

Some notes on mutual awareness

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‘Ensemble performance places a special responsibility on the concentration of the performer, who must attend not only to his own playing but also to that of all the others in the ensemble. All aspects of the performance depend on this **mutual awareness**.’

‘The Art of Music:
The nature and significance of music: PERFORMANCE:
Aspects of Western musical performance.: Mediums of performance.’
(Britannica Online, 1998)¹

The phenomenon of ‘awareness’ among members of cooperative work arrangements has long ago been recognized as crucial to CSCW and the term is now widely used.

What does it mean?

Consider a cooperative work arrangement. The actors are interdependent in their work in the sense that one actor’s actions will change the state of a set of objects and, in turn, this change of state has implications, directly or indirectly, for the work of the other members of the ensemble, and vice versa. Let us call the set of objects the members of the ensemble act upon *the common field of work* of this cooperative work arrangement.

(1) When an actor changes the state of the field of work, the field of work will, so to speak, emit signals of this change which the other actors may perceive. They may be able to perceive it directly (with their senses) or perhaps only indications of them (by means of sensors and other intermediate equipment). A change to the state of this common field of work will propagate within the field of work. As they propagate within the field of work, changes to the state of the field of work are perceivable by members in different ways. If the field of work is a tightly coupled system (e.g., a piece of music being played by an ensemble), changes will affect the work of others instantly and without exception. In a loosely coupled system, on the other hand, changes will propagate over time and contingently. Furthermore, the cooperative work arrangement may be deployed in such a way with respect to the field of work that actors are able to perceive the state of the field of work in its entirety or in such a way that they can only perceive only a section thereof.

¹ <<http://www.eb.com:180/cgi-bin/g?DocF=macro/5004/44/28.html>> Accessed 24 February 1998.

(2) From perceiving the state of the field of work and the changes to it, that is, without necessarily being able to perceive each other and each other's actions, competent members can develop a rudimentary mutual awareness of the activities undertaken by colleagues which enables them to align their own activities with unseen activities of their colleagues so as to accomplish the joint work in an orderly fashion (Popitz et al., 1957). In addition, also from perceiving the state of the field of work and the changes to it, that is, again without necessarily being able to perceive each other and each others actions, competent members can, to some extent, infer the plans and intentions of colleagues, detect if colleagues are facing disturbances etc. (Popitz et al., 1957).

In the steel plant where I've been doing field work, the ladle furnace operators are unable to see the operators of the preceding process (the two furnaces melting the scrap iron) nor can they see the operators of the subsequent processes of continuous casting. Instead they rely on a video link by means of which they have a bird's eye view, at a very low level of resolution, of the hall in which the two furnaces are placed; despite the low level of resolution the video link enables the ladle furnace operators to detect when the operators of the furnaces add new scrap iron to the furnaces (a sudden increase in light intensity often combined with booming sounds and vibrations in the walls and floor). These indicators, combined with laboratory analysis data of samples taken at the furnaces, which are displayed in the same computer monitor on which the analysis data from samples taken at the ladle furnace are displayed, enable the ladle furnace operator and her assistant to calculate when the next charge will be tapped and thus be ready for refinement at the ladle furnace. Similarly, as far as the subsequent process is concerned, the ladle furnace operator has no direct access to following the casting process but she has a meter on which she can see how many tons of steel have been cast from the current charge; this crude indicator enables the ladle furnace operator and her assistant to calculate when the next charge must be ready for casting. Furthermore, she can (with some difficulty, if she is sitting in her chair) see the 'tower' in which the ladle with melted steel ready for casting is placed on a turntable. If the operators of the casting processes encounter problems and have to discontinue the casting, they have to rotate the turntable 180 degrees, which is visible to the ladle furnace operator through a window. She will notice it, get up from the chair to see better, swear under breath, and then begin to reschedule her own work.

(3) Finally, if the members of the ensemble share the same space, they may also be able to perceive each others actions and postures with respect to the field of work: a nuclear power plant operator notices the other operator moving to the other end of the control room, to a particular set of control panels, and will infer that the colleagues is going to initiate certain changes which in turn will affect himself in his work (Kasbi and Montmollin, 1991) or an air traffic controller overhears radio conversations between his colleague and the pilots and takes appropriate steps etc.

(4) Articulation work is a recursive phenomenon (Schmidt and Simone, 1996). Activities undertaken to ensure the fluent articulation of activities within the arrangement (somebody observing another, somebody directing another's attention

to something, somebody asking somebody else about something, somebody requesting or ordering some action, and somebody negotiating actions to be taken) may themselves be perceived so as to enable activities to be aligned.

