

# Seven Types of Visual Ambiguity: On the Merits and Risks of Multiple Interpretations of Collaborative Visualizations

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## Abstract

*The use of visuals as collaboration catalysts has recently gained attention in research on group work, knowledge management, sense making, and collaboration in general. A special feature of such visualizations (i.e., sketches, diagrams, visual metaphors, etc.) is their ambiguity or their quality to be open to multiple interpretations. While such ambiguities may cause misunderstandings and lead to losing valuable time, they also offer the potential to reveal new insights, facilitate ad-hoc discoveries, reframe issues, increase identification, or stimulate group sense making. In this article we propose that visual ambiguity in group contexts is a relational variable that depends on three elements: the properties of the image, the people interpreting the image, and the interaction. We use these categories to propose a more fine-grained categorization consisting of seven types visual ambiguity: icon, symbol, index, interpreter background, familiarity, reference and scope ambiguity. We discuss the potential advantages and disadvantages of visual ambiguity for collaboration, as well as ways of exploiting or reducing it. Our contribution sensitizes researchers and practitioners to the crucial and often overlooked role of ambiguity in visual group communication, particularly in collaborative contexts. We highlight the diverse forms of visual ambiguity and how to use this communicative challenge as a resource rather than simply a risk. A discussion of future research needs concludes the article.*

## 1. Introduction

*'Ambiguity' itself can mean an indecision as to what you mean, an intention to mean several things, a probability that one or other or both of two things has been meant, and the fact that a statement has several meanings.*

WILLIAM EMPSON (*Seven Types of Ambiguity*, Empson, 1932, p. 5)

The use of visuals as collaboration catalysts has recently gained attention in research on group work, knowledge management, sense making, and collaboration (Henderson 1991, Whyte et al. 2007,

Tversky 2005, Fenton 2007, Keel 2007). A special feature of such visualizations (i.e., sketches, diagrams, visual metaphors, etc.) is their ambiguity or their quality to be open to multiple interpretations. Ambiguity is an inherent trait of language and can be used on purpose to trigger certain effects in an audience (as for example in poetry or rhetoric). It is an ambivalent notion, as ambiguity can be problematic, leading to misinterpretations and misunderstandings, or productive, showing nuances, uncertainties or tensions inherent in certain views, terms or statements. Whyte et al. (2007), in the context of visual practices in project work, state that "ambiguity may be useful for some tasks, where we want representations that help us move between focused reasoning and free association" (Whyte et al, 2008, p. 3).

While verbal ambiguity has received considerable attention in research (i.e., Eisenberg, 1984; Weick, 1995), the same does not hold true for visual or graphic ambiguity in collaborative groups contexts. The ambiguity of visuals has so far been primarily analyzed in terms of its *negative effects* (for example as a result of imprecision) on a single viewer and on ways of reducing or eliminating ambiguity (D'Ulizia et al. 2008, Avola et al., 2007), with the exception of Blackwell, Britton et al. 2001 who consider creative ambiguity in the context of visual programming environments.

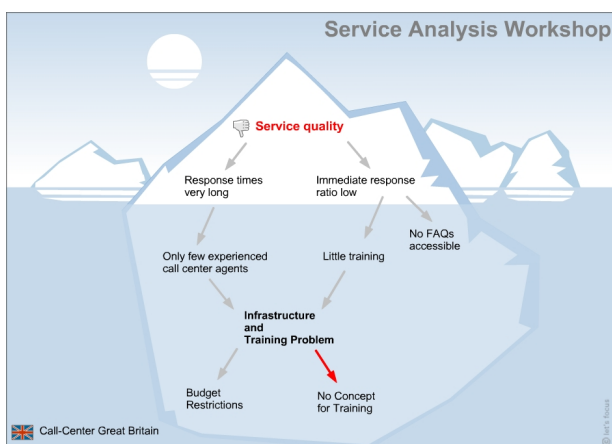
Simple examples of *intended* visual ambiguity can be found in pictures that amuse viewers by simultaneously depicting two alternative motives, thus provoking a perceptual ambiguity (see: Figure 1). The picture of a duck that, when rotated, becomes a rabbit, or the portrait of an old lady that can also be seen as the profile of a young one are examples of this kind.



