitted works were given by

Timothy A. Exell, Cardiff Metropolitan University, UK
Jack DiGiovanna, EPFL, Switzerland
Tong Li, ENS Cachan-Garches Hospital, France
Anand Tharanathan, Accenture, Chicago, US
Ebru Dogan, Institut VeDeCoM, Versailles, France
Claude Marin-Lamellet, IFSTTAR, Lyon, France
Xavier Chalandon Renault, France
Ronald A. Hess, University of California, Davis, US
Thomas Lendvay, Seattle Robotic Surgery Program and University of Washington, US
Stephen Robinson, University of California, Davis, US
Alex F. Neves, COPPE/UFRJ, Brazil
Thomas Seel, TU Berlin, Germany

William Pasillas-Lépine, L2S CNRS, Supélec, Univ. Paris Sud, France
Bruno Strah, TU Darmstadt, Germany
Franck Mars, IRCCyN, CNRS & Ecole Centrale de Nantes, France.
Sandra Hirche, TU München, Germany
Thierry Bellet, IFSTTAR, Lyon, France
Fréderic Vanderhaegen, LAMIH, Université de Valenciennes, France
Berenice Mettler, Minneapolis, University of Minnesota, US
Johann Kelsch, DLR, Allemagne
Ritsuko Ozaki, Imperial College, London, UK
Florian Allerding, KIT, Germany

Figure 2: From left to right and top, down : Prof. Ruzena Bajcsy, Prof. Sandra Hirche, Dr. Franck Mars, Prof. Thimothy Exell, Prof. Berenice Mettler, Prof. David Abbink chaired by Dr. Corine brusque, Prof. Vanderhaegen, Prof. Jack Digiovanna and Prof. Thomas Lendvay.

The addressed problems included robotic surgery, rehabilitation, driver assistance systems design for elder/disabled people, robotics, human-machine interaction in aircrafts and in automated vehicles, control of machines in hazardous environments as in space, and acceptation of new energy systems. The participants have been very happy to participate and exchange with colleagues from different areas but addressing similarly challenging problems in H-CPS-I and this provoked stimulating and motivated discussions. A large variety of points of view about human/machine interactions have been raised, and the potential benefits for humans of overcoming some key challenges for example in robotic surgery, have been pointed out.

V - SOCIAL EVENT

The social event has been a banquet dinner in the evening of the workshop first day, held at the La Baleine Restaurant, in Paris. All participants made a walk together in the 'Quartier Latin', from the IHP Institute to 'The La Baleine Restaurant'. Begun by a very nice and extremely agreable coquetel, the dinner at the sound of a Brazilian music orchestra has been a great occasion alltogether.

Figure 3 . From left to right: Dr. Mariana Netto, IPC co-chair, Prof. Anuradha Annaswamy, Panel Discussion chair , Dr. Tariq Samad, IPC Vice chair, Prof. Sarah Spurgeon, IPC Co-chair and Dr. Françoise Lamnabhi-Lagarrigue, NOC Chair.

Figure 4: H-CPS-I Gala Dinner at the "La Baline Restaurant" in Paris.

VI - OVERALL ASSESSMENT

The workshop, from both scientific and social aspects, has been a real and great success. The participants have had their attention catched by the talks and rich discussions involving different points of view, topics and disciplines related to human-machine systems have been raised. Below some comments sent by some of the participants after the event :

".....a brilliant workshop...."
Prof. Timothy A. Exell, Cardiff Metropolitan University, UK.

"...It was a very fruitful meeting..."
Prof. David Abbink, TU Delft, The Netherlands.

"...that was a fascinating workshop, a rich braintrust of intellectual creativity, and a huge variety in points of view about human/machine interactions. I thoroughly enjoyed it... "
Prof. Stephen K. Robinson, Director, Center for Human/Robotics/Vehicle Integration and Performance, UC Davis, NASA Astronaut (Retired)

VII - ACKNOWLEDGEMENTS

We would like to thank in deepness the IEEE CSS Outreach Fund for being with us from the very first begining through all the workshop construction process, first trusting the quite new idea of this workshop project and then for supporting us all throughout the event construction process and for the effective given support. We would like to also thank all people involved in the realization of this event. Special thanks to Prof. Janan Zaytoon, the IFAC President, for his precious and strong support to the workshop and the precious IFAC support. Infinite thanks to Dr. Françoise Lamnabhi-Lagarrigue for her incredibly precious and keen presence and help all through the workshop construction. Deep thanks to the workshop vice-chair Dr. Tariq Samad for his profound faith on the workshop idea and constant presence for the event to happen from its very first beginning. Special thanks to Prof. Sarah Spurgeon for her precious participation, support from its very first begining and for co-chairing H-CPS-I. Thanks so much to Prof. Wilfrid Perruquetti for his important support to the event. Thanks so much as well to all the IPC members for their high motivation during all the preparation process and for all the support given. Our thanks also go to all speakers and session chairs for their deep and important research work in fundamental topics for the society and for the highly motivated talks and chairings. Thanks also infinitely Prof. Stephen Robinson, Prof. Ron Hess, Prof. Ruzena Bajcsy, Prof. Ritzuko Osaki and Prof. Berenice Mettler for integrating the open panel Social Impact of the Human-CPS Nexus and infinite thanks to Prof. Anuradha Annaswamy and Dr. Tariq Samad for chairing the open panel to close the event in such a beautiful way. Our deep thanks also to Prof. Frederic Vanderhaegen for his presence and support. We express also all our gratitude to the administrative and technical staff of IFSTTAR and EECI for their constant presence all times when needed to the workshop. Thanks also to the Brazilian Orchestra for the wonderful music during the workshop Banquet that created an extremely agreeable and wonderful atmosphere to the workshop diner. Finally, thanks to all people that in one way or another, contributed to make this meeting a great and successful event for all its participants.