In all of the above actors, so to speak, exploit the what is there for the picking. They utilize the ubiquitous signals, signs, and clues which somehow indicate the state of the field of work and the state of the cooperative work arrangement and that are continually emitted and disseminated² as a by-product of the cooperative effort or, in the case of item 5, as a by-product of articulating the cooperative effort, to be aware of what their colleagues are doing, that is, to develop *mutual awareness*.

The exploitation of what is already there for the taking distinguishes mutual awareness from other modalities of articulation work, such as directing attention to something, asking about something, requesting or ordering some action, and negotiating actions to be taken, which are all characterized by being deliberate and intrusive in that they enforce a response. *Mutual awareness is the inexpensive mode of articulation work*: it emerges as a by-product of primary work activities, the requisite signals are emitted and disseminated without deliberate effort, and the ensuring awareness of the state of affairs does not intervene in the flow of work by enforcing a response.

Let us try a definition.

The concept of awareness

awareness *n* **1**: having knowledge of; “he had no awareness of his mistakes”; “his sudden consciousness of the problem he faced”; “their intelligence and general knowingness was impressive” [syn: {consciousness}, {cognizance}, {knowingness}] **2**: state of elementary or undifferentiated consciousness; “the crash intruded on his awareness” [syn: {sentience}]

sentience *n* **1**: state of elementary or undifferentiated consciousness; “the crash intruded on his awareness” [syn: {awareness}] **2**: the faculty through which the external world is apprehended [syn: {sense}, {sensation}, {sentiency}, {sensory faculty}] **3**: the readiness to perceive sensations; elementary or undifferentiated consciousness: “gave sentience to slugs and newts”-Richard Eberhart [ant: {insentience}]

(Hypertext Webster Gateway, 1998)

In English, the noun ‘awareness’ generally has two senses: (1) *consciousness, cognizance, knowingness: having knowledge of*: ‘he had no awareness of his mistakes’; ‘his sudden consciousness of the problem he faced’; ‘their intelligence and general knowingness was impressive’ and (2) *sentience*: state of elementary or undifferentiated consciousness; ‘the crash intruded on his awareness’ (Hypertext Webster Gateway, 1998; WordNet, 1998).

Within CSCW the term ‘awareness’ is generally being used in the second sense, that is, to denote actors’ ‘elementary or undifferentiated consciousness’ of or

² I prefer the term ‘dissemination’ (or ‘diffusion’) to ‘broadcasting’ because ‘broadcasting’ is far too specific. See the ‘Note on broadcasting’ in the appendix.

sentience to the state of affairs within the cooperative ensemble of which they are members, as opposed to deliberate and focused attention or knowledge derived from deliberate and explicit interactions such as conversations.

Sometimes the term ‘*mutual awareness*’ is being used instead of ‘awareness’ in order to emphasize that we are speaking of *awareness of the state of a cooperative effort* as opposed to awareness of other aspects of the world at large.

There are reasons to distinguish between ‘mutual awareness’ in the above sense and ‘*reciprocal awareness*’:

mutual *adj* [ME, fr. MF *mutuel*, fr. L *mutuus* lent, borrowed, mutual, fr. *mutare* to change--more at mutable] (15c) **1 a**: directed by each toward the other or the others <~ affection> **b**: having the same feelings one for the other <they had long been ~ enemies> **c**: shared in common <enjoying their ~ hobby> **d**: joint **2**: characterized by intimacy **3**: of or relating to a plan whereby the members of an organization share in the profits and expenses; *specif*: of, relating to, or taking the form of an insurance method in which the policyholders constitute the members of the insuring company.’ (Merriam-Webster’s Collegiate® Dictionary, 1998)

reciprocal: Inverse \In*verse”, a. [L. *inversus*, p. p. of *invertere*: cf. F. *inverse*. See {Invert}.] **1**. Opposite in order, relation, or effect; reversed; inverted; reciprocal; -- opposed to direct. **2**. (Bot.) Inverted; having a position or mode of attachment the reverse of that which is usual. **3**. (Math.) Opposite in nature and effect; -- said with reference to any two operations, which, when both are performed in succession upon any quantity, reproduce that quantity; as, multiplication is the inverse operation to division.

Usage: {Reciprocal}, {Mutual}. The distinctive idea of mutual is, that the parties unite by interchange in the same act; as, a mutual covenant; mutual affection, etc. The distinctive idea of reciprocal is, that one party acts by way of return or response to something previously done by the other party; as, a reciprocal kindness; reciprocal reproaches, etc. Love is reciprocal when the previous affection of one party has drawn forth the attachment of the other. To make it mutual in the strictest sense, the two parties should have fallen in love at the same time; but as the result is the same, the two words are here used interchangeably. The ebbing and flowing of the tide is a case where the action is reciprocal, but not mutual.

