A Newcomer's Guide to EICS, the Engineering Interactive Computing Systems Community

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Welcome to EICS, the Engineering Interactive Computing Systems community, PACMHCI/EICS journal, and annual conference! In this short article, we introduce newcomers to the field and to our community with an overview of what EICS is and how it positions with respect to other venues in Human-Computer Interaction, such as CHI, UIST, and IUI, highlighting its legacy and paying homage to past scientific events from which EICS emerged. We also take this opportunity to enumerate and exemplify scientific contributions to the field of Engineering Interactive Computing Systems, which we hope to guide researchers and practitioners towards making their future PACMHCI/EICS submissions successful and impactful in the EICS community.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**; **Interactive systems and tools**; • **Software and its engineering**;

Additional Key Words and Phrases: Interactive systems; Model-based design of user interfaces; Model-driven Engineering; Software Engineering; User Interfaces; Design; Formal methods; Verification and Validation.

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WHAT EICS IS

The scientific field and community of Engineering Interactive Computing Systems (put shortly, "EICS") are typically delineated at the intersection of Human-Computer Interaction (HCI) and Software Engineering (SE). Therefore, scientific and technical contributions that address the development life-cycle of interactive systems and associated user interfaces are relevant to EICS. If Software Engineering can be defined as the discipline where engineering techniques are applied to systematically develop a part or the entirety of a software product, EICS covers the engineering applied to systematically specify, design, develop, and test that specific part or the entirety of the

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interactive software application, prototype, or system. Consequently, *EICS focuses on models, languages, notations, methods, techniques, and tools that support the development life-cycle of interactive systems at any stage, from specification and requirements elicitation to validation.*

WHAT EICS IS NOT

While the EICS conference partially overlaps with other HCI venues, there are several specific aspects to it that are rarely covered by those other venues. *For this reason, it is important for newcomers to the field of EICS and especially to new submitters to PACMHCI/EICS to clearly understand the differences between EICS and other HCI venues so that their work can be submitted to, evaluated by, and presented in the right community.* For instance, the ACM SIGCHI flagship Conference on Human Factors in Computing Systems (CHI) focuses on end-users, user interface designers and practitioners, and sometimes developers, where EICS targets all stakeholders that are involved in the software development life-cycle of an interactive system with *explicit focus on analysts, developers, programmers, and system builders.* EICS is also different from the ACM Symposium on User Interface Software and Technology (UIST) that focuses on technological innovations regarding interaction techniques and user interfaces. When such techniques are introduced to the overall HCI community, UIST is the relevant sub-community to present them. However, when the innovations can be systematically specified, designed, developed, validated, and verified, they also become relevant to Engineering Interactive Computing Systems as well. EICS also overlaps with the ACM International Conference on Intelligent User Interfaces (IUI), a venue and community located at the intersection of HCI and Artificial Intelligence (AI).[1] When intelligent techniques for user interfaces are also relevant and employed for the systematic design, development, and evaluation of interactive systems, they become relevant to EICS as well. This intersection is often represented by model-based approaches; see Meixner, Paternò, and Vanderdonckt [17] for an overview.

A BRIEF HISTORY OF EICS

The EICS conference started as a sponsored ACM SIGCHI conference in 2009, but its journey as a scientific venue is probably one of the longest in the scientific field of Human-Computer Interaction. EICS was created as the union of several conferences (see Fig. 1 for a visual illustration):

- DSV-IS, the Design, Specification, and Verification of Interactive Systems International Conference, organized annually from 1994 [19] to 2008 [9].
- CCL, the IFIP Working Conference on Command Languages, with the first edition organized in 1974.
- TAMODIA, the Annual Conference on Task Models and Diagrams, organized annually from 2002 [21] to 2009 [6].
- CADUI, the International Workshop on Computer-Aided Design of User Interfaces, organized every two years since 1993 (first published online proceedings in 1996 [24]) to 2008 [14].