**Figure 1**  
**Two simple examples of perceptual ambiguity**  
**(Jastrow, 1899, p.312; Boring, 1930, p.444)**

Another example of visual ambiguity that goes beyond such entertaining perceptual effects based on dual silhouettes is shown in Figure 2. It was originally used in a large organization to facilitate a collaborative problem analysis in a team meeting. The iceberg metaphor itself can be interpreted in various ways, as can the arrows, the thumbs down icons or the color and strength of the arrows. The arrow, for example, can be used to represent a vector (with position, orientation, magnitude), a transition, a designator (i.e. pointing to an object) (Futrelle, 2000), or a casual or temporal relationship. Visual ambiguity also arises because conversers, depending on their background, may interpret the use or function of the visualization differently. Finally, ambiguity results when some discussants comment on the visual's upper part while others refer to its lower section without being aware of their differing areas of focus. These ambiguities can lead to numerous misunderstandings, lost time and frustration. However, as we will show in this article, visual ambiguity can also be a useful catalyst for knowledge integration in teams (Eppler & Sukowski, 2000).

When various professional groups converse using a common visual structure that yet has different meanings in their respective field, the visual can serve as a translation and transformation device and is called a boundary object (Star & Griesemer 1989). According to Star and Griesemer such boundary objects often have considerable *interpretative flexibility*, which is not always a disadvantage. We will argue that visual ambiguity can trigger useful sense making activities in groups, activate negotiations of meanings and interests, provoke probing questions outside one's area of expertise and lead to useful clarification discussions. Visual ambiguity can fulfill an important catalytic role for group communication and knowledge integration. This function may be particularly useful in the early stages of team collaboration when knowledge transfer needs to be intense and reciprocal, and multiple options need to be articulated and evaluated.



**Figure 2: Example of visual ambiguity of an image used during group communication**

The premise of this article is thus that visual ambiguity is not only problematic, but can also be fruitful for group collaboration. We aim at better understanding the multiple causes of visual ambiguity in order to harness its power adequately. To achieve this, one has to distinguish various *forms of visual ambiguity* that affect group communication. This is what we will set out to do in section three of this article, where a classification of visual ambiguity in team settings will be presented. Before, we will briefly review definitions and approaches to the study of ambiguity as far as they are relevant to our context of team communication. This should provide a more balanced view of the role of visual ambiguity for group collaboration. It should help to uncover mechanisms by which ambiguity can improve team collaboration, but at the same time lead to indicators that help to avoid unfruitful visual ambiguity.

## 2. Toward an understanding of visual ambiguity

The ambiguity of visual communication has been discussed prominently by Roland Barthes in his semiotic analyses of the rhetoric of images. He showed that images are polysemic (containing a plurality of possible messages) and imply a "floating chain" of meanings, of which the viewer can "choose some and ignore others" (1977: 39). The connotations of the image change depending on the *context of the image* (i.e. its relation to other images and texts) and depending on the *characteristics of the viewer* (i.e. his/her knowledge, expectations and psychological disposition, as well as the socio-cultural situation in which he/she finds him/herself). The picture of a woman smoking a cigarette, for example, refers not only to the person inhaling a specific tobacco product (its de-notational meaning), but evokes various other connotations, such as freedom and rebellion against social norms vs. feeble will and dependency. The image in its ambiguity "becomes more of an abstraction, an available site for the attachment of multiple connotations serviceable in multiple contexts" (Edwards & Winkler, 1997: 290).

Ambiguity is not only a trait of visual communication, it is a characteristic of communication in general: a message always has (although to different degrees) multiple and sometimes even conflicting meanings, depending on the interactional context in which it is communicated (e.g. Watzlawick & Weakland, 1977). At times, the locus of ambiguity cannot be bound easily to single elements of a communication event, such as to the intention and capabilities of the sender, the attributes of the message (i.e. abstract language, lack of detail), or the receiver's interpretation. Rather, ambiguity is "a *relational* variable which arises through a combination of source, message, and receiver factors" (Eisenberg, 1984: 229, emphasis added). In our current context this implies analyzing how the sources of ambiguity of a graphic representation (i.e. its metaphoric language or specificity in notational conventions) relate

to the characteristics of the communicators (i.e. their intentions, exposure to visuals, professional and cultural background) and to a specific communicative situation.

The relation between visual ambiguity and the communicative situation in which the visual is used refers, in particular, to how the visual is combined with verbal or spoken text. Barthes argues that whereas once, the image illustrated the written text and made it clearer, today, the "text loads the image, burdening it with a culture, a moral, an imagination" (Barthes, 1977: 26). The text thus can provide direction in the interpretation of the visual and may reduce (or amplify) its ambiguity. Sutcliffe (2005), when analyzing ambiguity in novel, high-risk situations, observes similarly that ambiguity can be *resolved* not by adding information, but by engaging in debate, clarification and discussion. This is one advantage of ambiguous visuals in group collaboration, others are elaborated below.

