

Connecting the real world with the digital overlay with smart ambient media—applying Peirce’s categories in the context of ambient media

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Abstract This article is based on the keynote held at the workshop on Events in Multimedia (EiMM09) that took place in conjunction with the ACM Multimedia conference in Beijing in October 2009. The idea of the keynote was to develop and explain the idea of ambient media in general, its principles, and additionally relate ambient media to information theoretical approaches such as Peirce’s categories, to the theories of decision making, and to theories discussing how smart objects can be made ‘smart’ by simulating the human mind. This article rounds up with practical examples underlining the presented ideas and theories.

Keywords Ambient media · Ubiquitous computation · Smart media · Creativity · Intelligent systems · Media studies · Theory of computation

1 Introduction

Historically, any type of technology was used to immerse humans into another world sooner or later—the subject ‘media’ therefore allows us to enter another world. We go to the cinema and are immersed into the story of a dramatic film. We surf the Internet, and are creating our content. Today another form of media is emerging—a media that is not only smart and intelligent but also reacts on our behalf. Media technology allows us to automate the process of content aggregation, creation, and delivery. The field of new media created a media environment that could be digitized. Ambient media allowed a media environment to emerge that is simply smart, intelligent, and proactively reacts to the consumer needs. However, in the far future next to ambient media all sorts of biotechnology will be used for creating a media environment for us. Thus, the key innovation will be the processification of media environments, and it will show us that Hollywood movies such as e.g. “The Game” are foreseeing.

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As depicted in Fig. 1 there have been many major changes that led to today's media environment. However, ambient media are still rather new, and demand a re-questioning of what they actually are. Therefore this article discusses this point in further depth. Let us start the discussion by stating a few questions that are discussed within the scope of this article:

- What are ambient media, what are their characteristics, what are their features?
- Which characteristics smart systems have to have in order to be able to learn and gain knowledge about their environment?
- What is the meaning of data, information, intelligence, knowledge and wisdom in the context of smart media?
- How are real world smart objects and their digital overlay related to each other?

Each media consist of three major components—media technology, media form, and media instance (content). Media technology makes media tick, it is the tools, methods, and the techniques that are required to create the medium. In the case of ambient media, ambient intelligent technology is the technology enabling the media form 'ambient media'. According to McLuhan, the medium is the message, and is not society driven. Thus the invention of technology takes place first, and afterwards the society finds an application for it. A media form is simply the appearance and the perceptible component of media. In the case of ambient media it is how media objects appear and how they are presented in terms of aesthetics—thus, it is a form of rendered objects e.g. on screens, the rendered sounds, or any other form of signaling. However, content is still the main human perceptible component of media. It is the actual information or message that is expressed in a certain form. It is the composition of objects, and the actual work. In the case of ambient media it is the actual signal attached to a light bulb giving the consumer feedback about his/her actions.

The field of logic provides many explanatory concepts to explain 'existence' or provides a categorization scheme for it. The foundation for this article is Peirce's logic to define 'existence'. Peirce developed categories to explain 'being' and intelligence (see [3]). The main question is how these concepts can be applied to the field of media in general, as well as to the specific case of ambient media. Especially the latter requires a re-thinking of the media landscape and of the application of concepts in order to explain the 'intelligence' of smart media environments. Let us consider a proposition as example: "The film is artistic". "The film" would be the *substance* (respectively *the medium* or *media object* using media terminology) while the *predicate* would be "is artistic". Thus both (the substance and the predicate) would act as conception of defining the film and its content. Let us ask the following questions to understand Peirce's way of thinking: First, if we have only one film (and no other film has been created before that could act as reference) how can we tell that

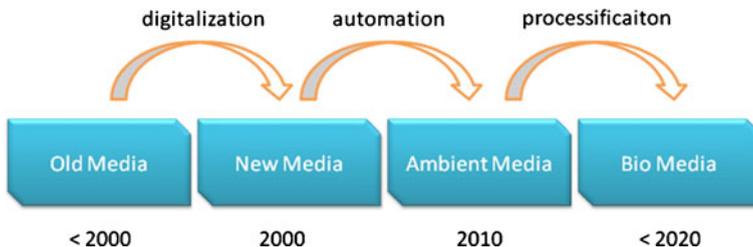


Fig. 1 Historical development of media and their key changes

the film is artistic? Second, who is deciding (or reasoning) that the film is artistic: the audience or film critics?