Some of these events were sometimes organized jointly as several of their topics were overlapping, such as CADUI '96 [24] and DSV-IS '96 [4] or EHCI-DSVIS '04 [2] and EHCI-DSVIS '07 [11]. In parallel, a subset of EICS topics have started to be addressed for a particular type of interactive systems, Distributed User Interfaces (DUI), where the user interface is distributed across users, tasks, devices, platforms, and environments. DUI was organized as an international workshop along various conferences between 2011 and 2016; see [7,8,15,16,23]. Since all these scientific events shared similar topics and goals regarding engineering aspects of Human-Computer Interaction,

[1] Actually, the relationship between EICS and IUI was very close at the beginning of IUI when, in March 1988, a group of researchers gathered in Monterey, California to participate in a workshop titled "Architectures for Intelligent Interfaces," according to https://dl.acm.org/event.cfm?id=RE306

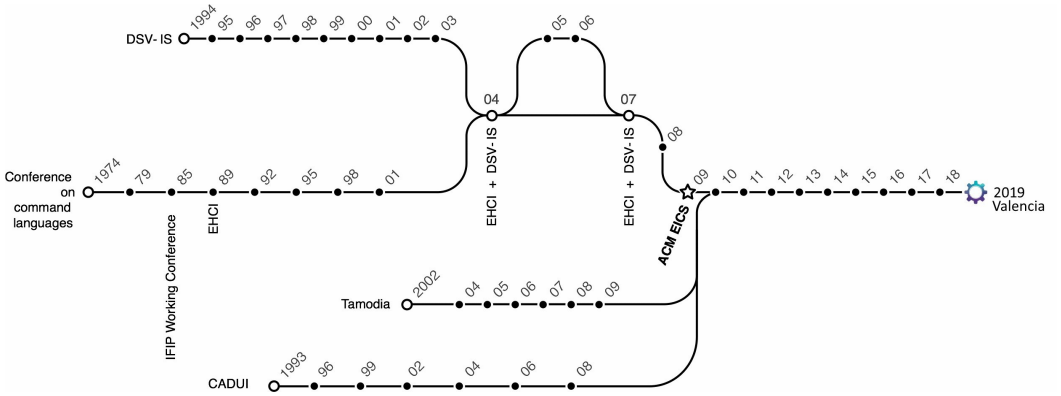

Fig. 1. A visual illustration of the history and legacy of the EICS community and conference showing past events, organized from as early as 1974, that contributed to EICS.

e.g., techniques, tools, and the practice of the software engineering life-cycle of interactive systems, merging them into one single event aimed at building a larger community was a natural thing to do. Since 2009 [10], EICS has been organized annually, reaching its 11th edition in 2019 [18]. Two years ago, EICS full papers were published as part of PACMHCI, the Proceedings of the ACM on Human-Computer Interaction, a scientific journal for disseminating results that are relevant for the intersection between human factors and computing systems. This year, the 3rd volume of PACMHCI/EICS has just been published, featuring the latest advances on engineering interactive computing systems representing the best work of our community. Besides full papers, the EICS conference also welcomes Tech Notes and Late-Breaking Results, which are traditionally published in the Proceedings of the EICS conference.

EICS 2019

EICS 2019 is the 11th edition of the ACM SIGCHI Symposium on Engineering Interactive Computing Systems, held during June 18-21 in Valencia, Spain. The university that officially hosts EICS 2019 is Universitat Politècnica de València, but two other universities co-participate in the organization of the event: Universitat de València, Spain and Université catholique de Louvain, Belgium. The organizing team from Universitat Politècnica de València is part of the PROS Research Center with a wide experience in software development using the model-driven paradigm; the organizing team from Universitat de València has been working for many years on aspects regarding usability addressed from the perspective of conceptual models; and the team from Université catholiqué de Louvain has achieved important milestones in the elaboration of models to represent various aspects of the interaction with computing systems. The expertise of these three teams subsumes the majority of the scientific investigation topics representative of EICS.