Webster’s Revised Unabridged Dictionary (1913),
(Hypertext Webster Gateway, 1998)

The term ‘reciprocal awareness’ should thus be used in the narrow sense of A’s awareness of *B’s awareness of A*, whereas the term ‘mutual awareness’ should be used in the broad sense to denote A’s awareness of B’s *activities* and, *vice versa*, B’s awareness of A’s *activities*. This is, in fact, the way the term ‘reciprocity’ or ‘reciprocal perception’ has been used in CSCW literature (e.g., Fish et al., 1990; Robertson, 1997, pp. 19-21, 155-158). For example, in ‘media spaces’ one actor does typically not become aware of another actor’s staring at the screen to monitor the first actor’s activities (Heath et al., 1995). This phenomenon can usefully be considered as a breakdown of reciprocal awareness.

Reciprocal awareness is recursive (A’s awareness of *B’s awareness of A*) but not frivolously recursive, as awareness of awareness of awareness etc. Reciprocal awareness is rather mutual awareness *with respect to articulation work*, i.e., in the specific sense of A’s awareness of B’s *monitoring* of A. This usage makes sense since we’re analyzing cooperative work, not the theoretically possible permutations of cognitive states.

From this perspective I will submit the following definition of the concept of awareness as an aspect of cooperative work and its articulation:

- (1) Mutual awareness is a mode of articulation work.
- (2) Mutual awareness is the elementary or undifferentiated consciousness of or sentience to the state of the cooperative effort.
- (3) The provision of information pertaining to mutual awareness is achieved in the course of doing the work, through the emission and dissemination of requisite signals, signs, and cues, by contrast to more deliberate modes of articulation work such as directing the attention of a colleague to a certain aspect of the setting or the processes, instructing or requesting a colleague to take certain actions, negotiating actions to be taken etc.
- (4) The acquisition of information pertaining to mutual awareness is non-intrusive in the sense that it does not intervene in the flow of work by enforcing a response: it merely enables the actor to adjust his or her activities to the perceived or projected state of affairs so as make his or her activities mesh seamlessly into the collective effort.
- (5) Mutual awareness is awareness of activities within the ensemble: their aim, state, possible effects and ramifications etc. whereas reciprocal awareness is awareness of those activities that serve the articulation of cooperative work and thus a special case of mutual awareness.

The production of mutual awareness

From a CSCW perspective, the crucial point about the concept of mutual awareness is to understand how mutual awareness is produced, i.e., (1) how information pertinent to mutual awareness is provided and acquired by members of the cooperative ensemble, and (2) how the characteristics of the work setting constrain and afford the provision and acquisition of information pertaining to mutual awareness.

Ad 1: While mutual awareness is based on exploitation of clues and signals that are emitted and disseminated in the course of the work, a range of workplace studies, that investigated how mutual awareness is produced and maintained by members of the cooperative ensemble, have demonstrated that mutual awareness does not occur through osmosis or some other automatic process. It does not simply happen by 'being there'. Mutual awareness is produced through very delicate practices. While much research is required for these practices to be well understood, the following summarizes what has been established so far:

On one hand, in doing their individual part of the joint effort, actors will typically modulate their own activities so as to provide their colleagues with clues and other kinds of information pertinent to their being aware of these activities; that is, they conduct their own activities in such a way that colleagues can perceive *that* they is being done, *how* they are being carried out, that it will meet constraints in terms of time and quality, that the apparent contingencies will not affect the work of

colleagues (as if to say, ‘don’t worry, I can handle that’), or that they will affect the work of colleagues and when and how and to which extent, so that they can adjust their part of the effort accordingly. In doing that, actors do not make their own work conspicuously and comprehensively visible — doing that would add to the complexity of the work of colleagues — but make it visible in a form and at a level of granularity which is appropriate to the situation facing the colleagues. In short, the message is tailored to the particular audience.

Conversely, actors continually ‘monitor’ or ‘scan’ the activities of their colleagues — by watching or listening, by observing the state of the field of work as it changes due to the work of colleagues etc. — so as to ascertain the state of these activities, that is, to ascertain whether they are being done and progressing as expected, to determine exactly how one own activities need to be adjusted to mesh with the unfolding work of the colleagues, and so forth. Again, this monitoring of the work of colleagues typically is not done conspicuously because doing so would make the colleague being watched aware of being watched — unless that (i.e., recursive awareness) is desirable, e.g., for safety purposes, as if to say ‘Don’t worry, I see what you’re doing’.

Ad 2: From a CSCW point of view, it is crucial to understand how articulation work is constrained and afforded by the specific characteristics of the work setting:

- (a) the shared physical work space and the media it provides for dissemination and interaction (e.g., sound, vision, odors, vibrations, touch, movement); and
- (b) the artifacts ‘inhabiting’ the setting (equipment, tools, materials, symbolic artifacts).