by Mariana Netto, H-CPS-I IPC co-chair

VII - ANNEX: WORKSHOP PROGRAM (next pages)

Speaker:

Monday 22 September 2014	
9:00 – 9h45	**Welcome and on-site registration**
9:45 – 10:00	**Introduction** Janan Zaytoon, Mariana Netto & Françoise Lamnabhi-Lagarrigue

	Session chair: Sarah Spurgeon
10:00 – 10:50	**Tutorial: Cooperative cyber-physical systems with human in the loop,** Ruzena Bajcsy, *University of California, Berkeley, and Center for Information Technology Research in the Interest of Science, USA*
10:50 – 11:10	*break*
	Session chair: Tariq Samad
11:10 – 11:35	**Control of functional electrical stimulation for upper-limb stroke rehabilitation,** Timothy A. Exell, *Cardiff Metropolitan University, UK,* Chris T. Freeman, Katie L. Meadmore, Ann-Marie Hughes, Emma Hallewell, Eric Rogers, and Jane H. Burridge, *University of Southampton, UK*
11:35 – 12:00	**Measuring, Inducing, and Controlling Human Motions in a Rehabilitation Context,** Thomas Seel, Thomas Schauer, Joerg Raisch, *TU Berlin, Germany*
12:00 – 12:25	**Brain-spinal interfaces to augment locomotor ability after injury**, Jack DiGiovanna, *Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland*
12:25 - 14:00	*lunch*
	Session chair: Franck Mars
14:00 – 14:25	**An autonomous wheel-based stair-climbing principle and its potential for wheel chairs and assistive robots**, Bruno Strah and Stephan Rinderknecht, *Technische Universität Darmstadt, Germany*
14:25 – 14:50	**Firing-rate models: A low-hanging fruit for the analysis of basal ganglia oscillations,** William Pasillas-Lépine**,** *L2S CNRS, Supélec, Université Paris Sud, France*
14:50 – 15:15	**HemiGaitEm : an embedded system for gait parameters acquisition for hemiplegic persons,** Tong Li, Gilbert Pradel, Nicolas Roche, *ENS Cachan-Garches Hospital, France*
15:15 – 15:40	**Biomechanical Human Models : Towards the virtual conception and assessment of the mobility,** Philippe Vezin, *Université de Lyon, Université Claude Bernard Lyon1, IFSTTAR, Bron, France*
15:40 – 16:00	*break*
	Session chair: Ronald Hess
16:00 – 16:25	**Enhancing situation awareness in process control,** Anand Tharanathan, *Accenture, Chicago, USA*
16:25 – 16:50	**Hierarchical control of driving and human-machine cooperation**, Franck Mars, *IRCCyN, CNRS & Ecole Centrale de Nantes, France*
16:50 – 17:15	**Automated vehicles: where are they heading to?,** Ebru Dogan, *Institut VeDeCoM, Versailles, France*
17:15 – 18:00	**Control in physical human-machine interaction**, Sandra Hirche, *TU München, Germany*
	Open discussion, Anand Tharanathan (Chair)
19:30	Workshop Banquet

Tuesday 23 September 2014

	Session chair: Corinne Brusque
9:15 – 10:00	**Tutorial: Human-centered haptic shared control: one design philosophy across different applications**, David Abbink, *TU Delft, The Netherlands*
10:00 – 10:25	**Advanced driving assistance systems for elder/disabled drivers - part I, identification of the drivers needs** , Claude Marin-Lamellet, *IFSTTAR, Lyon, France*
10:25 – 10:50	**Advanced driving assistance systems for elder/disabled drivers - part II, human-centered system design** Thierry Bellet, *IFSTTAR, Lyon, France*
10:50 – 11:10	*break*
	Session chair: Stephen Robinson
11:10 – 11:35	**Risk Analysis from the concept of dissonance to identify the gaps from design and usage of automated systems,** Fréderic Vanderhaegen, *LAMIH, Université de Valenciennes, France*
11:35 – 12:00	**Methodological elements in the analysis of faults in the Human-Machine coupling with applications in driving assistance systems**, Xavier Chalandon *Renault, Expert Leader HMI, France.*
12:00 – 12:25	**Modeling Human-Machine Interaction in the Cockpit**, Ronald A. Hess, *University of California, Davis, US*
12:25 – 14:00	*Lunch*
	Session chair: Berenice Metler
14:00 – 14:25	**What Does the Surgeon Really Need?** Thomas Lendvay, *Seattle Robotic Surgery Program and University of Washington, US.*
14:25 – 14:50	**Human skills and the evolving human-machine system,** Berenice Mettler, *Minneapolis, University of Minnesota, US*
14:50 – 15:15	**Human-Machine Interaction in Space,** Stephen Robinson, *University of California, Davis, US*
15:15 – 15:40	**A Software for Robot Teleoperation Applications based on ROS**, Alex F. Neves, Fernando Lizarralde, Ramon R. Costa, *COPPE/Federal University of Rio de Janeiro, Brazil*
15:40 – 16:00	*break*
	Session chair: Anuradha Annaswamy
16:00 – 16:25	**Joint system as a guiding approach for driver-automation system design**, Johann Kelsch, *DLR, Allemagne*
16:25 – 16:50	**Thinking of users in the smarter energy systems** Ritsuko Ozaki, *Imperial College, London, UK*
16:50 – 17:15	**Customizable user integrated Energy Management in Smart Buildings,** Florian Allerding, *Karlsruhe Institute of Technology (KIT), Germany*
17:15 – 18:00	**Panel Discussion : Prospectives & Social impact of the Human-CPS Nexus,** Anuradha Annaswamy and Tariq Samad (Chairs)