Chapter 2
Theoretical Framework

In this chapter the theoretical foundation will be unfolded. A part of the theoretical foundation has already been unfolded in the introduction chapter. This was done by identifying the intersection between the internal and external challenges, which face interdisciplinary teams working in the early phases of innovation, as a gap in the present knowledge (See Fig 1.3). Still, it is necessary to unfold the theoretical foundation in two additional directions. First of all, it is necessary to provide an understanding of the perspective, which is used in this book. As mentioned earlier, the book is directed toward an interdisciplinary audience; it is, however, built upon a design perspective and a 'designerly' way of understanding the early phases of innovation. This design perspective influences for instance the development of the workshop setup. Therefore, it is necessary to unfold these implicit insights and understandings from design in this chapter and also to explain, why the design perspective is relevant in respect to the early phases of innovation. The second direction is the theoretical framework. The theoretical framework is identified and developed in order to understand and interpret the empirical findings. The theoretical framework is going to be used as the lens in which the empirical data (and the complexity it holds) can be framed and understood. The theoretical framework will have an overall focus on meaning. Meaning will be reviewed in relation to three areas, which are relevant to the workshop setup. First of all, meaning will be reviewed in relation to how individuals are creating meaning, and how this meaning is communicated. Second, meaning will be reviewed in relation to how teams are creating shared frames. And finally, meaning will be unfolded in relation to physical artifacts in terms of how they impact the communication of meaning as well as the creation of shared frames. An overview of the theoretical foundation is shown in Fig. 2.1.

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2.1 The Design Perspective

In the following section the design perspective is presented. In detail, the objective is to present insights and understandings in relation to the following questions:

- How are problems or assignments understood and approached in design?
- What is the center of attention or value criteria in design?
- How can the process of designing be understood?
- In which ways is the design perspective relevant and useful in relation to the early phases of innovation?

The section is not to be seen as a comprehensive review in relation to the questions, but rather as a brief glimpse into the field. Likewise, only the insights and perspectives considered to be important to this book are presented.

2.1.1 Problems and Assignments in Design

Even though design is recognized as a problem-solving activity [37], it is argued that problem solving in a design context cannot be understood as it is in a mathematical/analytical context [11, 22, 31]. Instead it is argued that designers use design thinking and not analytical thinking, when solving problems.

According to Roger Martin [22] analytical thinking is characterized by a knowledge funnel, which gradually takes the mystery of every phenomenon and translates it into heuristics. The heuristics are later transformed into an algorithm and finally—what once was a mystery—may be translated into some sort of binary code. This is also illustrated in Fig. 2.2.

Design thinking, on the other hand, is more concerned with the reformulation of the mystery that is escaping the present realm of logic (or generally accepted knowledge funnel) and creating the basis for a new one.

In design methodology, this process of reformulating the 'mystery' is often referred to as repositioning [4] or reframing. Buchanan provides the following illustrative example of repositioning:

> Traditional graphic design yielded larger signs, but no apparent improvement in navigation—the larger the sign, the more likely people were to ignore it. Finally, a design consultant suggested that the problem should be studied from the perspective of the flow of the costumer experience. After a period of observing shoppers walking through stores, the consultant concluded that people often navigate among different sections of a store by looking for the most familiar and representative examples of a particular type of product. This led to a change in display strategy, placing the products that people are most likely to identify in prominent positions ([4], p. 12).

The reformulation of the mystery or escape from the present realm of logic is also represented in the kind of problems facing designers, and the way in which designers approach problems, in general.