Within the scope of this article the most significant concepts relating to ambient media are discussed within Peirce's categories: media theories; relation between the digital overlay of the real world; objects, events, and semantics; and the digital mind as such (see Fig. 2).

2 Background and related work

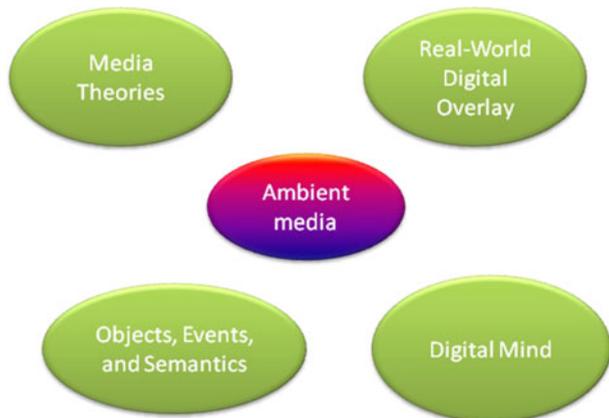
The basic idea for this keynote talk emerged while reading Rene V. Mayorga's and Leonid I. Perlovsky's edited book entitled "Towards Artificial Sapience", published by Springer-Verlag in 2008 [8]. In the book various aspects about sapience are discussed and the question is raised how systems can be made smart. Especially the first chapter entitled "Can Creativity Be Formalized? Peircean's Reflections on the Role of Abduction in Human Intelligence" [3] motivated to discuss Peircean's philosophies in relation to ambient media and was used as main work for explaining his line of thought. In this article a few examples from this book are derived for the illustration of Peirce's concepts. To get a deeper understanding of Charles S. Peirce's concepts, his original article from 1867 "On a New List of Categories" is the basis for this article [13] as well as his original work acts as basic reference for this article.

Any other categories and follow up discussions of Peirce's concepts have been avoided in order to focus this article and due to the complexity (to discuss solely) Peirce's viewpoint. The author has already published many articles in order to explore the field of ambient media (see [6] [5] [7]) and an association been formed to explore the theories (see [1]).

3 Ambient media

From the media studies viewpoint the simplest approach is to describe how the concepts of ambient media differ from the concept of new media. New media can be characterized by [4]: digital, interactive, hyper-textual, virtual, networked, and simulated. The ambient counterpart can be characterized by: being embedded into the natural environment, intuitive, smart, collaborative, proactive, contextual, etc. (see Fig. 3). Thus, ambient media know the context, in which they are functioning and they provide a possibility to the

Fig. 2 Most significant concepts related to ambient media



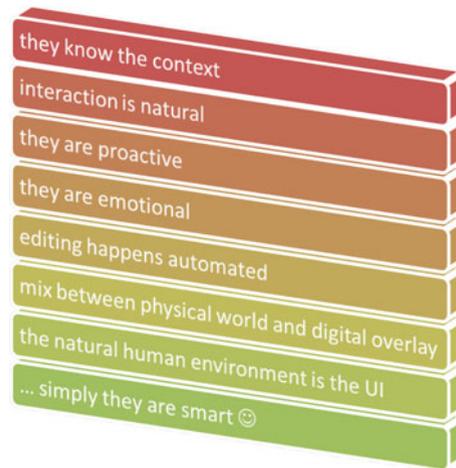


Fig. 3 What are intelligent media? They...

consumer to interact in a natural way, thus e.g. via voice-input, gestures, or gazing. The content is automatically aggregated by the ambient system, rather than via an editor, as e.g. in the case of newspapers. One of the most significant features of ambient media is the mix between the physical world and the digital overlay. In ambient media the natural environment is the user interface instead of complex input devices as they exist today.

While these concepts are generally true for new media, ambient media differ tremendously. To understand the difference, it is important to dig deeper in media theoretical concepts of analogue and digital media. It is essential to understand how the message of the medium is represented, processed and stored. On its atomic level, each message of the medium can be expressed or coded as data. Thus we have to distinguish how this process differs between analogue and digital media.

