

From Conversation to Interaction Via Behavioral Communication.

For a Semiotic Design of Objects, Environments, and Behaviors

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Interaction Design implies Communication Design; not only because communication is a form of interaction, but because interaction frequently is based on communication. However, while speaking of 'communication' we immediately have in mind linguistic exchange (in particular 'conversation'), or other forms of explicit and conventional signs and messages.

The message of this talk on the contrary is the following one:

1. Conversation in strict sense is *not the right model* for interaction; it is misleading: too intention based and too co-operative;
2. The focus of attention should not be on natural language, special languages, communication protocols, but much more on:
 - a. communication by action without special messages sending
 - b. communication by leaving traces in a shared environment.

In this perspective I introduce the theory of silent and physical communication which has a fundamental role in any human interaction and in any object mediation, and will play a crucial role in future technologies for domotic, Human-Robot, Robot-Robot, Human-computer interaction.

1. Against the Linguistic Communication Paradigm

Conversation and dialogue are a very peculiar form of interaction and of communication.

They provide *a misleading model* of both of them.

First of all they are a highly *cooperative activities*, that shouldn't be generalized to 'interaction' (covering also competition, interference, and conflicts) (Castelfranchi, 1998) nor to communication.

In current use of human language there are two goals:

- i) *the speaker's goal*: X behavior has the goal or function that Y recognizes the act, understands the meaning, comes to believe that p
- ii) *the interpreter's goal*: Y has the goal of interpreting X's (speech) act in order to give it a meaning, to get what X means.

Thus they have a "common goal" (Conte and Castelfranchi, 1995) (which can also presuppose mutual knowledge)²: the goal of: "Y understanding *what X means by ...*";

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This is a real common goal on which usually X and Y cooperate for a successful communication (Meijers, 2002).

The communication has been successful only when X and Y achieve this goal: that Y understands precisely what X intends to communicate to him (Castelfranchi e Parisi, 1980; Parisi and Castelfranchi, 1981).

This also because what characterizes linguistic communication is a meta-message "I'm communicating; I intend that you" (Grice, 1957).

Moreover, linguistic communication is characterized by special cooperative principles: altruism in knowledge sharing. These are the famous Grice's principles that I prefer to present as *default rules* of the speaker and of the hearer:

- the speaker's Rule:

provided that you do not have specific motives and reasons for deceiving, by default say to the speaker the truth, relevant for her/him;

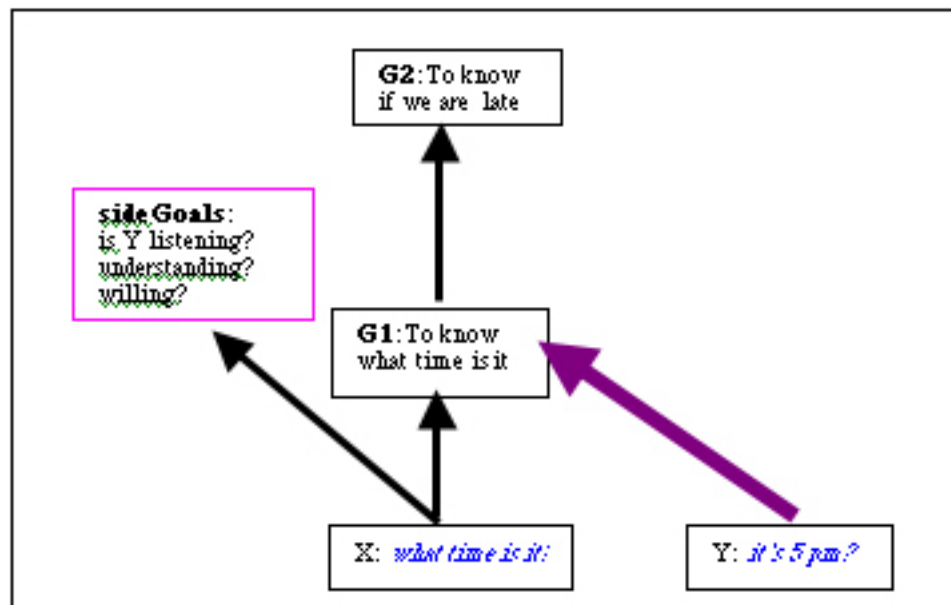
- the hearer's Rule:

provided that you do not have specific motives and reasons for being suspicious about him/her, by default believe what the speaker is saying.

In **conversation** too – which is a coordinated exchange of speech acts - X and Y cooperate in a stronger way: they are building a common goal structure.

The act of the 'responder' in fact *adopts* some of the goal of the act of the speaker, and so on. Let's give three example of different possible 'responses' in conversation (Poggi et al., 1987):