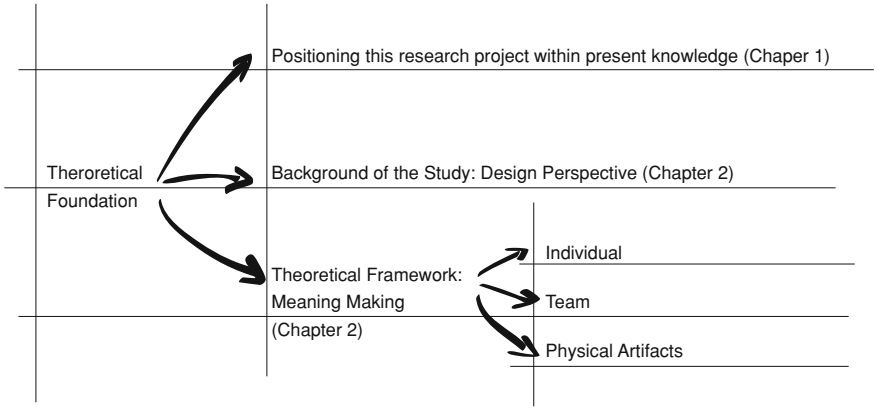

Fig. 2.1 Overview of the theoretical foundation

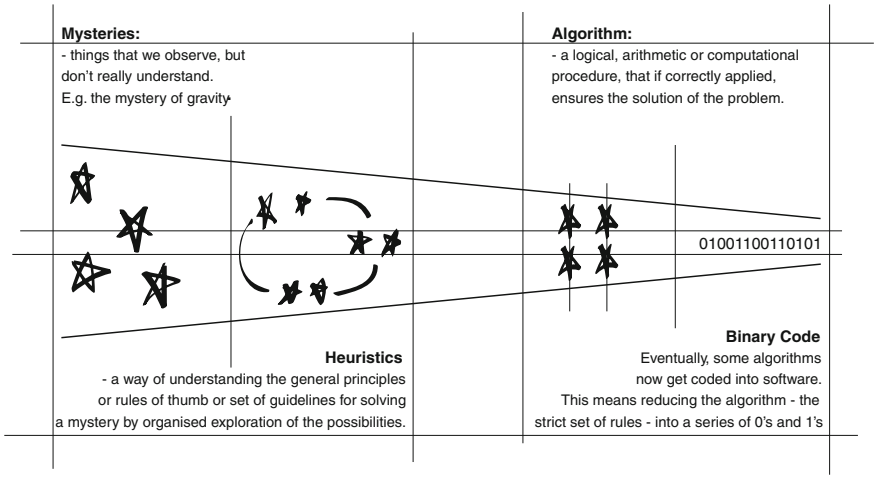

Fig. 2.2 The Knowledge funnel (Based on Martin's own illustration presented at the CONNECTING 07 conference in San Francisco, autumn 2007)

In 1972, Rittel introduced the term 'wicked problems' as a means to understand the types of problems designers are facing. Rittel [27] argues that in contrast to traditional analytical problem solving, with a clear definition and one solution, designers are faced with problems with no clear definition and therefore multiple possible solutions. In opposition to the wicked problems, he also introduced the term 'tame problems' and explained their difference as follows:

> (…) tame problems can be exhaustively formulated so that it can be written down on a piece of paper which can be handed to a knowledgeable man who will eventually solve the problem without needing any additional information. This is not so with wicked problems. When I tell somebody the problem is (…) to introduce a new product into our production

> line, I can write it down on a piece of paper, give it to him and lock him op. But it will not be long before this person will come out again and ask for more information: What kind of a new product are you talking about? How will it affect the other products already in operation? What markets do you expect for your product? etc. (…) ([27], p. 392).

Based on Rittel's work, Buchanan [4] has listed the attributes of wicked problems:

- Wicked problems have no definitive formulations, but every formulation of a wicked problem corresponds to the formulation of a solution.
- Wicked problems have no stopping rules.
- Solutions to wicked problems cannot be true or false only good or bad.
- In solving wicked problems there is no exhaustive list of admissible operations.
- For every wicked problem there is always more than one possible explanation, with explanations depending on the 'Weltanschauung' of the designer.
- Every wicked problem is a symptom of another, "higher-level" problem.
- No formulation and solution of a wicked problem has a definitive test.
- Solving a wicked problem is a "one shot" operation with no room for trial and error [after the implementation/commercialization].
- Every wicked problem is unique.
- The wicked problem solver has no right to be wrong; they are fully responsible for their actions ([4], p. 16).

The generally accepted understanding that designers are solving wicked problems also indicates that designers have a special approach in relation to the problem framings, problem scopes and problem formulations. According to Thomas and Carroll [41]:

> Design is a type of problem solving in which the problem solver views the problem or acts as though there is some ill-definedness in the goals, initial conditions or allowable transformations (p. 5).

And as a result of this, the designer will approach all problems as though they are ill-defined—regardless of whether they are or not [41]. This means that when the designer is given a problem formulation, he or she will look at the problem as only loosely 'defined' and assume that the project goal will be redefined during the project. Or as Jones [16] argues, the design brief will be seen as a kind of map for an unknown territory, rather than a specification for the solution.

2.1.2 Center of Attention or Value Criteria in Design

Another characteristic of design, which is described in many different ways, is its human-centeredness. This implies that designing is characterized by great attention and commitment in relation to the user or community for whom the design is intended. Therefore, the value of a design is constantly compared to the value it may or may not have to its users. Design activities are even argued to distinguish themselves from other creative and purposeful activities by their human-centeredness [17].

