

June 8–11, 2021
Virtual Event, Netherlands



Association for
Computing Machinery

Advancing Computing as a Science & Profession



ELCS '21 Companion

Companion of the 2021 ACM SIGCHI Symposium on
Engineering Interactive Computing Systems

Sponsored by:

ACM SIGCHI

General Chair:

Panos Markopoulos, Eindhoven University of Technology, Netherlands

Technical Program Chairs:

Jun Hu, Eindhoven University of Technology, The Netherlands

Philippe Palanque, ICS-IRIT, Université Paul Sabatier-Toulouse III, France

Proceedings Chair:

Jun Hu, Eindhoven University of Technology, The Netherlands



**Association for
Computing Machinery**

Advancing Computing as a Science & Profession

The Association for Computing Machinery

**1601 Broadway, 10th Floor
New York, NY 10019-7434**

Copyright © 2021 by the Association for Computing Machinery, Inc. (ACM). Permission to make digital or hard copies of portions of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyright for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permission to republish from: permissions@acm.org or Fax +1 (212) 869-0481.

For other copying of articles that carry a code at the bottom of the first or last page, copying is permitted provided that the per-copy fee indicated in the code is paid through www.copyright.com.

ISBN: 978-1-4503-8449-0

Additional copies may be ordered prepaid from:

ACM Order Department

PO Box 30777
New York, NY 10087-0777, USA

Phone: 1-800-342-6626 (USA and Canada)

+1-212-626-0500 (Global)

Fax: +1-212-944-1318

E-mail: acmhelp@acm.org

Hours of Operation: 8:30 am – 4:30 pm ET

Printed in the USA

EICS 2021 Chairs' Welcome

It is our great pleasure to welcome you to the *2021 ACM SIGCHI Symposium on Engineering Interactive Computing Systems – EICS'2021*. EICS 2021 is the thirteen international conference devoted to engineering usable and effective interactive computing systems. Work presented at EICS covers the full range of aspects that come into play when “engineering” interactive systems, such as innovations in the design, development, deployment, verification and validation of interactive systems. This venue focuses on models, languages, notations, methods, techniques and tools that support designing and developing interactive systems. It brings together people who study or practice the engineering of interactive systems, drawing from HCI, Software Engineering, Requirements Engineering, Conceptual Modelling, CSCW, Ubiquitous / Pervasive Systems.

This year's symposium aims to bridge between engineering and design perspectives. Current technological trends like the IoT, big data, and artificial intelligence, are often seen as enablers and accelerators for transitions that individuals and society as a whole need to make, in order to address challenges in areas such as healthcare, mobility, and the environment. Designing and developing related solutions necessitate a close interplay of engineering and design. Advances in this field thus require a balanced consideration of corresponding research perspectives. The need emerges for tools, processes, methods, and guidelines for designing and engineering interactive systems that will support weaving computing, intelligence, and interactivity to everyday things, that will enable designers to effectively and efficiently deploy prototypes in realistic contexts and scale and to learn from actual use.

The program committee reviewed and accepted the following:

<i>Venue or Track</i>	<i>Reviewed</i>	<i>Accepted</i>	
Full Technical Papers	62	21	33%
Late Breaking Work	13	6	54%
Technical Notes	8	6	75%
Workshops	4	2	50%
Tutorials	2	1	50%

The conference includes two keynote talks:

- *Designing Computational Tools for Behaviour and Clinical Science*, by Albert Ali Salah who is a Professor of Social and Affective Computing at Utrecht University and Adjunct Professor with the Computer Engineering Department at Boğaziçi University.
- *Finding and Fixing Design Debt*, by Rick Kazman who is a Professor at the University of Hawaii and a visiting researcher at the Software Engineering Institute of Carnegie Mellon University.

The final program included two workshops:

- *The Management of Risks and Benefits when Engineering Interactive Digital Systems*, organized by José Creissac Campos, T.C. Nicholas Graham, and Lucio Davide Spano.
- *CHIIoT : 2nd Workshop on Computer Human Interaction in IoT Applications*, organized by Rong-Hao Liang, Alessandro Chiumento, Marco Zuniga, Przemyslaw Pawelczak, Mathias Funk, Yaliang Chuang, and Joep Frens.