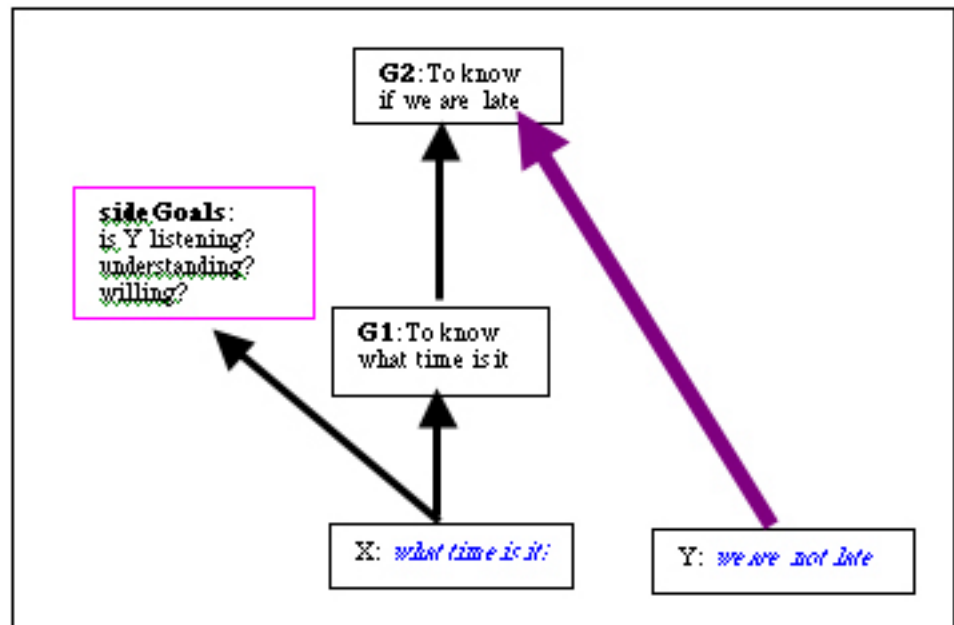
Direct answer:



² X and Y also cooperate in building and maintaining a "common ground" (Clark and Shaefer, 1989).

The goal of Y's speech act is to satisfy directly the main and explicit goal of X's question; the common goal is that X knows what time is it.

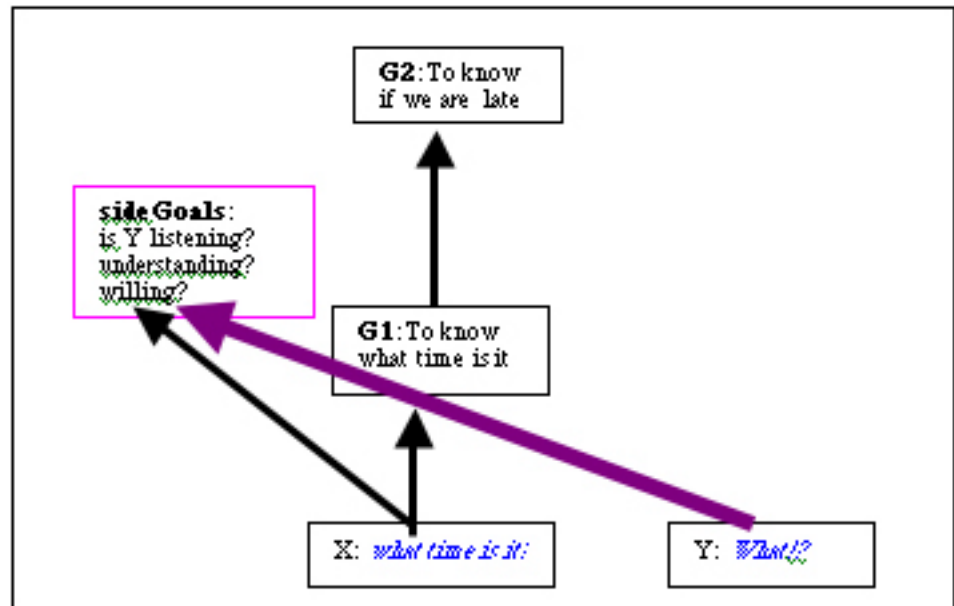
Over-answering (Over-Help):



The goal of Y's speech act is to satisfy the higher goal of X's question; the common goal is that X be quite: it is not late. Y is not literally answering to X's question; Y is helping X apparently doing something different from what has been requested.

Over-help is a very important aspect of human collaboration: Y is really helpful because does not limit himself to do as requested, but does more than expected or even something different. He is able to go beyond our literal request in order to satisfy our needs or interests. This is true and intelligent help. In fact our request might be wrong for our own needs, or (currently) impossible, or not the best solution, etc. while Y provides us a contextual and intelligent solution to our problems (Falcone et al., 2000). How much interactive technologies – on the contrary – are able to anticipate our need and to over-help us?

Side answer:



Y adopts just a side, control goal of X: to know whether Y is listening and understanding what X is saying (Y listen to but did not understand X)

To be true the 'cooperative' perspective and the 'conversation' prototype are misleading not only for a correct view of communication in general, but even for a complete view of *linguistic* communication, which is not always cooperative (as assumed for example by Clark).

Consider for example *exchanges of reciprocal insults*; where not necessarily it is a goal of Y to listen to, to understand, to dialogue with, to maintain a common ground. Cooperation – if any – is *just accidental*. (Castelfranchi, 1992).

Analogously, a normal use of linguistic communication, but non-cooperative at the gricean layer, is deception . Where we have:

- a) hidden intentions and "manipulation" of the other; and
- b) violation of the cooperative principles; or better exception to the default rule.

Communication is just a kind of "social action"; not necessarily bilateral, not necessarily *social interaction*, but necessarily *interactive* since its outcome, its success depends on another agent's activity.

I will not discuss here those general notions for answering the questions: What is Communication? And what about its relationships with interaction?

I will indirectly answer to these questions - and providing a different idea of communication - while exploring the theory of the most basic form of communication: **behavioral communication**; when simple behavior is or is not communication.

This is very important - I believe - for the theory of *meaningful interaction*, and thus also for "Interaction Design".

I will discuss co-ordination and interaction without communication at all; the fundamental notion of 'signification' (the very basic role of the 'receiver'), and the crucial theory of 'behavioral implicit communication' (BIC): how BIC is important in social interaction, and the role of the physical environment in it (*Stigmergy*).