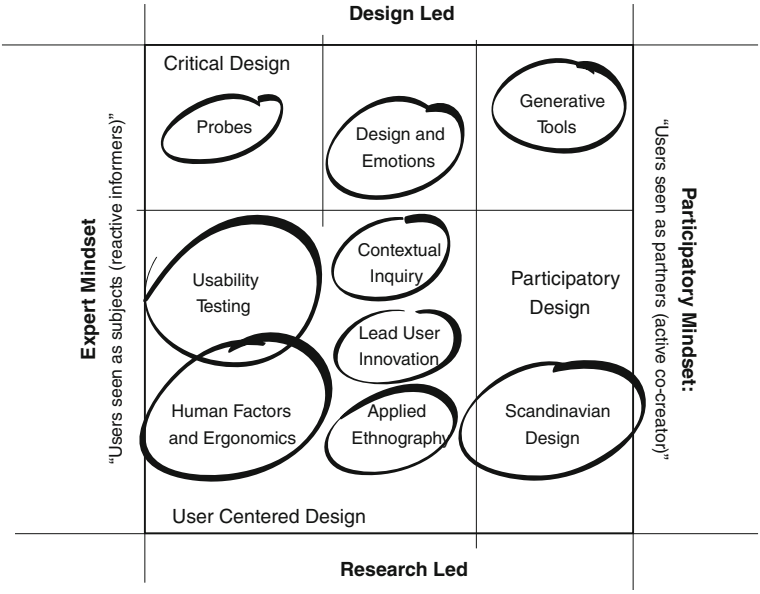

Fig. 2.3 Topography of User Research [30], own illustration

> Designers' extraordinary sensitivity to what artifacts mean to others, users, bystanders, critics, if not to whole cultures, has always been an important but rarely explicit acknowledged competence ([17], p. 48).

The human-centeredness of design is also evident in the myriad of methods in design also called design-research, user-research, or need finding [19, 23]. In 2006, Liz Sanders created Topography of User Research, in which she placed all the present methods and tools in a framework defined by the origin of the method and the mindset applied, when using it. Instead of ranging the different methods, her intention was to create a mental picture of the present approaches and mindsets used in user-research and to present these as equally valuable ways of approaching the challenges of human-centeredness. The topography can be seen in Fig. 2.3.

However, as Sanders' Topography illustrates, there is still a very lively discussion in the design community about how to view the user. The understanding of the user goes from a position, where the user is seen as a subject (reactive informer) to a position, where the user is seen as a partner (active co-creator). From a position where:

> Researchers talk about the people that they do research on as subjects, or informers or users. The people are asked questions and/or requested to respond to certain stimuli and/or observed (…) ([30], p. 5).

To a position where the designers invite the group of people, who the design is intended to benefit, to take part in the process as co-creators or partners instead of perceiving them as subjects.

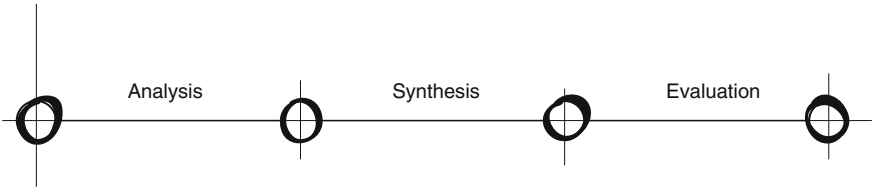

Fig. 2.4 The most basic design process model

Krippendorff [17] argues that the focus on the user in design is often misguided, and does not involve the necessary collaboration. Instead of looking at it as the user he suggests looking at it as a network of stakeholders, who:

- Are experts in their own worlds and usually are very knowledgeable about the stakes they claim in (a certain) development.
- Are willing to act in support or opposition of (a) development.
- Are willing to mobilize the resources they command: information, expertise, money, time, connections to members of their community, and the power of the institutional roles they occupy ([17], p. 64–65).

This is supported by Bucciarelli [3], who described designing in design teams as a process of achieving consensus among a group of participants with different interests. According to Bucciarelli, this process is necessarily social and requires participants to negotiate their different perspectives and construct meaning through direct interactions. However, Bucciarelli is not the only one, who has tried to explain the process of design. Like the myriad of methods to user-research and need finding there is also quite an extensive catalog of design process models.

2.1.3 The Process of Designing

In the design literature, various examples of design process models can be found, which assume that design can be organized in an identifiable process [42, 43]. Especially, the first generation models, which were introduced in the beginning of the 1960s, assumed that the design process could be divided into a set of discrete steps, which—when followed—would result in a design [28]. Most first generation models are based on the model shown in Fig. 2.4.

The underlying drive in the first generation models was to produce an approach to design based on objectivity and rationality—an approach to design in accordance with the values in science. Within this was also the wish to move from individual, intuitive, and experience based approaches to design into more stringent and explicit approaches.