Analogue (Greek: analogos) means “something that is [...] similar to something else” [10]. Looking at the meaning of analogue from a medical viewpoint, the idea is extendable to the resemblance of similar functions or processes or “a [...] part similar in function to a [...] part [...] but different in structure and origin” [10]. The concept of similarity extends in media to a plethora of similar processes for coding data. Objects storing data are similar of type with common features and processes. For example analogue signals (e.g. voice) are converted to other analogue data that is stored on another analogue medium (e.g. tape). Data is coded by similar processes. Considering a painting, the encoded message is represented, processed, and stored as an artistic visual expression on a canvas. The creation process is analogue through brush and paint as is the physical representation. Each of these objects contains analogue data that can be processed with analogue methods. In other words the message of the medium is expressed through physical forms. Examples of analogue media are well known: paintings, drawings, handwritten books, theatres, concerts, cinema, etc..

Thus, in analogue media data is in tight relation to its physical object representation, and how functionalities or properties of objects are converted to another analogue physical object. Analogue input data becomes analogue data acting as input on another physical object [4]. This differs from digital or new media in many ways. New media has an underlying concept of ‘digitalness’ that (Latin: digitalis) refers simply to the digitalization of the medium. Thus several processes—from media creation to media consumption—are taking place in the digital domain. The basic concept of digital media is to express “data or

information [...] in terms of a few discrete quantities” [12]. Data is expressed by a binary representation, and the properties of each object containing the data differ. The input of a digital camera is analogue, it is converted to its digital representation and stored on a digital storage device. Thus, the physical representation and its properties differ and also the methods that are required to process this data are different. In the case of analogue there is a directly physical relationship between the input and output signal (analogue-analogue), which is not obvious in the digital case (analogue-digital). Some might argue that a digital representation is reversible, e.g. that the digital representation can be transformed to an analogue counterpart. However, on this level of discussion this claim is obsolete, as we are purely focusing on the basic principles rather than on the encryption or compression techniques. On the other hand, digital signals—thus the output of a media—are also analogue signals to stimulate human senses and make media perceivable. An example of this are digital music players that make music perceivable for humans with analogue loudspeakers. Still, a conversion between analogue and digital (and vice versa) takes place.

Ambient refers to “encompassing atmosphere” [10], thus the main property is surrounding and encircling of the media environment into the natural space of humans. The encompassing sphere is the daily living environment; smart homes are currently one of the most prominent examples. Thus ambient media create an ecosystem of media content, media objects, services, and application in relation to each other. Compared to TV, where a single stream is sent to the TV set, ambient media go far beyond the ‘single stream’ concept. In ambient media an ecosystem of services, streams, applications, objects, etc. is streamed and consumed. A motion picture combines video with audio. Ambient media combine several concepts to one ecosystem—such as audio, video, signaling through objects, etc.

One might argue that ambient media are also solely digital. However, as seen from history, many new technologies rely on concepts of older technologies. An example of this is the network topology. While earlier terminals were connected to a central server via star cabling, the Ethernet enabled a distributed network with attached network nodes. Today we adapted the idea of star topologies in the form of switches, to which network nodes are connected. This parallels with ambient media. While several processes in analogue media take place in the analogue domain, in new media several processes take place in the digital domain. Ambient media merge both—the digital over the physical world merge. Thus digital information and services can be seen as existing parallel to the physical world. The processes in ambient media take place in both layers. A good example are e.g. location based services combining real world presence with the digital overlay of maps.

4 Formalization of characteristics of smart systems

A system has to be able to learn and turn data into knowledge. One of the central human abilities is to develop hypotheses due to their creative minds, external stimuli, and knowledge acquired during the past. The ‘digital mind’ of objects that would be able to react proactively and gain knowledge about its environment requires the same ability. To understand this feature we have to dig deeper into the theories of logic and existence. When does something exist, when ‘is’ something? Many attempted to explain ‘intelligence’ in the context of history. There are many theories deriving from artificial intelligence or logic. But to understand which characteristics and features a media environment requires to be ‘smart’ a more metaphysical concept is needed. The basic question is which features and characteristics a human or a system requires to make sense of the environment, and react smartly to turn data into knowledge and eventually even into wisdom.