I will explain why this will be very important in designing 'domotic' interaction, and human-'agent' and human-robot interaction.

2. BIC - Behavioral Implicit Communication Theory

Usual, practical, even non-social behaviors can *contextually be used as messages* for communicating. Behavior can be communication without any modification or any additional signal or mark.

I will call this form of communication *without specialized symbols: Behavioral - Implicit Communication* (BIC).

"Behavioral" because it is just simple non-codified behavior.

"Implicit" because – not being specialized and codified – its communicative character is unmarked, undisclosed, not-manifest, and thus deniable;

Communication is just a 'use' and at most a 'destination', not *the* shaping 'function' (Conte and Castelfranchi, 1995).

Normally communication actions are on the contrary special and specialized behaviors (like speech acts, gestures, signals, ...).

BIC is a very important notion, never clearly focused, and very frequently mixed up with other forms of communication (typically the so called "non-verbal" or "expressive" or "extra-linguistic" or "visual" communication).

It has been source of a number of misunderstandings and bad definitions.

This ill-treated notion:

A) It is crucial for the whole theory of social behavior: coordination, control, social order creation, norms keeping, identity and membership recognition, social conventions building, cultural transmission, deception, etc.

A lot of social control and collaboration monitoring and coordination, are in fact based on this form of communication and not on special and explicit messages (communication protocols).

B) Even for the theory of linguistic communication BIC theory is fundamental:

- it is the basis of several pragmatic inferences ("what does X's mean by saying this?")
- it is the origin of the Gricean meta-communicative character of linguistic communication (§ 1.);
- it is the basis of meaning and linguistic conventions negotiation, etc.
- moreover this form of emerging and spontaneous communication is one of the forerunners and premise for the evolution and acquisition of language (Giardini and Castelfranchi, 2003).

2.1 Against Watzlawicz: Are we damned to communicate?

A famous thesis of Palo Alto psychotherapy school was that: "***It is impossible do not communicate***", ... "***any behavior is communication***" in social domain (Watzlawicz et al., 1967).

In this view, a non-communicative behavior is a nonsense.

This claim is too strong. It gives us a notion of communication that is useless because it is non-discriminative. Is simple understanding already communication? Is it possible to clarify when behavior is communication and when is not?

In order to have communication having a "recipient" which attributes some meaning to a certain *sign* is a non-sufficient condition.

We cannot consider as communication any information/*sign* arriving from X to Y, unless it is *aimed* at informing Y.

A *teleological* (intentional or functional) "sending" action by the source is needed. The source has to perform a given behavior "**in order**" the other agent interprets it in a certain way, receives the "message" and its meaning.

Is, for example, an escaping prey "communicating" to its predator/enemy its position and move? Watzlawich's overgeneralization cannot avoid considering *communication* to the enemy the fact that a predator can observe the movement of the prey. Although this information is certainly very relevant and informative for the enemy or predator, it is not communication. Receiving the information is *functional (adaptive) for the predator* and for that species which have developed such ability, but it is not functional at all, is not adaptive for the prey. Thus "sending" that sign is not a functional (evolutionary) goal of the prey, that is what matters for having communication.

Analogously, is a pilferer informing or communicating to the guard about his presence and moves? The pilferer does not notice that there is a working TV camera surveillance system and thus *he does not* know that there is a guard that is following him on a screen!

Or when a pilferer while escaping from the police is leaving on the ground prints and traces of his direction, are those signs (very meaningful for the police) messages to it?

We should not mix up mere "Signification" with "Communication". Following Eco (1977) prints on the ground are *signs* for the hunter of the passage of a deer; smoke is the *sign* of a fire; some spots can mean "it is raining" (they are for Y *signs* of the fact that it is raining). We have here simple processes of *signification*.

Notice that *meanings are not conventional* but simply based upon natural perceptual experience and inference. Notice also that *the signal, the vehicle has not been manufactured on purpose for conveying this meaning*, it doesn't need to be "encoded" and "decoded" via some conventional artificial rule.

2.2 The "goal" of communicating: functional Vs intentional communication

The crucial component for the notion of communication is *the teleonomic nature of the act* of "sending" the message. Should we ascribe *intentions* and mental states to any animal (like insects) for accounting for animal *communication*? Or should we renounce to a general notion of communication?

We want to have a general notion and to coherently use the notion of animal communication. In order to do this we need to kind of 'finalism' of 'teleology'. On fact we distinguish between *Goal-Governed* and *Goal-Oriented Agents* and between *Intentions and Functions*.

There are two kinds of goal-oriented systems and behaviors,

- **the cognitive, intentional ones (goal-governed),**

- **the merely goal-oriented** ones

without any internal anticipatory representation of the goal of the action, where the *teleonomic* character of the behavior is merely in its adaptive function.

The teleonomic notion we need has two different meanings:

- either the message is sent *on purpose, intentionally* by X, which should be a cognitive purposive system, an intentional agent (in this case X believes and intends the result – see later);
- or, the message is *not intentional but simply functional*; the sending behavior is not deliberated but is mere goal-oriented behavior, either designed by some engineer, or selected by natural or artificial evolution, or selected by some learning.

Thus, we have two basic kind of communication:

- **Intentional** (or better "goal-governed") communication and
- **Functional** (or "merely goal-oriented") communication.

Functional communication has several sub-type: by evolution-selection; or by design; or by reinforcement learning based on the effects.

Fully Intentional BIC presupposes an intentional stance and more precisely a "theory of mind" in the interpreter, since the message bring by the action is about the mind of the source: his intention, or emotion, or motives, or assumptions, etc.