Finally, the program included a panel involving researchers from academia and industry on the topic of Humane Artificial Intelligence Systems, organized by Boris de Ruyter.

Putting together *EICS'2021* was a team effort. We thank the authors for providing the content of the program. We are grateful to the technical co-chairs for the different submission categories and the program committee who worked very hard in reviewing papers and providing feedback for authors, organizing communications and the running of the event. Finally, we thank the Department of Industrial Design at the Eindhoven University of Technology, and the ACM SIG CHI for their support in setting up and running this event.

We hope that you will find this program interesting and thought provoking and that the symposium will provide you with a valuable opportunity to share ideas with other researchers and practitioners from institutions around the world.

Panos Markopoulos

*EICS 2021 General Chair
Eindhoven University
of Technology,
The Netherlands*

Jun Hu

*EICS 2021 Technical
Program co-Chair
Eindhoven University of Technology,
The Netherlands*

Philippe Palanque

*EICS 2021 Technical
Program co-Chair
Université Toulouse III - Paul
Sabatier, France*

TABLE OF CONTENTS

Keynote Lectures

Designing Computational Tools for Behavioral and Clinical Science	1
<i>Albert Ali Salah</i>	
Finding and Fixing Design Debt	5
<i>Rick Kazman</i>	

Late Breaking Work Papers

Designing Individualised Virtual Reality Applications for Supporting Depression: A Feasibility Study	6
<i>Nilufar Baghaei, Lehan Stemmet, Imran Khaliq, Atefeh Ahmadi, Ilona Halim, Hai-Ning Liang, Wenge Xu, Mark Billingham, and Richard Porter</i>	
Playbook: An Animation-Based Game for Improving Children's Creativity and Problem Solving Skills.....	12
<i>Forouzan Farzinnejad, Jafar Habibi, and Nilufar Baghaei</i>	
Towards Enhancing Spatial Awareness through Electrical Muscle Stimulation	17
<i>Vimal Darius Seetohul and Matthias Böhmer</i>	
On Computational Notebooks to Empower Physical Computing Novices	22
<i>Fulvio Corno, Luigi De Russis, and Juan Pablo Sáenz</i>	
MR4ISL: A Mixed Reality System for Psychological Experiments Focused on Social Learning and Social Interactions	26
<i>Cristian Pamparău, Radu-Daniel Vatavu, Andrei R. Costea, Răzvan Jurchiş, and Adrian Opre</i>	
Using Augmented Reality for Enhancing Planning and Measurements in the Scaffolding Business	32
<i>Enes Yigitbas, Stefan Sauer, and Gregor Engels</i>	

Technical Notes Papers

Engineering the Interaction of a Humanoid Robot Pepper with Post-Stroke Patients During Training Tasks.....	38
<i>Peter Forbrig, Alexandru-Nicolae Bunea, and Sebastian Bader</i>	
A Software Toolbox for Deploying Deep Learning Decision Support Systems with XAI Capabilities.....	44
<i>Fabrizio Nunnari and Daniel Sonntag</i>	

Applying Long-Short Term Memory Recurrent Neural Networks for Real-Time Stroke Recognition	50
<i>Emanuele Ledda and Lucio Davide Spano</i>	
Featuring Dual Learning Experiences in Tangible CPS Education: A Synchronized Internet-of-Things – Digital-Twin System.....	56
<i>Christian Stary, Claudia Kaar, and Markus Jahn</i>	
Computational Framework to Support Development of Applications Running on Multiple Co-located Devices	63
<i>Pedro Albuquerque Santos, Rui Neves Madeira, Rui Porfirio, and Nuno Correia</i>	
ActuBoard: An Open Rapid Prototyping Platform to integrate Hardware Actuators in Remote Applications	70
<i>Sebastian Günther, Florian Müller, Felix Hübner, Max Mühlhäuser, and Andrii Matviienko</i>	
Workshops	
CHIIoT 2: 2nd Workshop on Computer Human Interaction in IoT Applications	77
<i>Rong-Hao Liang, Alessandro Chiumento, Marco Zuniga, Przemysław Pawełczak, Mathias Funk, Yaliang Chuang, and Joep Frens</i>	
The Management of Risks and Benefits when Engineering Interactive Digital Systems	81
<i>José Creissac Campos, T.C. Nicholas Graham, Lucio Davide Spano, and Jan Van Den Bergh</i>	
Author Index	84