To elaborate this further, a formalism is required to describe reality and the process of perceiving reality—a concept for ‘existence’ as such. Thus a framework is required to describe and interpret the real world based on a fundamental framework. This framework would help to gain understanding in the complex question what the characteristics of a smart system are, and when it ‘is’. Explaining ‘existence’ is a very hard task in general. For the purpose of this research work Peirce’s formalism is founding the basis of argumentation. His philosophy will lay the fundament for characterizing features of smart systems.

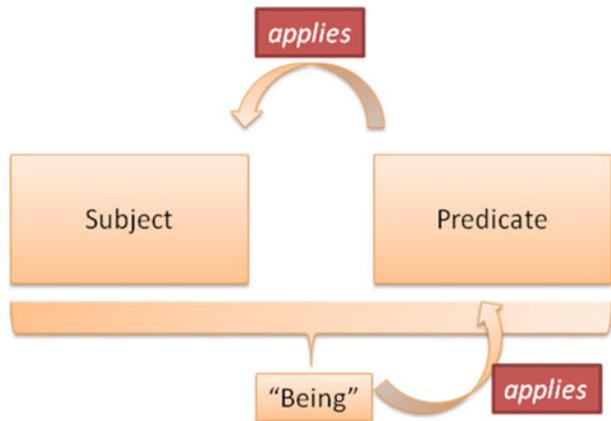
Scholars around this topic defined the concept of categories to explain this difficult challenge. Categories act as an abstract framework for explaining reality and the division of reality into its sub-components and the relation between these functions. Categories are attempting to formalize how the real world can be turned into knowledge, or even wisdom. Thus, categories provide us with a possible explanation how media systems can perceive and interpret the environment. In very general meaning the quest is simply to describe ‘being’ and how it functions in relation to media studies.

4.1 Peirce’s way of thinking

In Peirce’s way of thinking something must ‘be’ to exist. This can be formalized solely by expressing it via a proposition. Thus the proposition is the basic element of something that exists. A simple example shall underline this concept: a media object alone (let it be a movie, video, radio broadcast), which can be considered as the subject or substance, only exists in conjunction with an attribute. Thus the statement ‘the movie is exciting’ manifests the media object as existing. In short, according to Peirce something exists only as a predicate, while a subject is related to a predicate. Thus, something exists only as a unity of the subject and the predicate allows something to ‘be’. Thus ‘existence’ in Peirce’s meaning is related to a predicate. The predicate is further applied to a subject in the meaning of logic. Still, the concept of ‘being’ itself does not relate single ‘beings’ to others, nor does it put it into context, nor to a higher level meaning. A ‘being’ without any relation to anything else is not considered as intelligent, nor does it allow the concept of knowledge to emerge.

The concept depicted in Fig. 4 shows the essential unity of a *proposition* as the basis for ‘being’. The subject is linked to a *predicate*. On a general level, the object? sees a proposition and the relation between propositions as main conception for being. This differs from the way of thinking that a subject alone is the formation for being. One example is the proposition “the table is brown”. In this case the ‘table’ is the *substance* (or subject), and

Fig. 4 Peirce’s elements in something that ‘exists’



the statement ‘is brown’ is the *predicate*. The substance (or subject) alone would not make sense as there would be no meaning from a conception basis. The predicate “... is brown” alone would allow us to conclude and refer to something which is brown. This could be an infinite set of things that are brown . Therefore the main clue of Peirce’s idea is that “the unity of a proposition [...] consists in the connection of the predicate with the subject [...] implied in the [...] conception of being” [13].

4.2 Categories of Peirce’s logic

The quintessence of his logic relates ‘being’ to a subject. However, he also attempts to explain how beings can relate to each other. He does this by defining the categories of firstness, secondness, and thirdness. These categories explain how the subject and its being can be related to each other. Thus, how higher level meaning can be attached to objects and their existence. Table 1 illustrates this relation.