The **definition of BIC** (at the intentional level) is as follows:

in BIC the agent (source) is performing a usual practical action b, but he also knows and lets or makes the other agent (addressee) to observe and understand such a behavior, i.e. to capture some meaning m from that "message", because this is part of his (motivating or non motivating) goals in performing b.

In sum, BIC is a practical action primarily aimed to reach a practical goal which is also aimed at achieving a communicative goal, without any predetermined (conventional or innate) specialized meaning.

2.3 Why BIC is not "non-verbal", "extra-linguistic" communication

BIC is not the same and has not very much to do with the so called ***non-verbal or extra-linguistic communication*** (NVC) although NVC is through some behavior or behavioral features, and BIC is for sure non-verbal and extra-linguistic.

The few of BIC that has been identified has been actually mixed up with the never well defined notion of "Non Verbal Behavior" (ex. Porter, 1969).

Non-verbal and extra-linguistic communication refers to specific and specialized communication systems and *codes* based on facial expressions and postures, specific gestures, over-segmental features of voice (intonation, pitch, etc.), etc. that communicate specific meanings by *specialized, recognizable* (either conventional ex. policeman regulating traffic or universal ex. emotional signals) *signals*.

BIC on the contrary is not a "language". Any (verbal or non-verbal) "language" has some sort of "lexicon" i.e. a list of (learned or inborn) perceptual patterns *specialized* as "signs" (Givens, 2003): where "specialized" means either conventional and learned as sign, or built in, designed just for such a purpose (function) by natural selection, or engineering.

BIC does not require a specific learning or training, or transmission; it simply exploits perceptual patterns of usual behavior and their recognition.

BIC is an observation-based, non-special-message-based, unconventional communication, exploiting simple side effects of acts and the natural disposition of agents to observe and interpret the behavior of the interfering others.

BIC gestures are just gestures, they are not symbolic but practical: to drink, to walk, to scratch oneself, to chew.

They represent and mean themselves and what is *unconventionally* inferable from them.

2.4 The Stigmergic Over-generalization

The notion of stigmergy comes from biological studies on social insects: how termites (unintentionally) coordinate themselves in the reconstruction of their nest, without sending specific and direct messages to each other. Communication works through physical work traces (stigma) and through the *modification of the environment* (like when a thief leaves fake footprints in order to put the police off the scent).

Stigmergy is defined as "indirect communication through the environment". (Holland and Beckers -1996) This definition of Stigmergic communication is very weak and unprincipled. Doesn't speech propagate through the environment as energy? Isn't a letter or a book a physical environmental sign? Any kind of communication exploits some environmental "channel" and some physical outcome of the act.

The real difference is that in Stigmergic communication we do not have specialized communicative actions, *specialized messages* (that unambiguously would be "direct" messages because would be *just* messages); we have practical behaviors (like nest building actions) and objects, that are also endowed with communicative functions.

Stigmergy is a special form of BIC where the addressee does not perceive the *behavior* (during its performance) but perceives other *post-hoc* traces and outcomes of it.

To be true, perceiving behavior is *always* perceiving traces and environmental modifications due to it, it is just a matter of perception time and of duration of the trace.

2.5 Behavioral Communication step by step

There are several steps in the evolution from mere practical behavior to BIC and to a conventional sign. Let's examine these transition.

i) Just behavior: An agent X is acting in a desert word; no other agent or intelligent creature is there, nobody observes, understands or ascribes any meaning to this behavior b.

Neither "signification" nor -a fortiori - "communication" are there.

ii) Signification: An agent X is acting by its own in a word but there is another agent Y observing it which ascribes some 'meaning' m to this behavior b.

There is in this case "signification" (X's behavior has some meaning for Y, inform it of something), but there is no necessarily "communication".

By "signification" I mean that the behavior of X is a *sign* of something, means something else for Y. For example: "it is moving", "it is eating", "it is going there".

As we know to have communication the signification effect must be on purpose; but this presupposes that X is aware of it. Thus in (ii) we have two possible circumstances:

(iia) X does not know

Consider the pilferer example where he is not aware of being monitored.

(iib) X's awareness: "weak BIC"

Consider now that X knows about being monitored by a guard, but that he does not care at all of it, because he knows that the guard cannot do anything at all.

Y's understanding is here among *the known but unintended effects* of X's behavior. Although perhaps being an 'anticipated result' of the action it is not intended by the agent.

Not only indifferent or negative expected results can be non-motivating, non-intended, but also positive (goal-realizing) expected results can be non-intended in the sense of "non motivating the action", neither sufficient nor necessary for the action.

In our example the pilferer might be happy and laughing about the guard being alerted and powerless and angry.

(iii) true or strong BIC

The fact that Y knows that p is "co-motivating" the action.

The behavior is both a practical action for pragmatic ends (braking the door and entering, etc.) and a "message".

• I call this "strong or true behavioral communication", the pragmatic behavior which maintains its motivation and functionality acquires an additional purpose:

to let/make the other know/understand that p.

(iv) meta-BIC

In BIC there are two goals/functions meeting each other:

i) the communicator's goal: X's behavior has the goal or function that Y "understands", recognizes, comes to believe that p (and this holds from step (iii))

ii) the interpreter's goal: Y has the goal/function of interpreting X's behavior in order to give it a meaning (and this holds from step (ii))

However those goals in the previous forms of BIC are *independent* from one the other.

"Cooperation" is just accidental. They do not really have a "common goal"

Since, in (ii) X does not know that Y wants understand his behavior; while in (iii) Y does not know that X is communicating to him through it behavior b.