### 3. Risks and Benefits of Visual Ambiguity in Group Collaboration

Ambiguity, visual ambiguity in particular, is mostly described in the literature as something problematic and dysfunctional that has to be avoided. The most prominent case, in which ambiguity proved catastrophic, is the Challenger space shuttle incident where the presentation of the test and temperature data was not fully clear so that different conclusions of the 'ambiguous' data were equally plausible (Sutcliffe, 2005; Tufte, 1997; Weick, 1997). In another context, it has been shown that causal ambiguity impedes the transfer of best practices (Szulanski, 2000) because the ambiguity reduces the credibility of a certain practice. In the specific context of *visualization*, the few authors who have paid attention to ambiguity mostly regarded it as something that has to be avoided (Futrelle 2000, Favetta and Aufaure-Portier 2000, D'Ulizia et al. 2008).

However, ambiguity is not something per se negative. Ambiguity allows, for example, for *flexibility over time*, for adaptation and fluid re-interpretations, and is conducive to organizational change (Eisenberg, 1984). A concept that entails some ambiguity, for example the formulation of an organizational goal, gives the organization the possibility to change operations when they have become maladaptive over time. Ambiguity can thus prove particularly beneficial in turbulent environments (Eisenberg, 1984: 233).

Another important potential benefit of visual ambiguity is that it allows for the coexistence of *several perspectives*. Weick (1995) argued that the maintenance of various perspectives is of particular importance for gaining resilience in complex situations and high reliability organizations. This function is important to support collaborations of cross-disciplinary groups. Eisenberg and Witten (1987) state that ambiguous communication "allows divergent interpretations to coexist and (...) [is] more effective in *allowing diverse groups to work together*" (p. 422, emphasis added).

Visuals can take over the form of 'boundary objects' because their ambiguity makes them flexible enough to be adapted to the specific local needs of different professional groups (Star & Griesemer, 1989). The ambiguity of a visual representation enables participants to maintain diverse perspectives. Still it provides a shared platform that can ensure sufficient common ground to translate idiosyncratic perspectives and make them meaningful across disciplinary boundaries. Visuals, with their ambiguity, therefore provide '*unified diversity*' to a cross-disciplinary group (Eisenberg, 1984). The collaboration and dialogue around an image gives a team a direction for the interpretation of the visual (which may be altered later on if need be, given that the ambiguity of the visual is high enough). The visual representation then stands for the knowledge co-created in the group and later on serves as a reminder for that knowledge or consensus. In this way, the visual also enlists the participation of the group (see: Henderson, 1991 on 'inscription device') and its elasticity is crucial not only to mediate multiple perspectives, but to organize collaboration and facilitate consensus seeking.

Given these various advantages of visual ambiguity, ambiguity can be used on purpose, as '*strategic ambiguity*', which can serve different functions, among them the following: It "(1) promotes unified diversity. (2) preserves privileged positions. (3) is deniable, (4) facilitates organizational change" (Eisenberg and Goodall, 1997: 24).

In view of these aspects, one wonders how ambiguity can be, at the same time, highly problematic and beneficial for collaborative work. From a prescriptive perspective one could ask whether there are uses of visualization which reduce the risks and capitalize on the potential of visual ambiguity. A first step in answering these questions is to gain a more systematic understanding of *what causes* visual ambiguity. In the next section, we will propose, on the basis of existing classifications, a cause-based classification of visual ambiguity specific for collaborative contexts.

### 4. A Classification of Visual Ambiguity for Collaborative Work

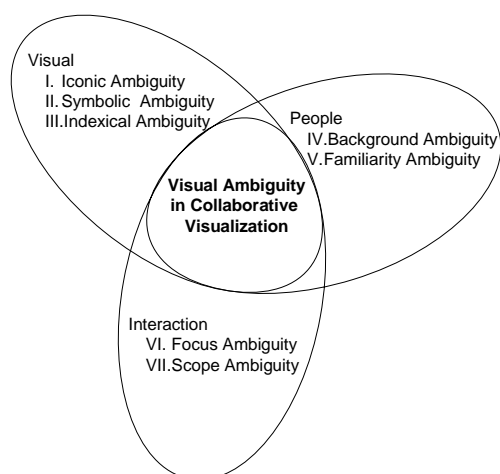
Our previous discussion on the benefits of visual ambiguity has hinted to a first categorization of visual ambiguity: the distinction between '*strategic ambiguity*' (i.e. when visual ambiguity becomes a purposefully used communication device) and '*perceived ambiguity*' (i.e. when the ambiguity arises unintentionally during the communication) (Eisenberg, 1984). Further categorizations discussed in the literature are more indicative for understanding the *causes* of visual ambiguity.