(a) The issue of how shared physical work space and the media it provides offer different constraints and affordances with respect to the facilitation of mutual awareness have been investigated fairly systematically (albeit far from conclusively) within CSCW, especially by CSCW researchers addressing the difficulties that arise when one attempts to support the provision and acquisition of mutual awareness through ‘media spaces’, i.e., continually open audio-video links (e.g., Gaver, 1991; Heath and Luff, 1991; Gaver, 1992; Heath and Luff, 1992; Gaver et al., 1995). For example, in a brilliant analysis Gaver (1992) found that media spaces were characterized by the following constraints when compared to a shared physical space:

Vision:

- Video provides a restricted field of view on remote sites; this limits peripheral vision and constrains perceptual exploration.
- The resolution of video limits detailed inspection.
- Video offers limited information about the spatial configuration of remote scenes; and thus limits exploration, inspection, and peripheral awareness.

Listening:

- Audio links are usually monophonic which impedes localization.
- Sounds are altered by electronic media.

Movement:

- Cameras and microphones are stationary or can only moved at the remote site.

Interactive movement:

- Media spaces are often discontinuous, reducing the ability to create communicative gestures and to control conversational access.

Predictable interaction:

- Media spaces are often anisotropic, making prediction difficult.
- Video is anisotropic, interfering with the design of communicative gesture and with gaze awareness.

This approach to the analysis of the affordances and constraints characterizing media spaces should be pursued further, without necessarily focusing on issues pertaining to the design of media spaces. In particular, it might very well prove fruitful to conceive of the field of work along those lines and analyze it as a medium facilitating the dissemination of mutual awareness.

(b) By contrast to the research motivated by the media space idea, surprisingly little research has investigated how information pertaining to mutual awareness is produced through the manipulation of artifacts in the course of work [for excellent exceptions, cf. Popitz, 1957 #47; Harper, 1989 #246]. For CSCW purposes, this scarcity is problematic.

Finally, the two set of issues intersect: information pertaining to mutual awareness produced through the manipulation of *artifacts* in the course of work is disseminated through different *media*.

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Appendix: A note on ‘broadcasting’

Broadcast, *n.* (Agric.) A casting or throwing seed in all directions, as from the hand in sowing.

Webster’s Revised Unabridged Dictionary (1913),
(Hypertext Webster Gateway, 1998)

broadcast *adj* **1**: made widely known especially by radio or television; “the broadcast news”; “everyone heard the broadcast rumors” [*syn*: {aired}] **2**: sown by casting over a wide area especially by hand; “the broadcast sowing of wheat” *n* **1**: message that is transmitted by radio or television **2**: a radio or television show; “did you see his program last night?” [*syn*: {program}, {programme}] *adv*: so as to scatter or be distributed widely or in all directions *v* **1**: broadcast over the airwaves, as in radio or television; “We cannot air this X-rated song” [*syn*: {air}, {send}, {beam}, {transmit}] **2**: as of information [*syn*: {circulate}, {circularize}, {circularise}, {distribute}, {disseminate}, {propagate}, {spread}, {diffuse}, {disperse}, {pass around}]

(WordNet, 1998)

broadcast: A transmission to multiple, unspecified recipients. On Ethernet, a broadcast packet is a special type of multicast packet which all nodes on the network are always willing to receive.

The Free On-line Dictionary of Computing (15Feb98)
(WordNet, 1998)

We may distinguish three elemental communication protocols:

- Conversation: exchanges among two or more specified interlocutors who take turns as speakers and listeners.
- Broadcasting: dissemination of information to multiple, unspecified recipients; the roles are typically fixed: speakers and listeners do not take turns.
- Multicasting: dissemination of information to multiple, specified recipients; the roles are typically fixed: speakers and listeners do not take turns.

The term ‘broadcast’ antedates the age of radio and TV broadcasting and can very well be used in a general sense to denote a transmission to multiple, unspecified recipients, but it is still too specific and not very appropriate for designating the processes of producing mutual awareness. Is the dissemination of information that occurs in the course of doing the work ‘broadcasting’ or ‘multicasting’?

To make matters worse, in real life the distinction between these protocols breaks down. Conversations may be broadcast (like in TV talk shows) and in a broadcasting or multicasting session a recipient may shift role and become a speaker or engage in a conversation with another person who was also previously a recipient (like in some radio talk shows). In the steel plant where I’ve been doing field work, the operator of the ladle furnace has two radio sets on in order to listen to two local radio channels: one for crane-drivers, and one for maintenance. She will be having the two radios running in the background, on low volume, and she

will, from time to time, turn to the radio, turn up the volume and listen attentively. Sometimes, she will hit a button and join the conversation by asking a question or making a comment. Is this then broadcasting, multicasting, or conversation?