Thus Y has not the goal of: "understanding what X means by b"; that is the real *common goal* of higher form of communication (like *linguistic communication*) on which usually X and Y cooperate for a successful communication.

In **meta-BIC** (without specialized messages) the agent *cooperate*, and the two goals (i and ii) are complementary, convergent and functional one to the other.

There is a meta-communication in higher forms of communication:

BIC meta-message is as follows:

"this is communication, this is a message not just behavior; it is aimed at informing you".

Also because of this Y knows that X is communicating. Therefore he has a special form of goal (ii), the goal of catching what X is *communicating*

iiB: goal Y to understand what X's intends to communicate, to understand which is the meaning in X's mind.

(Y understands/interprets X's behavior as a communicative behavior).

Frequently BIC has such a high level (Grice's way) nature.

For example **the act of giving** or offer is not only a practical one, but is a communicative act where X intends that Y understands that she is putting something closer to Y *in order* Y (understanding that she intends so) takes it.

Beyond BIC: (iv) For communication only

the behavior b is intended and performed by X only for its meaning, only for making Y know that p. There are no longer practical purposes. The act is usually performed either out of its practical context or in a incomplete and ineffective way.

Simulation

Notice that in the pilferer's scenario, that fact that the β has *only a communicative goal* means that it is **a fake action!** In fact, if β has no other goals apart from communicating to Y, Y will be deceived, the information he will derive from observing β will be false (and β is precisely aimed at this result). It is just a bluff.

Ritualization

The practical effect is irrelevant: the behavior is ready for **ritualization**, especially if is not for deception but for explicit communication.

Ritualization means that _ can loose all its features that are no longer useful (while were pertinent for its pragmatic function) while preserving or emphasizing those features that are pertinent for its perception, recognition and signification.

After *Ritualization* the behavior will obviously be a specialized communicative act, a specialized and artificial signal (generated by learning and conventions).

3. Ubiquitous BIC

BIC is ubiquitous in human life, environments, interactions. However, different messages and different meanings are communicated via mere behavior. Let us examine some of them.

3.1 "I'm able" or "I'm willing"

The most frequent message sent by a normal behavior is very obvious (inferentially very simple, given an intentional stance in the addressee) but incredibly relevant:

*"(as you can see/realize) **I'm able to do, and/or I'm willing to do; since I actually did it (I'm doing it) and on purpose"**.*

Let's now explore several different uses of this crucial BIC message.

Skills demonstration in learning, examines, and tests

When X is **teaching** something to Y via examples and observes Y's behavior or product to see whether Y has learned or not, then Y's performance is not only aimed at producing a given practical result but is (also or mainly) aimed at showing the acquired abilities to X.

NB. Also the behavior of the teacher is a BIC; its message is: "look, this is how you should do". Usually this is also joined with expressive faces and gestures (and with words) but this is not the message I'm focusing on.

Showing, Exhibiting and Demonstrating

If showing and exhibiting are intentional acts they are always communication acts

Demonstrating is a true action not a simulation, a faked action.

ex. Gandhi's protest

Warnings without words

This is a peculiar use of *exhibition of power* and dispositions that deserves special attention.

Mafia's "warning", monition. The act (say: burning, biting, destroying, killing) is a true act and the harm is a very true harm, but the real aim of this behavior (burning, killing, etc.) is communicative. It is aimed at intimidating, terrifying via a specific meaning or threat: "I can do this again; I could do this to you; I'm powerful and ready to act; I can even do worst than this". This meaning - the "promise" implicit in the practical act - is what really matter and what induces the addressee (that not necessarily is already the victim) to give up. The practical act is a *show down* of power and intentions; a "message" to be "understood". The message is "if you do not learn, if you will do this again I will do even worst".

The same do nations: consider for example the repeated reaction of Sharon after terrorist attacks in Israel; it is not only a revenge, it is a message: "do this again and I will do this (bombing) again"; the same holds for terrorist bombs. Perhaps it would be better communicating via words and diplomacy, this is a horrible way of communicating.

Is all this "expressive - non verbal - communication"? Bombing is bombing (not particularly "expressive"), and can be unintentional (by mistake and accident), or intentional just for destruction and/or mere

revenge or material prevention, but it can (*also*) be a message, possibly without any different features at all.

3.2 "I did it"

Another typical meaning of BIC is simply "I did it; I did so". This is very relevant in several human interaction where a given behavior of X is expected by Y. Consider for example, I child *showing* the mother that he is eating a given food, or a psychiatric patient *showing* to the nurse that he is drinking his drug

This message is particularly important in the satisfaction of social commitments and obligations (see later), but it has other uses.

For example, for serial synchronization in coordination and collaboration: if the action of Y in a common plan presupposes the previous accomplishment of the act of X, and the coordinate is based on observation, then the act of X means: "done! its your turn".

For example, when being invited at dinner our finishing the food and 'cleaning the plate' means "I finished it, I liked it", as the guest wish and expects.

3.3 "I conform; I agree". Imitation-BIC as convention establishment and memetic agreement

Imitation (i.e. repeating the observed behavior of Y – the model) has several possible BIC valences (we already saw one of them).

The condition is that Y (the model) can observe (be informed about) the imitative behavior of X.

We can consider at least the following communicative goals:

- a. In **learning-teaching via imitation**. X communicate to Y "I'm trying to do like you; check it: is it correct?"
- b. In **convention establishment and propagation**. "I use the same behavior as you, I accept (and spread) it as convention; **I conform** to it".
- c. In imitation as emulation and **identification**: "I'm trying to do like, you **I want to be and to behave like you**" you are my model, my ideal"
- d. In imitation as **membership**: "I'm trying to do like, you I want to be and to behave like you; since **I'm one of you**; I want to be accepted by you; I accept and conform to your uses (see -b)".