Firstness addresses ‘being’ without any reference to anything else, thus what?firstness? is simply the unity of a proposition as connection between a subject and a predicate. The proposition “the table is brown” is an example of firstness. A more practical example can be found in psychology, where a feeling is experienced; however, it is neither interpreted nor reflected. In the world of media a simpler example can be constructed. Watching a movie and simply enjoying it passively without reflecting or reasoning about its content is an example of experiencing this mode of category (see [3]). (Table 2)

Secondness focuses on the interaction between solely two ‘beings’—or existences. Thus ‘being’ is in reference to another ‘being’ in time and space. Rather than solely focusing on the unity between a proposition, secondness expresses the relation between something. A more practical example is a knock on the door, while a person is watching a television stream. The person is disturbed and the existence of ‘a person is watching television’ is related to an external event. However, according Peirce there is only a relation between two, rather than a third event (see [3]).

Thirdness extends the idea of secondness by relating higher level constructs to the ‘beings’ that are related to events. Thirdness relates events, elements and things and also mediates through a network of higher level constructs. While a being related with an event places the concept of time and space into context, it also requires a higher level structure to relate a meaning and structure to these. Thirdness requires therefore interpretation and reasoning. One example is a television show whose higher meaning is defined by concepts coming from film making, such as film language, rhythm of editing, and genre. This leads to a higher level structure and meaning (see [3]).

Table 1 Peirce’s categories (left—cited from [13]) translated into more understandable terminology

Being	Existence
Firstness: Quality (reference to a ground)	Firstness: Characteristic (reference to a basis)
Secondness: Relation (reference to a correlate)	Secondness: Relation (reference to a correlate)
Thirdness: Representation (reference to an interpretant)	Thirdness: Representation (reference to an interpretant)
Subject	Substance

Table 2 Peirce’s categories in context (based on [13] and [8])

	Firstness	Secondness	Thirdness
Peirce’s view	Quality	Relation	Representation
Reference to	Ground	Correlate	Interpretant
Media	Object (e.g. medium + message)	Space-Time-Event	Structuring e.g. film language, etc.
Ambient Media	Object	Space-Time-Event	Semantic
	Quality	Relation	Representation
Psychology	Feeling	Perception	Reasoning
Logic	Abduction	Induction	Deduction

4.3 Giving things meaning

In logic induction can be seen as firstness—an induction just stands for itself without any reference to any other case. Deduction (secondness) assigns a rule as statement between cases, thus relates entities to each other. However, a hypothesis (thirdness) generalizes and is the starting point for exploration for achieving further results. This is exactly the issue in which Peirce’s logic differs—according to him the process of forming the hypothesis is critical. It is a matter of creativity, experience, and previous knowledge. Thus the forming of the hypothesis is the key to a smart system. This is depicted in Fig. 5.

5 Smart media in the context of Peirce’s logic

Media research is a wide area; however, to place smart media into Peirce’s logic this research work tackles the problem by four different attempts:

1st attempt: relating general media concepts to Peirce’s logic

2nd attempt: relating smart media objects into the context of Peirce’s logic

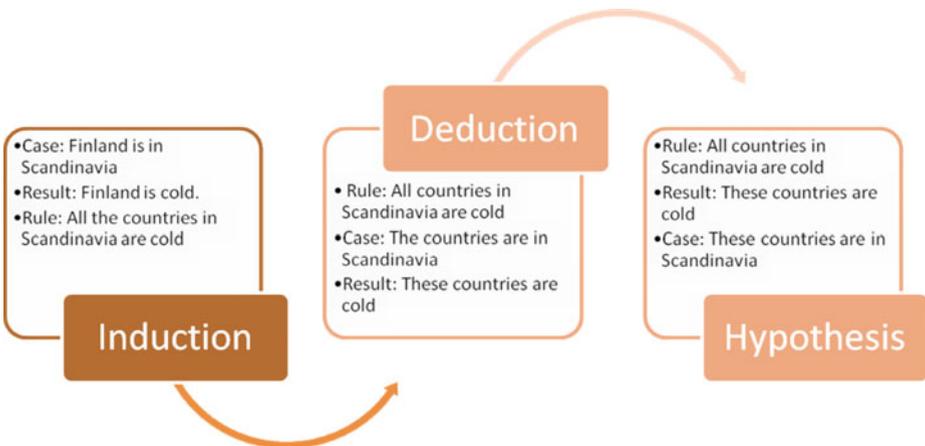


Fig. 5 Induction, Deduction, and Hypothesis

3rd Attempt: Ambient Media as Digital Mind for Decision Making in the Context of Peirce's Logic