Futrelle (2000) distinguishes between *lexical* and *structural* ambiguity: lexical ambiguity arises when the context is insufficient to determine the sense of a single item that has more than one accepted meaning, while

structural ambiguity arises when the structure of the sentence permits more than one correct interpretation. Gaver et al. (2003), in the context of human computer interaction, propose three classes of ambiguity as a resource for design: *information* (the artefact itself), *context* (socio-cultural discourses used to interpret the artefact), and *relationship* (interpretive and evaluative stance of the individual). The uniqueness of Gaver et al.'s work is the focus on ambiguity as a virtue, as it can be intriguing, mysterious and delightful.

Whilst the above cited works are important for gaining a first understanding of what causes visual ambiguity, they are also limited as they exclusively focus on how a *single* viewer interprets a visual. They do not consider collaborative work contexts, in which the group interaction itself mediates visual ambiguity. Visual ambiguity in collaborative settings, is defined by a situation where a graphic representation of a group's work are open to multiple interpretations or when a visual-verbal contribution of a group member can be interpreted in more than one way by the participants. We thus propose a classification of visual ambiguities that takes into consideration this overlooked aspect of collaborative work.

We propose a two-level, cause-based classification of visual ambiguity, which distinguishes between three categories: the properties of (1) the visual, (2) the people interpreting the visual, and (3) the interaction among the people through the visual. Under those broad categories we identify seven more specific ambiguity types: iconic ambiguity, symbolic ambiguity and indexical ambiguity (belonging to the property of the visual category), background ambiguity and familiarity ambiguity (belonging to the property of the people), and focus ambiguity as well as scope ambiguity (belonging to the interaction category). Figure 3 summarizes these three related groups and seven types.



**Figure 3 Categorization of visual ambiguity in group contexts**

We will now explain each ambiguity category. Then we will briefly focus on the seven types of ambiguity by providing a definition, an example, and by discussing its

positive and negative effects, as well as possible countermeasures. Countermeasures need not be applied immediately to fully profit from the potential of an ambiguous depiction for group sense making.

The *visual* refers to the visualization itself, and specifically to the ambiguity that can be caused by the designer choices of symbols, metaphors, etc (called information in Gaver et al. 2003 and materialization in d'Ulizia et al. 2008). For the three types of this category, we refer to Peirce's (1894) categorization of signs into icons, symbols and indices.

The *people* refers to ambiguities that are created by differing professional, cultural, and intercultural backgrounds of the interpreters (called relationship in Gaver et al. 2003 and interpretation in d'Ulizia et al. 2008).

The *interaction* refers to ambiguities that are created by the use of a visual within a specific context of interaction and collaboration. This category contains focus ambiguity (the part of a visual to which a group refers in a specific moment of their interaction) and scope ambiguity (the goal for which a visual is used within a process of collaboration).

### Type I: Iconic Ambiguity

- Definition: Openness in the interpretation of visual signs that refer to their content by a relation of resemblance, likeness, or mimesis. Images, diagrams and metaphors are all forms of icons (Eco, 1976; Peirce, 1894)
- Example of ambiguity induced by icon: "I thought you meant that the iceberg shown in the slide is melting and that our problems are going away, not that the most important causes of the problem remain hidden to us."
- Positive Effect: New views, ideas and perspectives on a depiction are brought into the discussion.
- Negative Effect: un-coordinated discussions, deviations
- Countermeasure: make the interpretation (associations) of an icon or metaphor explicit

### Type II: Symbolic Ambiguity

- Definition: Openness in the interpretation of visual signs that are based on agreed conventions and that "have become associated with their meanings by usage" (Eco, 1976, Peirce 1894). Such conventions can relate to the use of symbols, colors, size, shape, or position.
- Examples of ambiguity induced by symbol: "I thought that element is more important and risky than the others because it's bigger and drawn in red color"; "I thought that with the arrow you sketched on the flipchart you were indicating a sequence and not a causality" (see Tufte, 2007 for more information on the latter example)
- Positive Effect: May lead to an unanticipated change in the interpretation of the visual and promote serendipity (that is, making a fortunate discovery by

accident), may foster “translation” between different organizational departments.

- Negative Effect: disagreements based on misunderstandings
- Countermeasure: general visualization rules and conventions and making them explicit

### **Type III: Indexical Ambiguity**

- Definition: Openness in the interpretation of visual signs that receive their meaning by the objects they designate in the concrete communicative context in which they are used (inductive process). Typical indices are “a guidepost, which points down the road to be taken, or a relative pronoun, which is placed just after the name of the thing intended to be denoted” (Peirce 1894: Chapter 2 §3).
- Example: “I thought the sand glass projected by the beamer was indicating how much time we have already spent in our meeting and not how far we have progressed in our meeting agenda.”
- Positive Effect: Clarification of group process through reflection on interaction process such as time management, agenda
- Negative Effect: misunderstandings, lost time, potential for conflict
- Countermeasure: explicitly labeling all items through a legend

### **Type IV: Background Ambiguity**

- Definition: Potential difference in the interpretation that arises out of the differing cultural, cross-cultural or professional backgrounds of the collaborators (including educational level).
- Example: “I was reading your diagram from right to left instead of vice versa, as we usually do this in Arab countries. No wonder it didn’t make sense.” “I thought that symbol represented a decision point, as we used it in flow charts, and not a document.”
- Positive Effect: learning effects about other cultures or professions (if discovered), new perspectives. Its function as a boundary object: loose enough to be meaningful to many different people in the organization, like a “social glue” (Fenton 2007)
- Negative Effect: fosters misunderstandings and emphasizes professional or cultural boundaries.
- Countermeasure: Agree on shared, explicit conventions and set standards

### **Type V: Familiarity Ambiguity**

- Definition: Potential difference in the interpretation of a visual, which arises amongst collaborators out of their different familiarities with a specific visual, i.e. their visual literacy and prior knowledge and exposure to a specific visual.
- Example: “I interpreted the avalanche pictogram inside the loop diagram as meaning ‘natural causes’, not as defining it as a vicious, self-intensifying cycle.”

- Positive effect: an unfamiliar visualization may show new perspectives.
- Negative effect: it may frustrate unfamiliar users if visual is too difficult to understand or if they had previous negative experiences with it.
- Countermeasure: conduct an introductory session on the characteristics of the visual and its meaning and conventions.

### **Type VI: Focus Ambiguity**

- Definition: Potential difference in the interpretation of a visual which arises because conversers refer to different parts of it.
- Example: “I thought you were referring to the lower part of the drawing right now, not the upper part.”
- Positive Effect: new interpretation of comment, more cross-references
- Negative Effect: misunderstanding, confusion, lack of group attention
- Countermeasure: Pointing while talking, using pointing devices such as lasers or mouse.

### **Type VII: Scope Ambiguity**

- Definition: Potential differences in the interpretation of a visual because collaborators assume it serves a different purpose.
- Example: “I thought this picture was only helping us to analyze the problem, not already document a final decision”; “I didn’t know we can still change the diagram.”
- Positive Effect: new uses of a visualization may be invented ad-hoc.
- Negative Effect: may cause conflicts or prevent contributions
- Countermeasure: clarify the scope and usage context of the discussed visualization

Given this overview on the various causes of visual ambiguity, it is important to underline that visual ambiguity in collaborative settings is not caused by one single category, but *is defined in the relation between the three categories* (as is indicated in Figure 3 by the intersection area). In future research, we would like to examine these interactions more closely. Further future research needs are outlined in the conclusion below.

## **Conclusions**

In this contribution we have highlighted the potentially productive effects of visual ambiguity for collaborative work while not neglecting its risks. Based on the main causes of visual ambiguity, we have distinguished among seven different forms and have categorized them into three groups (visual, people, and interaction-related ambiguities) that – in their concomitance – lead to the emergence and resolution of visual ambiguity.

Currently, we are gathering empirical evidence to illustrate each type of visual ambiguity and its positive and negative effects on group collaboration. First

collections of evidence (gathered through narrative interviews in companies) confirm the potential of visual ambiguity to lead to greater identification, more engaging and clarifying debates and creative re-interpretations. In future research we will connect these testimonials with the developed classification and extend or adapt it accordingly. This should ultimately lead to a better understanding of visual ambiguity in group contexts and to practical advice of when and how to use visual ambiguity in group contexts.

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