Let me focus a bit on the second BIC use of imitation, that is really important and probably **the first form of memetic propagation through communication**.

X interprets the fact that Y repeats its innovation as a confirmation of its validity (good solution) and as an agreement about doing so. Then X will expect that Y will understand again its behavior next time, and that Y will use again and again it, at least in the same context and interaction.

An example: linguistic negotiation (terms, meaning, rules, ...)

Very rarely we explicitly negotiate and discuss about the new terms that we introduce, the use and meanings of words, the linguistic rule and conventions. We just try to understand and to be understood and to understand whether the other understood us. Linguistic conventions are just a particular case of social conventions we live of.

Our claim is that tacit agreement or consent ('Qui tacet consentire videtur') is the way social conventions and informal norms emerge. (Castelfranchi et al. 2003). Let's simplify this complex domain with a simple example from linguistic negotiation about the creation and establishment of a new name (as for social norms see 4.).

To name X I use the new term *bbb* (for example to call Amedeo I introduce the name "Amed") with my hearer H:

1. my hearer understands (I infer this from her answer or reaction)
2. my hearer does not protest/discuss

I interpret H's non-protesting/discussing as an implicit acceptance (at least passively and for the moment) of my use; and -more than this- of an implicit behavioral communication of such an acceptance (in not reacting H is *communicating* me "OK, I let you use this term")

this is some sort of **weak "implicit acceptance"** of my use of *bbb* by H. When I will use again *bbb* with H I will **expect** (believe + want) that

- H understands again,
- H will not protest/discuss
- H knows about my expectations.

In **strong implicit acceptance, H re-uses** herself the term *bbb* (in the same occasion or later). In doing so H expects that:

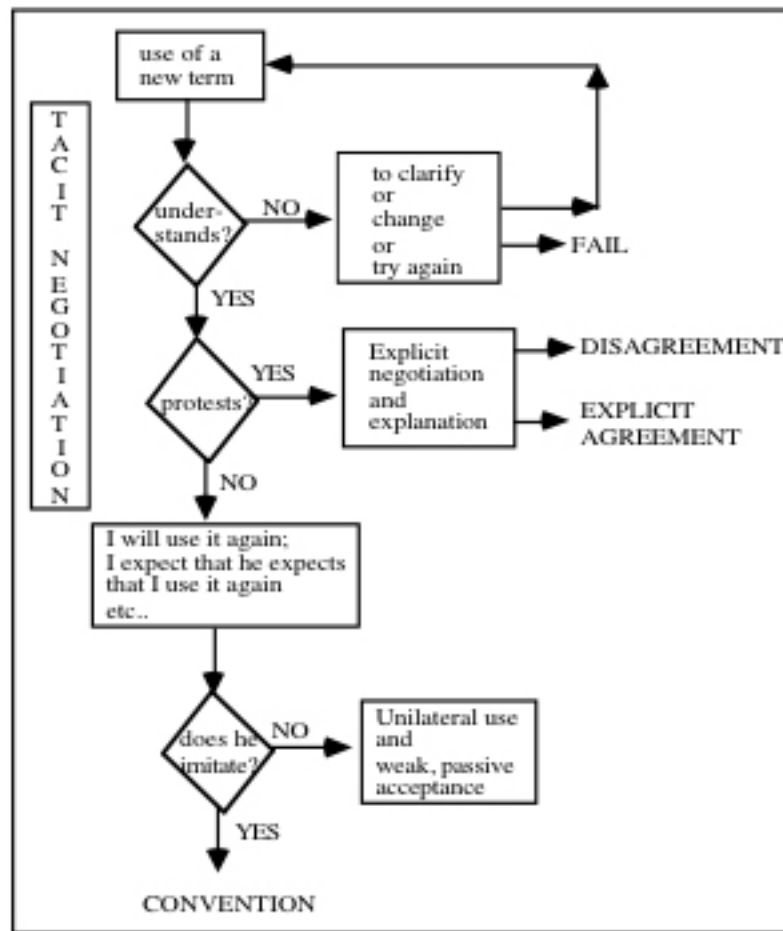
- I understand,
- I do not protest/discuss
- I know about these expectations.

There is now a true implicit **convention**, a tacit agreement about using *bbb* (at least between us and in similar contexts)

If somebody else listen to us in using *bbb*, or H uses *bbb* with other people, the new term is spreading around and a diffuse collective linguistic convention is establishing.

We can distinguish **two phases**.

- One is a **tacit negotiation** and produces weak implicit acceptance;
- the other is **active reuse** and produces a true convention.



3.4 Stigmergy in humans: some nice example with deontic components

Let's now mix up several possible meanings of BIC messages while focusing on various interesting uses of them, like human Stigmergy.

Leaving the coat on the seat

meaning "already taken, not free". This is a *sign*, deliberately used for meaning (signaling) this. It's communication. But for communicating we simply use an usual object in its usual practice: putting a beg on a seat

Since people derive from this "trace" the fact that "this seat is already in use by somebody that is momentary absent but will be back" and we know that, we use on purpose this as a BIC message. We didn't need establishing this meaning arbitrarily.

Let's notice that this diffuse social practice has later become a "convention", this sign/message start to be 'conventionalized' and specialized.