EICS 2021 Conference Organization

General Chair: Panos Markopoulos (*Eindhoven University of Technology, The Netherlands*)

Technical Program Chairs: Jun Hu (*Eindhoven University of Technology, The Netherlands*)
Philippe Palanque (*ICS-IRIT, Université Paul Sabatier-Toulouse III, France*)

Full papers Chairs: Mathias Funk (*Eindhoven University of Technology, The Netherlands*)
Rong Hao Liang (*Eindhoven University of Technology, The Netherlands*)
Philippe Palanque (*ICS-IRIT, Université Paul Sabatier-Toulouse III, France*)

Technical Notes Chairs: Anke Dittmaar (*University of Rostock, Germany*)
Javed Vassilis Khan (*Sappi Europe, The Netherlands*)

Late Breaking Work Chairs: Teresa Romão (*Universidade NOVA de Lisboa, Portugal*)
Daniel Tetteroo (*Eindhoven University of Technology, The Netherlands*)

Workshops Chairs: Gavin Doherty (*Trinity College Dublin, Ireland*)
Bastian Pfleging (*Eindhoven University of Technology, The Netherlands*)

Doctoral Consortium Chairs: Regina Bernhaupt (*Eindhoven University of Technology, The Netherlands*)
Kaisa Väänänen (*Tampere University, Finland*)

Tutorials Chairs: José Creissac Campos (*Universidade do Minho & HASLab/INESC TEC, Portugal*)
Kris Luyten (*Hasselt University, Belgium*)

Panels Chair: Boris de Ruyter (*Philips Research, The Netherlands*)

Proceedings Chair: Jun Hu (*Eindhoven University of Technology, The Netherlands*)

Local Arrangements and Accessibility Chair: Rosalinde Kennis (*Eindhoven University of Technology, The Netherlands*)

Publicity Chairs: Carlos Santos (*Breda University of Applied Sciences, The Netherlands*)
Davide Spano (*University of Cagliari, Italy*)

Steering Committee Chair: José Creissac Campos (*Universidade do Minho & HASLab/INESC TEC, Portugal*)

Steering Committee Executive Board: Kris Luyten (*Hasselt University, Belgium*)
Philippe Palanque (*ICS-IRIT, Université Paul Sabatier-Toulouse III, France*)

Program Committee Simone Barbosa (*PUC-Rio, Brazil*)

(Associate Chairs): Arnaud Blouin (*INSA Rennes, France*)
 Judy Bowen (*University of Waikato, New Zealand*)
 José Creissac Campos (*Universidade do Minho & HASLab/INESC TEC, Portugal*)
 Anke Dittmar (*University of Rostock, Germany*)
 Sophie Dupuy-Chessa (*Univ. Grenoble Alpes, France*)
 Florian Echtler (*Aalborg University, Denmark*)
 Peter Forbrig (*University of Rostock, Germany*)
 Mathias Funk (*Eindhoven University of Technology, The Netherlands*)
 Michael Harrison (*Newcastle University, United Kingdom*)
 Janet Yi-Ching Huang (*Eindhoven University of Technology, The Netherlands*)
 Jeeun Kim Texas (*A&M University, United States*)
 Christian Kray (*University of Münster, Germany*)
 Rong-Hao Liang (*Eindhoven University of Technology, The Netherlands*)
 Célia Martinie (*Université Paul Sabatier - Toulouse III, France*)
 Jeff Nichols (*Google, United States*)
 Philippe Palanque (*Université Paul Sabatier - Toulouse III, France*)
 Fabio Paternò (*CNR-ISTI, Italy*)
 Carmen Santoro (*ISTI-CNR, Italy*)
 Albrecht Schmidt (*LMU Munich, Germany*)
 Beat Signer (*Vrije Universiteit Brussel, Belgium*)
 Lucio Davide Spano (*University of Cagliari, Italy*)
 Daniel Tetteroo (*Eindhoven University of Technology, The Netherlands*)
 Jean Vanderdonckt (*Université catholique de Louvain, Belgium*)
 Marco Winckler (*Université Nice Sophia Antipolis, France*)
 Luciana Zaina (*Federal University of São Carlos, Brazil*)
 Yang Zhang (*Carnegie Mellon University, United States*)
 Jürgen Ziegler (*University of Duisburg-Essen, Germany*)