4th Attempt: The Real World and the Digital Overlay in the Context of Peirce's Logic

5.1 1st attempt: relating general media concepts to Peirce's logic

To apply Peirce's logic in the context of media, we have to define the subject matter first. However, each media relies on media technology to transmit a message or information. The medium, thus the utilized technology therefore is the substance as such. Neglecting the discussions of Marshall McLuhan and Raymond Williams that is dealing with the question if either the medium is the message or the media is society implicated (see e.g. [9]), the medium simply is, and requires no relation to other objects or conscious interpretation as such. A motion picture simply 'exists' without reference to anything else. However, Peirce logic indicates that the substance 'medium' alone would not make sense in having a conceptual meaning. Solely in relation to a predicate the medium 'is'. The medium is a "mode of artistic expression or communication" [10]—thus the predicate 'medium is the message' allows us to refer to firstness. Simply, the medium is the subject, and the 'medium is the message' or the 'medium is the information channel' is firstness. Therefore a medium as mode of artistic expression and communication implies the concept of being in the view of Peirce. Considering the media genre motion pictures film is the medium acting as a particular mode to express visually and auditory. The medium as a particular mode does not provide any information about its composition, nor about any relationship between the composition nor anything about how the audience interprets the content. The medium simply 'is' the channel for communication without any reference to anything else.

The medium and its existence alone does not define the complete nature of media, as media are a means of mass communication and interpretation. Each medium has a form that composes media objects and brings them into relation to each other. The form of media manifests in different modes of being. As each medium has its specific form, it relates the medium to its form. Thus the media form means secondness—the medium relates to another concept—the concept of media form. In media this relations take place on diverse levels. On a general level media objects relate to their underlying technology, thus to their underlying physical form. Considering motion pictures every film relies on film technology and on the processes to create an artistic film—the relationship between the medium and its form can therefore be seen as Peirce's case of secondness. Media form also addresses the composition of media objects in time and space, which provides these objects with a gives these objects a basis for their existence in the real world. The principle of *mis-en-scene* (see e.g. [2]), thus how and which objects are placed on the scene of a film shot, would be an example of secondness on media object level. We can also consider genres and their instances as an example of secondness. However, it is still not sufficient to express media in a certain form—a medium requires higher level concepts for a particular instance of a media form. In general we can refer to it as content. Thus content is the expression in media, and requires concepts such as interpretation, giving meaning, and higher value. Genres, the artistic concepts to convey the message, and concepts like aesthetics, languages, etc. belong to this category. This leads us to the definition of thirdness in the field of media.

Firstness defines the characteristic with reference to a basis, thus how media exist as a subject. Secondness relates two existences to each other, e.g. media objects, or the composition of media objects within a medium—simply the media and its structure and

form. Yet we did not define the reference of media objects to an interpretant. This requires a certain generalization of the total concept of media, as well as it requires general valid laws to explain them. In the media landscape many of these general valid concepts exist: aesthetics, semiotics, media languages, rhythms, lyrics, etc. These concepts rely on a certain formalism, which allows interpretation of communication and artistic expression. In secondness only the objects are related to each other; however, not the total concept of how to arrange media objects and how to create ‘content’. To avoid a conflict with terminology this category was called media instance rather than content, since content might be misleading. Communication as well as artistic expression requires interpretation and creation of meaningful messages.

Thus, the form of media defines the way how media exist and appear, but it does not define the actual content or instances of the media. This notion can be referred to as thirdness in the way how Peirce interprets existence. In order to empower media and to create content reflection and an intelligent mind is necessary. The key issue is the intelligent and smart interpretation of content. Media content are nothing else than media instances. And media instances are compositions of various media objects or media genres. Thus the interpretation of media content is left to the audience. And especially this involves many higher level concepts such as the understanding of semiotics and aesthetics to create a media instance. Semiotics is of especial importance as it can be defined as “philosophical theory of signs and symbols” [10]. Semiotics assigns meaning and requires a reference to higher level concepts to be able to understand and interpret the message. This tightly relates to aesthetics because the “conception of beauty or art” [10] as aesthetics exists only based on human interpretation. The development of advertisements is a good example of aesthetics in terms of e.g. gender roles or nudity. However, in the media landscape many more general valid abstract concepts exist such as languages: film language, the language of new media, or visual language just to mention a few. All languages such as film language, media language, or the language of new media are concepts contributing to enable the representation of media so that they can be interpreted and gain a higher level of meaning. To simplify these concept we refer to them as media instance—thus a media instance is extending the meaning of media content by concepts such as aesthetics, semiotics, interpretation, etc.