Bestsellers

While buying a book (for your own pleasure- we in fact leave **a strange trace** in the environment: we modify the number of sold copies. This changes the position of the book in the bestsellers list, and this is an information (intentionally sent by the publisher or by the booksellers to the potential clients) that will be taken into account by other persons. Is communication, although your act just remains

the practical act of buying a book, with its practical intended effect for you. You do not intend in this case to communicate anything at all, but in fact in that market your behavior has acquired such a parasitic (exploited) communicative *function*

Parking marks

A beautiful example of stigmergic communication with normative (prescriptive and permissive character) is the use of painted blue or white lines on the ground for car parking, delimiting the car area and *indicating* their disposition: either in form of a comb, or parallel to the side-walk. Those lines not are just signs and instructions: "you are allowed to park; and should park in this position", but they also have a practical and physical function.

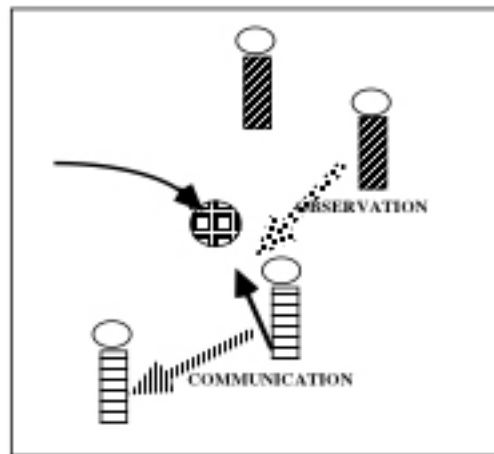
They are not merely messages; in fact, they cannot be replaced by a simple poster illustrating the prescribed car disposition in that street. They also have the practical function of visual reference point in the manoeuvre to be used during the act of parking.

So we put in our physical environment - for coordinating our actions - physical object that are at the same time messages: precisely like termites, but with an additional deontic character.

3.5 BIC Soccer: BIC actions + Stigmergic Communication Through the Ball

In soccer the players of the same team usually communicate with one the other – in order to coordinate their actions – simply through their movements and through the ball itself ("Look, I'm going on the right!"; "Look, I'm passing you the ball! Take it!").

The same moves are for their opponents just 'signs' not 'messages', except when they are faked or in a few circumstances where I intend that my adversary understands what I'm doing.



3.6 Silence as communication

It is very well known that silence can be very 'eloquent'. In general, doing nothing, abstaining from an action, is an action (when is the result of a decision or of a reactive mechanism), thus it can be – as any behavior – aimed at communicating via BIC.

The meanings of silence or passivity are innumerable, depending on the context and on the reasons for keeping silence (or doing nothing) that the addressee can ascribe to "sender". We can for example mean

indifference "I'm not involved, I do not care", "I do not rebel", – "I do not know", etc.; or respect and obedience; or stoicism; etc. . The most important social use, however, as we already saw is for 'tacit agreements' that by definition are BIC-based. It is opportune that we spend some more word on BIC and Social Order.

4. BIC basement of Social Order

BIC has a privileged role in social order, in establishing commitments, in negotiating rules, in monitoring correct behaviors, in enforcing laws, in letting spontaneously emerge conventions and rules of behaviors. If there is a 'Social Contract' at the basement of society this Social Contract has been established by BIC and is just tacitly signed and renewed.

4.1 Fulfilling Social Commitments and Obeying Norms as BIC

This is another kind of demonstrative act, not basically aimed at showing power and abilities, or good disposition, but primarily intended to show that one have done the *expected* action. Thus the performance of the act is also aimed at informing that it has been performed! This is especially important when the expectation of X's act is based on *obligations* impinging on X, and Y is monitoring X's non-violation of his duty. Either X is respecting a prohibition, or executing an order, or keeping a promise.

A second order meaning of the act can also be: "I'm a respectful guy; I'm obedient; I'm trustworthy", but this inferential meaning is reached trough the first meaning "I'm respecting, obeying, keeping promises".

A **Social-Commitment** of X to Y of doing the act, in order to be really (socially) fulfilled, requires not only that agent X performs the promised action , but also that the agent Y knows this.

Thus, when X is performing the act in order to keep his promise and fulfill his commitment to Y, he also intends that Y knows this.

(If there are no explicit and specific messages) any act of S-Commitment fulfillment is also an implicit communication act about that fulfillment.

Notice that what is important for exchange relationships or for social conformity, is not that x really performed the act, but that y (or the group) believes so.

One of the functions of norm obedience is *the confirmation of the norm itself, of the normative authority* of the group, and of conformity in general thus one of the functions of norm obeying behaviors is that of informing the others about norm obedience.

At least at the functional level X's behavior is BIC.

Frequently, X either is aware of this function and collaborates on this, thus he intends to inform the others about his respect of norms, or he is worrying about social monitoring and sanctions or seeking for social approval, and he *wants the others see and realize that he is obeying the norms.*

In both cases, his conform behavior is also an *intentional* implicit communication to the others.

Of course, X can also *simulate* his respect of the norms, while secretly violates them.³

³ In conformity to conventions the behaviour is less intentional (Lewis' restriction)and more routinary and automatic; they are our habits, they do no require a conscious decision. Thus, although clearly there is an informative aim of this behaviour (since the whole convention is based

At the collective level, when I respect a norm I pay some costs for the commons and immediately I move from my mental attitude of norm addressee (which recognized and acknowledge the norm and its authority, and decided to conform to it) while adopting the mental set of the norm issuer and controller (Conte and Castelfranchi, 1995):

I wants the others to respect the norm, pay their own costs and contribution to the commons.