EICS 2019 has received 63 full paper submissions during three reviewing rounds (Q3 and Q4 2018 and Q1 2019), of which 21 were accepted to be included in the 2019 volume of the PACMHCI journal, representing an acceptance rate of 33.3%. The EICS 2019 conference also includes 2 Doctoral Consortium presentations, one tutorial titled "Measuring the Quality of Interactive Systems", 4 Tech Notes (from a total of 7 submissions, representing an acceptance rate of 57.1%), and 11 Late-Breaking Results (from 20 submissions with an acceptance rate 55%; LBRs are presented as posters during the conference). One of the Late-Breaking Results is represented by an invited paper from the Full Papers track. The programme of EICS 2019 is completed by 3 remarkable keynotes: Jacob O. Wobbrock discussing "Situationally Aware Mobile Devices for Overcoming Situational

Impairments"; Julio Abascal presenting "Engineering Inaccessible Computing Systems"; and Pedro J. Molina sharing results about "Modeling and Producing User Interfaces with Web Components in Quid." Overall, the EICS 2019 conference proposes its audience and community a programme composed of 42 selected presentations.

A SUBMITTER'S GUIDE TO ENGINEERING INTERACTIVE COMPUTING SYSTEMS

While EICS 2019 is in progress, future EICS conferences await contributions from the community. As the community is growing and attracting new researchers and practitioners interested in aspects that relate to engineering interactive systems, we believe that it is important to present them with an overview, in the form of a practical guide, regarding the types of contributions that are usually expected by the members of the EICS community for the PACMHCI journal as well as by the Programme Committee members and audience of the annual EICS conference. *Our main goal in this section is to provide a guide to newcomers' to the field towards making their PACMHCI/EICS submissions successful and impactful.*

Work intended to be 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.* Consequently, topics of interest to the EICS audience include the design and development of systems incorporating new interaction techniques, multimodal interaction, multi-user, multi-device, multi-screen, and multi-environment interaction, mobile, wearable, and pervasive systems, large-scale and big data applications, Augmented and Mixed Reality, deployment of interactive systems, as well as novel methods and techniques to improve the development of interactive systems. *Overall, EICS focuses on models, languages, notations, methods, techniques, and tools that support designing and developing of interactive systems.* The EICS conference aims to bring together researchers and practitioners that study or practice the engineering of interactive systems, drawing from the fields of Human-Computer Interaction, Software Engineering, Requirements Engineering, Conceptual Modeling, Computer Supported Cooperative Work, Artificial Intelligence, Augmented Reality, and Ubiquitous and Pervasive Systems. For instance, one topic that fits EICS well is *modeling interactions.* Although there are several well-known models to represent persistency (such as the UML class model diagram) and behavior (the UML sequence model and the use case diagrams), more innovations, consolidation, and development are welcome. For instance, conceptual programming is not feasible if persistency, behavior, and interaction are not adequately integrated with a sound conceptual basis [5]. Also, as new I/O devices become available, each device featuring diverse and different interaction modalities and characteristics, the study of alternative I/O modalities and multimodal interaction is timely and relevant to EICS. Note that even in traditional interactive systems, such as video games or television, there is continuous evolution in terms of interaction modalities, *e.g.*, starting with the joystick decades ago [12] to motion-sensing game controllers [20] and whole-body gesture-based input [26,27], and moving towards mass-computer interaction [13] involving hundreds and thousands of video game players at the same time.

Inspired by Wobbrock and Kientz's [28] discussion of research contributions in Human-Computer Interaction, we provide in the following a list of contributions relevant to EICS together with example of papers published at previous EICS events:

(1) **Contributions to software engineering for interactive systems** by following sound software development methods, in the same way that UML is widely employed for data persistence and behavior. Several model-based approaches [17] exist to support the user interface development life-cycle and particularly design and code generation. Model-driven Engineering (MDE) is different from model-based approaches in that all models have to

be compliant with a meta-model, which also applies to transformations between models (Model-to-Model) and code generation (Model-to-Code transformations) [25].

> ✍ **Example:** Sandra Trullemans, Lars Van Holsbeeke and Beat Signer. 2017. The Context Modelling Toolkit: A Unified Multi-layered Context Modelling Approach. *Proc. ACM Hum.-Comput. Interact.* 1, EICS, Article 7 (June 2017), 16 pages. DOI: http://dx.doi.org/10.1145/3095810

> ✍ **Example:** Kai Breiner, Marc Seissler, Gerrit Meixner, Peter Forbrig, Ahmed Seffah, and Kerstin Klöckner. 2010. Pattern-driven engineering of interactive computing systems (PEICS). In *Proceedings of the 2nd ACM SIGCHI symposium on Engineering interactive computing systems (EICS '10)*. ACM, New York, NY, USA, 367-368. DOI: http://dx.doi.org/10.1145/1822018.1822085

(2) **Novel interactive artifacts** include prototypes, software architectures, applications, and toolkits that contribute to the practice of engineering of interactive systems.

> ✍ **Example:** Fredy Cuenca, Jan Van den Bergh, Kris Luyten, and Karin Coninx. 2014. A domain-specific textual language for rapid prototyping of multimodal interactive systems. In *Proceedings of the 2014 ACM SIGCHI symposium on Engineering interactive computing systems (EICS '14)*. ACM, New York, NY, USA, 97-106. https://doi.org/10.1145/2607023.2607036

> ✍ **Example:** Miriam Greis, Hendrik Schuff, Marius Kleiner, Niels Henze and Albrecht Schmidt. 2017. Input Controls for Entering Uncertain Data: Probability Distribution Sliders. *Proc. ACM Hum.-Comput. Interact.* 1, EICS, Article 3 (June 2017), 17 pages. DOI: https://doi.org/10.1145/3095805

(3) **Formal methods** contribute approaches to specify, design, develop, verify, and validate the user interfaces of interactive systems. The topic of formal methods, located at the intersection of HCI and SE, is helpful for proving quality properties for interactive systems overall and safety-critical systems in particular.

> ✍ **Example:** Judy Bowen, Steve Reeves. 2017. Generating Obligations, Assertions and Tests from UI Models. *Proc. ACM Hum.-Comput. Interact.* 1, EICS, Article 5 (June 2017), 18 pages. DOI: http://dx.doi.org/10.1145/3095807

> ✍ **Example:** Werner Gaulke and Jürgen Ziegler. 2015. Using profiled ontologies to leverage model driven user interface generation. In *Proceedings of the 7th ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS '15)*. ACM, New York, NY, USA, 254-259. DOI: https://doi.org/10.1145/2774225.2775070

(4) **Design spaces** cover the construction of design options in structured and systematic ways. A design space represents the combination of various *design dimensions* (*e.g.*, user interface properties, high-level specifications, etc.) and *process parameters* that contribute to the systematic analysis of interactive systems and to their exploration. When a new design space is proposed, its systematic exploration falls under the specific area of interest called Design Space Exploration (DSE), referring to the systematic analysis and pruning of design options based on the dimensions of interest. Design spaces are particularly useful to address the following three modeling virtues [3]: (1) *descriptive* (any interactive system should be

consistently described using the properties of the design space), (2) *comparative* (two or more systems can be compared using the properties of the design space), and (3) *generative* (the systematic comparison of existing interactive systems leads to identifying new, previously uncovered areas, under-represented design options, and potential avenues for future research and development).

> ✍ **Example:** Sara Bouzit, Gaëlle Calvary, Denis Chêne, and Jean Vanderdonckt. 2016. A design space for engineering graphical adaptive menus. In *Proceedings of the 8th ACM SIGCHI Symposium on Engineering Interactive Computing Systems* (EICS '16, Brussels, Belgium, June 21-24, 2016), pp. 239–244. DOI: https://doi.org/10.1145/2933242.2935874

(5) **Conceptual modeling of interaction features** to abstractly represent the interaction. Model-to-Model and Model-to-Code transformation rules can be applied in a model-driven development paradigm. The conceptual modeling of interaction [1] remains an open challenge addressed not only by EICS, but which has recently raised interest in other communities, as well, such as the International Conference on Conceptual Modeling (ER).

> ✍ **Example:** Ivan Logre and Anne-Marie Déry-Pinna. 2018. MDE in Support of Visualization Systems Design: A Multi-Staged Approach Tailored for Multiple Roles. *Proc. ACM Hum.-Comput. Interact.* 2, EICS, Article 14 (June 2018), 17 pages. DOI: https://doi.org/10.1145/3229096

> ✍ **Example:** Marco Manca, Parvaneh Parvin, Fabio Paternò, and Carmen Santoro. 2017. Detecting anomalous elderly behaviour in ambient assisted living. In *Proceedings of the ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS '17)*. ACM, New York, NY, USA, 63-68. https://doi.org/10.1145/3102113.3102128

(6) **Empirical research in engineering interactive systems** contributes with findings gained by means of observation and data collection to create knowledge and inform new research and development.

> ✍ **Example:** Aitor Apaolaza and Markel Vigo. 2017. WevQuery: Testing Hypotheses about Web Interaction Patterns. *Proc. ACM Hum.-Comput. Interact.* 1, EICS, Article 4 (June 2017), 17 pages. DOI: https://doi.org/10.1145/3095806

(7) **Requirements elicitation of interaction features** to improve the usability and accessibility of interactive systems. Requirements that relate to interaction need to be considered from the earliest stages of the software development life-cycle.

> ✍ **Example:** Parvaneh Parvin, Stefano Chessa, Marco Manca, and Fabio Paternò. 2018. Real-Time Anomaly Detection in Elderly Behavior with the Support of Task Models. *Proc. ACM Hum.-Comput. Interact.* 2, EICS, Article 15 (June 2018), 18 pages. DOI:https://doi.org/10.1145/3229097

(8) **Methodological contributions** describing the way in which the different facets of engineering interactive systems should be addressed. These contributions regard analysis, design, development, and measuring aspects that relate to the engineering of interaction.

> ✍ **Example:** Sara Bouzit, Gaëlle Calvary, Denis Chêne, and Jean Vanderdonckt. 2017. Polymodal Menus: A Model-based Approach for Designing Multimodal Adaptive Menus for Small Screens. *Proc. ACM Hum.-Comput. Interact.* 1, EICS, Article 15 (June 2017), 19 pages. DOI: https://doi.org/10.1145/3099585

> ✍ **Example:** José C. Campos, Camille Fayollas, Célia Martinie, David Navarre, Philippe Palanque, and Miguel Pinto. 2016. Systematic automation of scenario-based testing of user interfaces. In *Proceedings of the 8th ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS '16).* ACM, New York, NY, USA, 138-148. DOI: https://doi.org/10.1145/2933242.2948735

(9) **Theoretical contributions in the engineering of interactive computing systems** consider novel concepts, definitions, models, principles, or frameworks.

> ✍ **Example:** Reinout Roels, Arno De Witte, and Beat Signer. 2018. INFEX: A Unifying Framework for Cross-Device Information Exploration and Exchange. *Proc. ACM Hum.-Comput. Interact.* 2, EICS, Article 2 (June 2018), 26 pages. DOI: https://doi.org/10.1145/3179427

(10) **Survey contributions** include analysis and meta-analysis of developments and results on a specific topic in the form of systematic mapping studies, systematic literature reviews, and thematic synthesis. This type of contribution is particularly welcome since EICS has accumulated considerable knowledge, which is now in the need of consolidation. A recent survey [22] of EICS approaches revealed that the pool of entries is large and challenging.

> ✍ **Example:** Paulo Pinheiro Da Silva. 2000. User interface declarative models and development environments: a survey. In *Proceedings of the 7th international conference on Design, specification, and verification of interactive systems* (DSV-IS'00), Philippe Palanque and Fabio Paternò (Eds.). Springer-Verlag, Berlin, Heidelberg, 207-226. DOI: https://doi.org/10.1007/3-540-44675-3_13

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