5.2 2nd attempt: relating smart media objects into the context of Peirce’s logic

In the case of smart media environments media objects have to become aware of their environment, and have to understand the context they are existing in. Thus objects understand and interpret the context, and trigger actions in the behalf of the consumer. In the category mode firstness media objects simply **are** without any reference to any other objects or even without any relation to a human. They can be seen as the atomic unity or the substance with certain attributes or features. In ambient media an object can rather be arbitrary. It can be any object stimulating human senses—a light bulb, a screen, or a sound signal.

To provide a smart ambient media environment, many of the media objects embedded throughout our natural environment require a certain smartness to understand their environment and to be able to react upon situations. However, in the meaning of the category firstness these smart objects would exist without any awareness of the environment. This mode is currently present in the existing media environment, in which the media consumer enjoys the media object without relating, interpreting, or reasoning about it. But many of the media objects embedded throughout our natural environment (e.g.

video screens, background audio, smart objects) require a certain ability to understand their environment and interpret it, thus to relate it to other entities. The relation as such can be formed via events that are triggered by objects. This process(?)h will be explained later on during the discussion of secondness.

Passive attentive ambient media object are perceived subconsciously and they act as secondary sensory stimuli. Alert lights on smart fridges and background music adapted to our personal mood are just a few examples of *passive attentive* ambient media objects. These forms of ambient media come close to experiencing firstness. Similar, *active attentive ambient media objects* fully consume our attention and they require active intervention from the human side. Explicit personalization systems can be mentioned as an example. Humans have to fill in their preferences to obtain the optimal personalization result. These types of ambient media often require a relation to more subjects rather than to a single one. They can be seen as a matter of secondness.

Secondness in the context of media objects simply relates objects to a second one. An easy way to explain this mode is the concept of events. Events relate an object to other objects but events as such are not interpreted. Thus events relate to the object without further interpretation. An example is presented in [14], which describes a system and an event ontology that can be utilized by emergency departments. Citizens may report an event to a control center, thus the event is the ‘reporting’. The control system investigates these events, and triggers actions. However, the interpretation of the events is to be done by humans. In this case the media ‘object’ triggering a chain of events is the human itself and also the interpretation of the event is performed by humans. However, in ambient systems not solely humans shall trigger and react on events, it is also the ambient system that is capable of interpreting and reacting to inputs. It is important to note that in the case of ambient media the notion of ‘objects’ refers to humans, media objects, as well as to systems. Humans collaborate with machines as well as machines collaborate with other machines when discussing the context of ambient media.

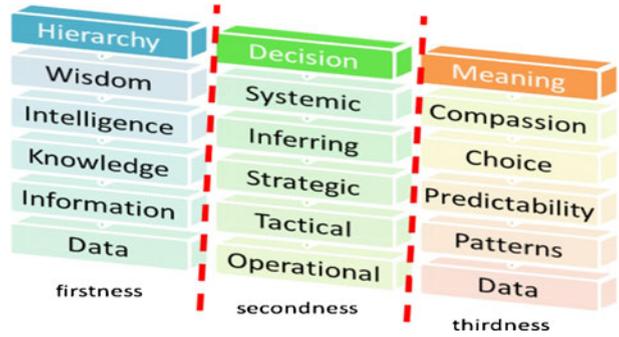
Thirdness therefore refers to the interpretation of objects and to the network of events, that is the network of triggered events and the chain that leads to a decision. Thirdness therefore deals with the semantic interpretation. That is why we can also speak of semantic ambient media, which are capable of turning information and data to intelligence and eventually wisdom.

5.3 3rd attempt: ambient media as digital mind for decision making in the context of Peirce’s logic

Ambient media require the possibility to make decisions. A good approach comes from the field of decision making and how humans turn information to knowledge. This approach is called the extended knowledge hierarchy (see [15] and [16] and depicted in Fig. 6). By applying Peirce’s logic we can divide the knowledge hierarchy into two dimensions. First, the dimension of the actual entity upon further actions is made upon (the hierarchy). Thus the hierarchy as such would be referred to as firstness. A decision is triggered in relation to something else without the involvement of some other third meaning, thus inferring intelligence as such can be described as secondness. The meaning (e.g. the actual choice when inferring intelligence) refers to the basis of many linked pieces of intelligence, patterns, or semantics.

The second dimension of the extended knowledge hierarchy devotes to the level of processing components and modalities of the hierarchy. The very basic objects simply standing for themselves are data and information. They exist without further relation to any other entity.

Fig. 6 Extended knowledge hierarchy (extended from [15] and [16])



On this level also decisions as such do not relate to anything else but to the tactical or operational decision. Patterns and data on this level are simply existing but are not interpreted nor are they relating to other objects. Going one level higher in the hierarchy—thus talking about intelligence and knowledge, both (intelligent and knowledge) relate to other entities. For example knowledge relates to information and inferring relates information.

5.4 4th attempt: the real world and the digital overlay in the context of Peirce’s logic

A simpler aspect of applying Peirce’s logic in the field of ambient media is emerging from another characteristic of ambient media: the digital overlay of the real world. Ambient media are embedded throughout the real world—the natural living environment—but span a digital overlay consisting of smart algorithms that react on the input through sensors. A good example of this principle are decision support systems (see [11] and Fig. 7) and their loop of closure. This will be the basic example given within the scope of this section.

Real world objects, sensors, the actual world, and actuators act as firstness. They simply exist without any reference to anything else. However, the link between the existence in the real world and the digital overlay are a matter of secondness, and create a reference to something else. Therefore just the simple existence of the link between the real world and its digital overlay is a matter of secondness. It is the link between sensors and perception in the digital overlay. However, the inference and the modeling of a representation of the real world within the digital overlay is a matter of thirdness—it relates and triggers actions via a behavior model.

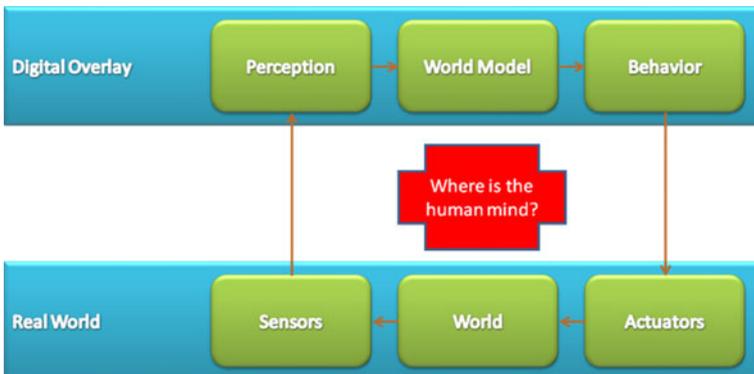


Fig. 7 Loop of closure in the meaning of ambient media (extended from [11])

6 Discussion

This article solely focused on the categories of Peirce, which definitely would require an extension to other category definitions e.g. stated by Aristotle or Kant. However, to understand even Peirce's conceptions much complexity is required that is why a comparison of other categories will be done in the future.

In general, it was hard to discuss categories coming from the field of logic—especially Peirce's logic—in the context of media. However, this should have been just a first attempt and should stimulate further discussion. Yet, this particular discussion provided an insight into the development of a framework defining ambient media on a metaphysical level. This is especially of relevance to the field of intelligent media:

- provision of a framework for explaining the notion of 'smartness' to provide solutions and technologies for realizing smart media;
- media are the primary means of exchanging information through symbolism and coding on content as well as on systems level (e.g. symbols in a piece of art);
- explanation of the ideas of smart media and how media objects relate to each other and interpret reality;
- in media, the medium refers to firstness, the media form to secondness, and the media instance to thirdness;
- ability to create and interfere hypotheses in order to gain knowledge about their environment;
- and finally the most important reason: developing a philosophical model to explain 'being' and stimulate thinking about intelligence and the impact on 'things', no matter if they are artificial or real.

This paper should stimulate further discussions and provide a few models, which can be used in the context of ambient media research, although it was still not possible to answer all the questions stated at the beginning of this article.

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