While doing so I'm **reissuing** the norm, **prescribing** a behavior to the others and **checking** their behavior (expectation). Thus the meaning of my act is twofold:

"I obey, you have not to sanction me";
"Do as I do, norms must be respected".

As an example of the second behavioral message let me propose Socrates' drinking the poison. Although his friends and fellows were pushing him to escape Socrates wants to *drink in order to teach* us and his fellows that norms (although iniquitous) must be respected: *the content of the message, the conveyed meaning of the act is its motivation, its reason*. Which sermon could be more eloquent than his act?

Also the act of violating a norm can be a communicative act, either intentional or even functionally. This is for example the case of the "provocative" attitudes of adolescents

5. Designing for Behavioral and Trace-Based Communication

While *Designing Interaction* we have to design:

- Visibility and monitoring: we should wonder whether the actors in a given context can see each other (glasses, windows, ...), or who sees whom and for what, and whether monitoring the other's behavior is possible or not (consider the rooms of certain offices with transparent walls). This was the idea of the celebrated *Panopticon* of Bentham.
- Self-explanatory artifacts (Norman, 1997) and behaviors The very famous capability that tools and artifact should have for 'signifying' their function, for making intuitive the comprehension of their use, when designed on purpose would be a form of communication, to be carefully designed.
- Stigmergy in the shared environment: we should wonder whether the environment is apt for leaving traces on/in it in order the others can recognize and use them.
- Messages endowed in environment, objects, dresses, acts, ...
- Coordination channels should be foreseen:
 - Coordination without any communication;
 - Coordination via BIC;
 - The possibility for an object to work as a coordination device;
 - Specialized coordination artifact
 - Coordination via communication protocols and devices;
 - Coordination via natural language
- Environments and devices both for cooperation, for isolation and privacy, for conflicts.

on mutual assumptions and expectation about the others' conformity), this aim is usually a function of the behaviour not an intention; it becomes an intention in cases that I want that people notice that I'm following that convention.

5.1 BIC in domotic, robotic and human-agent interaction

A wrong or at least limited paradigm is currently dominating the approaches to Human-computer and human-robot interaction. HCI is in fact moving towards a new paradigm: from the 'Interactive' paradigm to what we call the 'Collaborative' paradigm. In the Interactive perspective the priority was about dependability, comprehensibility, the right feedback and interface, the possibility to intervene actively by the side of the user, the personalization and presentation of information, etc., while in the Collaborative perspective there is a 'mixed initiative' approach. The computer (especially in terms of some 'Agent' in the role of 'personal assistant', or mediator, or representative, or mobile agent, etc.) is supposed to have some initiative, to learn or understand about current user's intentions, plan, or needs and anticipate her request or 'over-help' her for example providing more information or operations than explicitly requested. A real collaborator is expected to be able to do more and better than planned by us, and to go beyond the request for really helping us (Falcone et al. 2000).

In this collaborative paradigm based on mutual understanding, anticipation and initiative BIC communication (the possibility to rely upon the other perceiving the results of our action, and understanding what we did or our plan and aim) is crucial. This holds in our interaction with our personal computer that is supposed to understand and anticipate what we are doing or with our personal assistant Agent.

This should also apply to CSCW and computer mediated collaboration: we cannot send boring messages for informing partners that we did our job and keep our commitments, especially when we did them on and through the computer or the net. Some form of 'observation' by the partners should be allowed and exploited; or some machine-understanding of our acts. When humans cooperate the product itself of the action of X passed to Y is *the message* "I did; this is for you; now its your turn". We do not want be obliged to unnatural and explicit coordination messages.

Analogously, I do not want to interact with my domestic robot or with my smart and animated house always by verbal order or special gestures. First of all I want that the robot or the house 'observes' (perceives) me, understand me and what I'm attempting to do, and coordinate with my behavior, for example as for the robot by letting me pass in the corridor or by imitating me or by following me, as for the house by anticipating (adjusting light, conditioning, etc. opening/closing doors, windows, etc.) my movements (Castelfranchi and Giardini, 2003).

6. Concluding remarks

Designers should not have in mind conversation and dialog as the prototype of communication and interaction. Linguistic communication (and even more conversation) biases our view of human interaction. I have illustrated the importance of mere behavior and its environmental traces as communication, and explained how important it is in human coordination, cooperation, social order, cultural transmission, etc.

My suggestion – on that basis – is that while designing an 'object' one should take into account as primary properties not only the practical,

so called 'functional' properties of it and the esthetic ones (from mere formal beauty to affective impact - Ortony and Norman, this book), but also its *semiotic and communicative* properties and its functionality as *coordination or communication 'artifact'*.

Objects are repositories of knowledge, of practices, of memories, of culture. Are they able to store this, to preserve this, to make this accessible, readable? Or are they close and resisting to distributed cognition and memory, to semiosis? Are they able to pass messages, to inform the user or to recall her their appropriate use, to facilitate learning, participation, to favor and do not obstacle interpersonal coordination?

In particular, I have stressed how objects and environments are fundamental *vehicles* and *mediators* of interaction and of communication not in term of explicit and symbolic messages (like blackboards, answering machines, or traffic signals) but in term of 'tacit' although very eloquent behaviors and traces.

Designers should take into account this prominent function of objects, environments and behaviors as *vehicle of meanings* more or less extemporary or conventionalized. Otherwise it would be like designing money simply as strange disks of metal or pieces of paper with figures.

In addition, I have claimed that silent and physical communication will play a relevant role in human-computer, human-robot, human-smart/environment (domotic), robot-robot interaction, and this should be taken into account while design these technologies.

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