Additional reviewers	Pierre Akiki	Benedikt Loepp
(Full Papers):	Jason Alexander	Peter Lovei
	Wei Bai	Kris Luyten
	Nanyi Bi	Zhihan Lv
	Jacky Bourgeois	Christian Maertin
	Alexandru Bunde	Marco Manca
	Sybille Caffiau	Paolo Masci
	Stefan Carmien	Aline Menin
	Gilbert Cockton	Timothy Merritt
	Paul Curzon	Christian Meurisch
	Luigi De Russis	Alberto Monge Roffarello
	Alexandre Demeure	Muzayun Mukhtar
	Tim Donkers	Michael Nebeling
	Bruno Dumas	Moira Norrie
	Cathy Mengying Fang	Kathia Oliveira
	Sebastian Feger	Lucas Oliveira
	Andrea Giachetti	Tom Owen
	Patrick Girard	Parvaneh Parvin
	Eduardo Guerra	Oscar Pastor
	Josefina Guerrero García	Roberto Pereira
	Taisa Guidini Gonçalves	Peter Peters
	Zengrong Guo	Helen Petrie
	Jürgen Hahn	Bastian Pfleging
	Luke Haliburton	Susanne Putze
	Rüdiger Heimgärtner	Steve Reeves
	Florian Heller	Philippe Renevier Gonin
	Seongkook Heo	Gustavo Rossi
	Sungsoo Ray Hong	Jinsil Hwaryoung Seo
	Hermann Kaindl	Williamson Silva
	Dietrich Kammer	Eugene Taranta
	Jakob Karolus	Mark Thielen
	Nam Wook Kim	Jan Van den Bergh
	Konstantin Klamka	Sarah Völkel
	Rossitza Kotelova	Tim Weissker
	Laetitia Lambillotte	Benjamin Weyers
	Florian Lang	Raphael Wimmer
	Luis Leiva	Jason Wu
	Katy Lewis	Xuhai Xu
	Franklin Mingzhe Li	Enes Yigitbas
	Zhen Li	Jacob Young
	Yuan Liang	Mingrui Zhang

Additional reviewers (LBW): Ashish Aggarwal
Soraia Meneses Alarcão
Vasco Amaral
Fernando Birra
Kayla DesPortes
Catarina Gralha
Esteban Guerrero
Rajiv Khadka
Baisong Liu
Rui Madeira
Alberto Monge Roffarello

Kathia Oliveira
Peter Peters
Valentim Realinho
Andrew Robb
Vimal Darius Seetohul
Zohreh Shaghayeghian
Cristina Sylla
Yudai Tanaka
Jessica Turner
Suwen Zhu

**Additional reviewers
(Tech Notes):** Tahir Abbas
Michelle Annett
Paolo Bottoni
Prasun Dewan
Esther Durá
Augusto Esteves
Pieterjan Geens
Matthias Hirth

Stephane Huot
Dietrich Kammer
Kris Luyten
Gerrit Meixner
Konstantinos Papangelis
Fabio Paternò
Aurélien Tabard

Sponsor:



Supporter:

