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Guest Editorial. The Role of Gesture in Designing

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Abstract. This paper introduces the special issue of AIEDAM on the role of gesture in designing. It starts with the context of the papers submitted and a summary of the papers accepted. We then introduce gesture studies, one of the two main domains with which this special issue is concerned. We do not introduce design research: we suppose the readers of AIEDAM are familiar with this domain. After this general introduction to the domain of gesture studies, we provide an overview of gestures in design, that is, the research environment of the papers in this special issue. We then discuss some dimensions on which these papers differ—and are related.

Keywords. Gesture; Design; Collaboration; Cognitive design research; Design thinking; Computer-supported design systems

Résumé. Cet article constitue l'introduction à ce numéro spécial d'AIEDAM sur le rôle du geste dans la conception. Il commence avec une présentation du contexte des textes soumis et un résumé des articles acceptés. Nous introduisons ensuite les études sur le geste, l'un des deux principaux domaines auxquels ce numéro spécial est dédié. Nous n'introduisons pas la recherche

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sur la conception: nous supposons que les lecteurs d'AIEDAM sont familiers avec ce domaine. Après cette introduction générale, nous donnons un aperçu des gestes dans la conception, qui est le contexte de recherche des articles dans ce numéro spécial. Nous discutons ensuite des dimensions sur lesquelles ces textes diffèrent - et sont liés.

Mots-clés. Geste; Conception; Collaboration; Cognitive design research; Design thinking; Systèmes d'assistance à la conception

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1. Introduction

This special issue of AIEDAM concerns the role of gesture in designing. This topic is relatively new in the field of design research and is only recently become of interest to research in computational support for designers. This special issue aims to raise awareness of recent research and to inspire additional research at the intersection of theory and practice.

Gesture has been studied from various perspectives, sometimes with respect to computer support for human communication and collaboration but also with respect to the psychology of gesture. Some examples are:

- Human-computer interaction (HCI) (Pavlovic, Sharma, & Huang, 1997, and the Gesture Workshop (GW) series that has taken place since 1996)
- Interactive dialogue systems (Cassell & Stone, 1999)
- Collaborative task-completion tools (Kraut, Fussell, & Siegel, 2003)
- Semiotic analysis (Calbris, 1990)
- Gesture recognition and generation (Mitra & Acharya, 2007)
- Language development (Goldin-Meadow, 2003).

While gesture is most commonly assumed to play a role in communication, it has been shown that gesture also plays an important role in thinking (McNeill, 1992). These findings have implications for the role of gesture in designing: the role it plays in design thinking and the role it plays in design collaboration. Studies of designers, working alone or collaborating, have been primarily concerned with studies of verbal protocols and very little with gestures. With this

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special issue, we raise awareness of the role of gesture in designing, primarily through the research on gesture when designers communicate and collaborate, but also in the implications of research related to gesture and thought on the design of HCI devices. At this stage, the studies reported here serve as a precursor to the development of computational support for design and design collaboration, and provide methodological approaches for understanding the impact of computational support and novel HCI technology on design thinking.

The analysis of the function of gesture in face-to-face collaborative design may have implications for environments that support remote collaborative design. Until now, these systems mainly support pen-based pointing or (other) "command" gestures. If such environments are to effectively support designers collaborating from remote locations, then representational and other types of gestures must also be visible and transmitted to the design partners.

To advance this important topic, the editors of this special issue sent out an open call for papers that provide theoretical or empirical contributions to the role of gesture in designing, either in the context of computer-supported collaborative work (CSCW) in the domain of design or as a precursor to designing effective computational support and mediation for design. Relevant research on the role of gesture in designing can come from all the disciplines involved in gesture studies: artificial intelligence (AI), HCI, or CSCW perspectives as well as cognitive-science disciplines, such as psychology and pragmatics.

In the call for papers, we suggested the following topics, but announced explicitly that this was not an exhaustive list:

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- Theoretical aspects of gesture in design interaction
- The role of gestures in design thinking
- Gesture and multimodal interaction in design interaction: gesture with speech, writing, drawing, and other modalities
- AI and cognitive models of gesture in design interaction
- The role of gesture and multimodal interaction in remote design collaboration
- HCI and studies of gesture in collaborative design environments
- New HCI technologies that enable gesture in design environments
- Gesture and multimodal interaction in CSCW design environments
- The role of gestures in defining an external representation of the design model (either to the computer or to a person).

1.1 Organisation of this paper

This paper introduces the special issue, starting with the context of the papers submitted and a summary of the papers accepted. We then introduce gesture studies, one of the two main domains with which this special issue is concerned. We do not introduce design research: we suppose the readers of AIEDAM are familiar with this domain. After this general introduction to the domain of gesture studies, we provide an overview of gestures in design, that is, the research environment of the papers in this special issue. We then discuss some dimensions on which these papers differ—and are related.

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2. Papers accepted

The role of gesture in designing is new to the AIEDAM readership and authorship: we received notification that nine authors intended to submit a paper. This led to seven actual submissions, which were each reviewed by at least three reviewers. Three papers were accepted for publication. While these papers do not cover the entire domain of gesture in designing and are not representative of the scope of gesture in designing, they provide a contribution to three important areas:

- The role of pointing in design meetings
- A computational approach to identifying gestures in design protocols
- The role of gesturing in graspable user interfaces

"Getting the point: The role of gesture in managing intersubjectivity in a design activity" by Jared Donovan, Trine Heinemann, Ben Matthews and Jacob Buur describes the complexity of pointing as it is employed in a design workshop. Using the method of interaction analysis, the authors argue that pointing is not merely employed to index, locate or fix a reference to an object, but rather constitutes a practice for re-establishing intersubjectivity and solving interactional trouble, such as misunderstandings or disagreements, by virtue of enlisting something as part of the participants' shared experience. The authors discuss implications for how such practices might be supported with computer-mediation, arguing for a 'bricolage' approach to systems development that emphasises the provision of resources for users to collaboratively negotiate the accomplishment of intersubjectivity rather than systems that only support pointing as a specific gestural action.

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In "Using speech to identify gesture pen strokes in collaborative, multimodal device descriptions," James Herold and Thomas F. Stahovich argue that a challenge in building collaborative design tools that use speech and sketch input is in distinguishing gesture pen strokes from those gestures that represent device structure, i.e., object strokes. Starting from previous work that had shown the critical importance of speech-sketch alignment in order for a gesture/object classifier to establish this distinction, Herold and Stahovich, in their present study, develop a new alignment technique. The authors report experiments that showed that speech features are the most important for distinguishing gestures, thus indicating the critical importance of the speech-sketch alignment. The authors' new technique automates the alignment and employs a two-step process, that is, speech segmentation followed by alignment of the speech segments with the pen strokes. Herold and Stahovich describe their two-step technique and present data showing results that improve the accuracy of gesture classification over an existing automated process, and that the automated technique performs nearly as well as the benchmark manual speech-sketch alignment.

The starting point of Elise van den Hoven and Ali Mazalek, in "Grasping gestures: Gesturing with physical artifacts," is that in HCI, gestures are used more and more to facilitate communication with digital applications because their expressive nature enables less constraining and more intuitive digital interactions than conventional user interfaces. The authors call attention to the fact that interaction devices often make use of hand-held objects, or graspable interaction devices. In most cases, the physical objects as interaction devices are used for sensing or input, such as the mouse. In contrast, tangible interaction devices often make use of physical objects as

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embodiments of digital information. The physical objects in tangible user interfaces thus serve two purposes: as a physical embodiment of a digital object and as controls for modifying the associated digital information. Building on this, the authors emphasise the potential of gesture interaction to make use of the physical properties of hand-held objects to enhance or change the functionality of the gestures made. This combination of gestural interaction and tangible interaction—that is, gesturing while holding physical artefacts—underlies the authors' concept of "tangible gesture interaction."

3. Gesture studies

Gestures have been studied since antiquity. Kendon (2004), who gives a detailed historical presentation of the work in this domain, has been himself one of the first modern authors starting to do research on gesture and other "non verbal" communication, such as gaze and posture, in the 1960s of the 20th century (see Müller, 2007, for a presentation of Kendon's work; see also some other representatives of these early gestures studies: Efron, 1941/1972; Ekman & Friesen, 1969). As a research community, however, "gesture studies" exists since only some 20-30 years (Kendon, 2004). It is an interdisciplinary field: gesture researchers come from many disciplines, especially anthropology, linguistics (in particular, pragmatics), psychology, sociology, semiotics, computer science, neuroscience, communication sciences, (art) history, performance studies, music, theatre, and dance.

"Founded in 2002, the International Society for Gesture Studies (ISGS) is the only international scholarly association devoted to the study of human gesture," as one can read on the website of ISGS, http://www.gesturestudies.com/. The Society organises conferences and supports the

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international journal Gesture (http://www.benjamins.com/cgi-bin/t_seriesview.cgi?series=GEST).

One often reads that gesture studies are concerned with how people use their hands and other parts of their body for communicative purposes. This communicative function of gesture seems obvious because of our every-day, pre-scientific experience. What may seem more surprising is that people may also gesture when their interlocutor cannot see them, for example, during a telephone conversation (Bavelas, Gerwing, Sutton, & Prevost, 2008), or because they are blind (Iverson & Goldin-Meadow, 1997). Unsighted people themselves also gesture—also when they did not learn to sign using a sign language (Goldin-Meadow, 1999). In addition, people also may use gesture when they are completely alone, for example, in order to solve a problem. These findings build on and are consistent with McNeill's (1992) views on the relationship between gesture and thought. This research also has implications on the role of gesture in designing to be more than just communicating to another designer, and therefore on the way that we design interfaces to digital design models.

In this paper, we leave aside gesture studies in previous centuries, where, for example, several authors analysed its rhetorical use (see Kendon, 2004). The first contemporary studies in this domain have been concerned with gesture used in face-to-face conversation, often in narrative situations (Bavelas, Coates, & Johnson, 2000; McNeill, 1992) and in learning (Goldin-Meadow, 2009; Roth, 2001). Universal and cultural aspects of gesture are also a recurrent topic, as are the relationship of gesture to thought and language and, related to this, the role of gesture in human evolution and child development and the evolution of sign languages from gesture. Studies on

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sign language, the way it is used and its relations with other gestural communication constitute an important sub-domain in gesture studies (Liddell, 2003). Similarly, the use of gesture in HCI is a contemporary issue in the study of gestures (Herold & Stahovich's and Van den Hoven & Mazalek's papers in this issue reflect this). Often this research aims to make human-system or system-mediated human-human communication more "multimodal," that is, not limited to the verbal and/or graphical modalities. Gesture in a professional context (for example, in designing) unmediated by computer systems—still a very frequent situation—has come into focus more recently.

We also ignore the question of what "is" a "gesture." In their review of gesture in HCI, Van Hoven and Mazalek discuss this topic. Their paper indeed seems an appropriate place for such a discussion, given that, in HCI, the term "gesture" is often used for behaviour that other researchers in gesture studies would rather qualify as a "manipulative" or "practical action," or as a "command" that is the object of a particular type of "communication," given the way in which the computer "understands" this "gesture."

In his review on the "recognition and comprehension of hand gestures," Sowa (2008) remarks that, in HCI, "the term gesture input refers to a range of different interaction styles, many of which have little or nothing in common with coverbal gestures observed in human communication" (p. 39). In Sowa's opinion, his review of the computational approaches shows that there is still "a huge gap between gesture recognition and comprehension technology in HCI and the potential of coverbal gesture as a carrier of meaning in human communication. The majority of systems still focus on gesture recognition as a pattern classification problem" (p. 52).

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In face-to-face interaction, gesture may play many roles. Some examples of gesture use in a face-to-face social-interactional situation are gestures used in turn taking for interaction management or in modelling one's interlocutor's "personality." Dominance, for example, a supposed "personality trait," is expressed by kinesic cues. "Dominant people are often more active, and gestures associated with speech are correlated with dominance." (Gatica-Perez, 2009, p. 1781, in his review of automatic nonverbal analysis of social interaction in small groups).

3.1 Studies of gestures in design

Design generally involves teams of designers who collaborate on a project (Détienne, 2006; Olson & Olson, 2000; Stempfle & Badke-Schaub, 2002). While individual participants in a design team may make independent contributions to the project, collaborative design assumes that contributions are based on the interaction among different participants (Visser, 2006). This interaction occurs through different modalities (that is, different semiotic systems): verbal, graphical, gestural and other modalities (gaze, posture, prosody). Research in the domain of design, however, has given much less attention to gesture (and other non-verbal modalities, except graphical) than other expression and/or interaction modalities that designers use. Until now, verbal interaction has, by far, received most attention (Cross, Christiaans, & Dorst, 1996; Gero & Tang, 2001). A substantial amount of research has concerned graphical interaction (Gross & Do, 2004; Purcell & Gero, 1998), but the role of gesture in designing has been the object of few studies.

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The scarcity of research on gesture in designing should not be interpreted as a decreasing importance of gesture's role in collaborative design interaction, although some people—even design researchers —think or consider it is. Gesture continues to be seen as mostly playing a supplementary role compared to verbal (and graphical) interaction: gestures "illustrate" representations constructed verbally, they are not considered to play an equivalent, and thus essential, role in interaction. Nevertheless, with respect to design interaction between human designers in face-to-face interaction, empirical studies have shown that gesture is being used frequently in design meetings, and serves varying functions.

In an analysis of the empirical studies on the use of gestures in face-to-face collaborative design situations (Bekker, Olson, & Olson, 1995; Murphy, 2005; Tang, 1991), Visser (2009) highlighted two functions. (1) Gesture offers specific possibilities to render spatial (especially 3D) and motion-related qualities of design objects, and to embody action sequences through their mimicked simulation. (2) Gesture plays an important organisational role.

The function of gestures can also be organisational. Visser (2010a) distinguished two types of such gestures. (1) "Interactive" gestures (Bavelas, Chovil, Lawrie, & Wade, 1992) are used to manage the interaction between the different participants in the design meeting. (2) Gestures can also play a role in organising the functional design activities of generation, transformation, and evaluation of design proposals (Visser, 2006).

The use of gestures in the construction of representations of design objects is fundamental. We already underlined the role of gesture in representing both spatial, especially 3D, and non-static qualities of design objects, such as their motion or the action sequences in which they are

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involved (cf. also Bischel, Stahovich, Peterson, Davis, & Adler, 2009 presented below). Such qualities are central in domains of design related to physical objects, such as architectural design, and mechanical, industrial and other forms of engineering design. They are difficult, if not impossible, to render verbally or to represent in drawings in the plane. That is one of the reasons why computerised design environments can be so useful. They offer the possibility to represent design objects in 3D and to work with these representations. However, without such systems (but also when using them, see below the interest of TUI identified by Kim & Maher, 2008; see also Van den Hoven & Mazalek, this issue), speech and even graphical 2D representations are poor instruments to represent these qualities of design objects. Based on her view of designing as the construction of representations (Visser, 2006), Visser (2010a) distinguished two families of representational gestures: gestures that designate and gestures that specify design entities (representational gestures proper).

A particular type of representational gestures are those that serve to express feelings, emotions, and other less factual qualities of design objects than, for example, their size or location. Visser (2010b) analysed how architectural designers used metaphoric gestures in order to represent the atmosphere of the building they were designing (for example, its intimate or bold character). The use of gestures and other non-verbal modalities, such as gaze and posture, in order to translate feelings and emotions, is a timely research topic in the research on embodied conversational agents (Cassell, 2001; Ruttkay & Pelachaud, 2004).

Bischel et al. (2009) conducted an experimental study in which designers in a remote communication situation were asked to describe a mechanical device to another designer. This

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study underlies Herold and Stahovich's (this issue) paper. In order to explain the devices to their colleague, the designers observed by Bischel et al. (2009) made gestures. The authors identified "six common types of gestures … used either to illustrate behavior or to provide spatial context for a part of the description." They distinguished two functional categories: "'selection gestures,' used to relate a spoken description to a spatial location in the sketch, and 'motion gestures,' used to give spatial context to how things move or interact." (p. 1402) Selection gestures were the most frequent type. They are the famous "deictic" gestures (see, for example, McNeill, 1992). Herold and Stahovich take over these two categories, distinguishing gesture pen strokes "to indicate motion" (Bischel et al.'s, 2009, motion gestures, for ex. drawing an arrow to express the movement by an object or a part of it) from gestures produced "to single out a component being discussed" (Bischel et al.'s, 2009, selection gestures, for ex., drawing a circle around an object or a part of it). These are, however, two types of "gesture strokes," which Herold and Stahovich, through their "gesture/object classifier," wish to be able to distinguish from "non-gesture strokes" or "object strokes."

3.2 Gesture in computer-supported design systems

Computer-supported design environments highlight the importance of studies of gesture because they restrict the ways in which designers can communicate their design ideas as input to a digital model, as well as restrict the ability to communicate gesture when the computer mediates a remote design session. Early examples of CSCW include the use of multimodal systems enabled by the use of cameras and microphones to transmit and, in some cases, superimpose gesture to remote participants. Donovan, Heinemann, Matthews and Buur (this issue) provide a good overview of these early systems, showing that many of them are still highly relevant for today’s

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needs for computer-mediated design collaboration. In the interaction modalities provided in HCI, be it between human designers (computer-mediated interaction) or between humans and the system, the use of "gesture" is primarily associated with pen- or stylus-based input or to the use of data gloves that track movement and translate the movement to input. Van den Hoven and Mazalek (this issue) present and advocate that gesture is an important consideration in designing and evaluating HCI for designers and that pointing is only one of many gestures to be considered.

Moving beyond the pen-based interface, the use of tabletop systems as a platform for design meetings, has introduced the use of graspable objects as input devices (for example Maher et al., 2004; Ulmer & Ishii, 1997). These tabletop systems are primarily used for collaboration, where a design team works around a single tabletop. There have been some studies of remote collaboration using tabletop systems, where gesture is recorded and displayed on the remote sites (Obeyesekare et al., 1996; Schmalstien et al., 1999). While these novel HCI environments involve the use of hand and arm movements, little has been studied with respect to these movements as gestures.

Kim and Maher (2008), for example, compared the use of a traditional keyboard and mouse interface to the tangible interaction on a desktop when designers are collaborating on a design configuration task. They specifically observed differences in the frequency and occurrence of types of gestures in the two types of interface, with more gestures occurring in the tangible interface. They also found that designers, when using the tangible interface, had more segments coded as cognitive behaviours associated with generating creative designs. The implications of

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studies of this kind are that interactive devices can be designed specifically to encourage gesture rather than to restrict the use of gesture in computer environments for collaborative design.

3.3 This special issue

This section discusses four dimensions on which the three papers in this special on gesture in design differ—and are related.

3.3.1 Design situation: Face-to-face vs. remote collaboration

Following from the focus on gesture as communication, many design researchers study gesture in a collaborative design scenario. In this issue, two of the three papers report on studies of collaborating designers. Herold and Stahovich study remote collaboration, although their results may have implications for face-to-face collaboration. Donovan, Heinemann, Matthews and Buur study face-to-face design collaboration and report on the implications for remote collaboration. Van den Hoven and Mazalek do not report on the study of designers; however, their survey and analysis of gesture and tangible interaction has implications for the design of computer-mediated remote collaboration.

Herold and Stahovich develop and evaluate a method for the alignment of speech and gesture using data collected while designers were communicating remotely using a tablet PC with a pen interface and drawing program. In this study, the designers communicated using a microphone and earphones while located in different rooms. Therefore, the authors' data on multimodal interaction comes from a remote collaboration environment in which the designers can communicate only by voice and pen strokes. Herold and Stahovich's technique for identifying

discrete gestures in design communication is not specifically based on remote collaboration, but it is tested in that environment. Their work is clearly related to analysing multimodal data in remote collaborative settings, but arguably may also be used to automatically analyse multimodal data of designers using tablet PCs in a face-to-face setting.

Donovan, Heinemann, Matthews and Buur study pointing while observing designers collaborating in a face-to-face scenario. They develop a technique for tracing the pointing action on a video of the design session to identify the roles of pointing. The study identifies several roles of pointing that are not associated with identifying an object. The purpose of the study is to highlight the numerous roles that gesture, and specifically, pointing can play in design and how pointing is used to establish understanding and a shared representation. They include a survey of computer-mediated environments for remote collaboration and argue for a "bricolage" approach, that is, the end users bring together the elements of their environment to support remote collaboration. The end users, for example, "[try] to identify the recurring elements of systems (e.g. projector-camera pairings, display surfaces, drawing implements) and consider how these might be incorporated into new kinds of systems that [they] could bring together in particular ways to suit their needs."

3.3.2 Methodology

Methodology is a critical aspect of understanding the study of the role of gesture in designing. Psychological studies of gesture provide a precedent for this area, but due to the large number of confounding variables in the complex scenario of collaborative designing, the methodologies relevant to studying designing draw from various computational, social and behavioural science

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methodologies. The three papers in this special issue are very different methodologically: real-world vs. experimental setting; qualitative analysis of observations made on designers vs. development and quantitative analysis of gesture features vs. analysis of the literature.

Donovan, Heinemann, Matthews and Buur conducted a case study in a professional working context: they identify and discuss the pointing gestures made in a particular face-to-face design workshop. The interaction-analysis method they use is inspired by the ethnomethodologically-inspired Conversation Analysis, a social-science method launched in the 1960s by the sociologists Sacks and Schegloff [Sacks, 1995 #2779]. Donovan, Heinemann, Matthews and Buur focused on the gestures made by the six participants in the second part of the workshop, which lasted for just over two hours. As part of their study, they develop an approach to characterising the gestures by tracing over the video image of the design session. These traces provide a way of seeing and comparing the different gestures in a still image. Their methodology is effective in providing an exploratory account of the variety of gestures situated in a very specific context and place.

Herold and Stahovich's research commences with an experimental approach, based on the experimental study conducted by Bischel et al. (2009). In Herold and Stahovich's study, the designers are placed in remote locations with specific computer and communication devices, and given a fixed period of time to work together. The data collected during this period of time is the basis for Herold and Stahovich’s contribution: an automated approach to segmenting and identifying gestures using a gesture and speech-alignment technique. The methodology is drawn

primarily from computational science, in which the computational approach is evaluated against other computational methods and a manual method.

Van den Hoven and Mazalek provide a critical survey of HCI technologies with a focus on the design opportunities for new technologies that lie at the intersection of gesture and tangible interaction. They start with an overview of the study of gesture and then consider gestures in HCI in three areas: 3D space, such as gloves, 2D surfaces, such as pens and fingers, and with physical objects in hand, such as batons, game controllers, toys, and custom tangibles. The authors conclude their paper with a discussion of design guidelines for tangible devices for designers based on gesture interaction, because of the possibilities it offers through the use of physical devices that facilitate, support, enhance or track gestures people make for digital interaction purposes.

3.3.3 Domains of design

The two papers in this issue that report on the study of designers, studied mechanical engineering designers. The third paper, a survey paper, is concerned with the design of HCI technology.

The data collected and analysed by Herold and Stahovich is a mechanical engineering design scenario. They claim that their method for aligning speech and gesture is relevant for any domain that involves drawing a sketch or a diagram and explaining its elements. Some examples of other domains that the authors identify as being similar are: giving driving directions, explaining the solution to a problem in a physics lecture, and explaining a sports play.

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Donovan, Heinemann, Matthews and Buur also observed mechanical engineering design, and specifically, "a collaborative project focusing on designing a new type of sustainable energy generator that can replace the noisy, polluting and fault-prone diesel engines that are currently used to power independent camps and shelters for landmine clearing operations in Angola." Even though the authors do not discuss this question, we assume that their observations concerning the use of pointing are not specific to mechanical engineering design.

Van den Hoven and Mazalek are concerned with the design of HCI technology. The design opportunities identified by the authors concern the possibilities that tangible gesture interaction offers through the use of physical devices for facilitating, supporting, enhancing or tracking gestures people make for digital interaction purposes. The authors do not allude to specific domains of design that might take advantage of environments in which such digital interaction could be used.

3.3.4 Type of gestures studied

Countless classifications of gestures have been made in the classical gesture-studies literature (Kendon, 2004; McNeill, 2000). While one of the papers in this issue, Van den Hoven and Mazalek, presents a review of some of the distinctions made by several authors, the other papers focus on specific types of gestures. Pointing is probably the gesture that has been most studied—and implemented in HCI systems. Not surprisingly then, all three papers in this special issue are concerned with pointing, in one way or another.

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Donovan, Heinemann, Matthews and Buur analyse pointing gestures. In their analysis, they focus on the use of these gestures that go beyond identifying a specific object and characterise pointing as "a practice for re-establishing intersubjectivity and solving interactional trouble such as misunderstandings or disagreements." The authors analyse how pointing may "enlist" something "as part of the [design] participants' shared experience." The authors describe in detail four instances of pointing.

Van den Hoven and Mazalek claim that pointing gestures are also the gestures that are made most frequently in the great majority of today's HCI systems, probably because they are the most easily interpreted gestures in current HCI technology. As Van den Hoven and Mazalek notice, other authors—and we add, laypeople—might qualify many of these "gestures" rather as "actions" or "practical actions," that is, for example, manipulative or performative spatial. Van den Hoven and Mazalek, in addition to presenting gestures used in HCI, emphasise the possibility of designing for gestures made while holding physical artefacts, that is, the intersection of gesture and tangible interaction.

Herold and Stahovich examine pen strokes performed in collaborative design situations—in which designers are allowed to hold a multimodal dialog, that is, in this case, on the one side, talking, on the other side, sketching and "gesturing" through pen strokes. The authors distinguish two types of "gesture strokes" (besides "object strokes," see above). One of those are gestures resolving deictic references. The authors note that these gestures can take many forms such as tapping, circling, highlighting, and tracing. Interesting enough, the authors do not speak of "pointing" (except in their discussion of "Related Work").

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Gesture pen strokes are useful for the designers in their interaction, but, for the most part, only temporarily. That is why it is important to distinguish them from other pen strokes. To keep a trace of all the gesture strokes indeed obscures the sketch on which they have been made. Their accumulation causes essential features of the sketches—representing the structure of the device under design—difficult to discern. So, in Herold and Stahovich's paper, the gestures made over design sketches are identified in order to get rid of them! Doing so, Herold and Stahovich aim to contribute to the construction of more useful collaborative design tools that allow speech and sketch input.

5. Conclusion

This special issue provides a starting point for further research on the role of gesture in designing with a focus on the use of computational systems. We have seen that computational systems provide a role in facilitating and automating the analysis of data that includes gesture, speech, and video. We have also seen that the design of new technologies for interacting with design information can take into consideration the role of gesture in designing. We anticipate that increasing interest in the role of gesture in design thinking and design collaboration will have a major impact on how we support and augment designers using computational systems.

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