Ever since the introduction of the first generation models (and later second and third generation models) a vivid discussion in the design community has taken place regarding to which extent the models are useful, and to which extent they

can be ignored. The argument to keep the design process models is that the increased complexity in the design projects as well as the need to work together with other professionals makes it necessary to apply new and explicit methods [16]. The argument to skip the design process models is that they are not useful and do not represent what happens, in practice. Or as Gedenryd [11] sums up in a number of studies:

> On the one hand, (Design Process Models) do not work as prescriptions. People do not use them, because they do not work for their advertised purpose; those who actually tried them failed to reach the stated results. On the other hand, they are also inadequate as descriptions. If you study how practitioners really work, you will find what they really do to be something quite different (p. 66).

Parallel with the discussion on design process models in the design community, several studies have been made with designers in practice and design as something separate from science. An e.g of this is Bryan Lawson's book: *How Designers Think* [20].

In this book, Lawson argues that designers are very different from scientists in that scientists set out to study the problem, whereas designers learn about the problem as a result of trying out the solution. This means that designers co-develop the understanding of the problem along with the creation of the solution. According to Lawson, this also means that designers are more inclined to generate a fairly quick and satisfactory solution, rather that prolonging the analysis of the problem.

This is also related to the kind of reasoning deployed in design. Roozenburg and Eekels [29] argue that design reasoning is abductive. Instead of building an hypothesis, which can be tested (deductive reasoning) or gathering a large set of inquiry, on which a rule or argument can be based (inductive), designers start off with a set of seemingly unrelated facts, sensing that they are somehow connected. Both the solution and the hypothesis emerge as an end result of connecting these facts.

Another significant study of designers in practice was made by Donald Schön. In his book 'The reflective Practitioner', Schön argues that design is a 'reflective conversation with the situation' [31]:

> (…) I shall consider designing as a conversation with the materials of a situation. A designer makes things. (…)
> He works in particular situations, uses particular materials, and employs a distinctive medium and language. Typically, his making process is complex.
> There are more variables—kinds of possible moves, norms, and interrelationships of these—that can be represented in a finite model.
> Because of this complexity, the designer's moves tend, happily or unhappily, to produce consequences other than those intended.
> When this happens, the designer may take account of the unintended changes, he has made in the situation by forming new appreciations and understandings and by making new moves. He shapes the situation in accordance with his initial appreciation of it, the situation "talks back," and he responds to the situation's back-talk. In a good process of design, this conversation with the situation is reflective. In answer to the situation's back-talk, the designer reflectsinaction on the construction of the problem, the strategies of action, or the model of the phenomena, which have been implicit in his moves ([31], p. 79).

2.1.4 The Design Perspective Versus the Early Phases of Innovation

As described in the introduction chapter, interdisciplinary teams working in the early phases of innovation are challenged by (1) Diversity, (2) Complexity and Ambiguity, and (3) Asymmetry or Stickiness of information. These challenges can also be found in design projects in general—if not all at once then at different times in the projects. This indicates that some of the approaches and perspectives from design may be relevant to use in projects in the early phases of innovation. This argument can also be supported by the characteristics of the designer, which can be summed up on the basis of the review above:

- Designers tackle wicked problems and approach all problems as if they were ill-defined.
- Designers are human-centered and have a myriad of tools and methods to approach the user (or the network of stakeholders).
- Designers co-develop the understanding of the problem along with the creation of the solution.
- Designers use abductive reasoning and strive for a solution.
- Designers engage in a reflective conversation with the situation.

All of these characteristics or attributes seem relevant, when it comes to approaching the challenges in the early phases of innovation.

In relation to the challenge of diversity in the interdisciplinary team, the design perspective is relevant because of its human-centeredness. The human-centeredness is a focus point, which is shared by all the team members and stakeholders, irrespective of their background or perspective. Furthermore, the aim in the interdisciplinary team working in the early phases of innovation is to find the right problem, need, or opportunity, and to accomplish this a human-centered approach is very relevant.

In relation to the challenge of complexity, the design perspective is relevant, because of its ability to tackle wicked problems and the co-development of problem understanding and solution. First of all because the problems in the early phases of innovation are wicked, and often ill-defined. And second, because one of the most plausible ways to handle the complexity in the early phases is by co-developing the understanding of the problem along with the creation of the solution—in a reflective conversation with the situation.

In relation to the challenge of ambiguity, the design perspective is also relevant, because of its abductive reasoning and reflective conversation with the situation. In the early phases of innovation, there is no causality, and therefore abductive reasoning becomes a relevant approach along with probing different possibilities.

And finally, in relation to the asymmetry or stickiness of information, the design perspective is relevant, because of its human-centeredness and the myriad of methods with which to approach the user (or the network of stakeholders).

Another link between the early phases of innovation and the design perspective can be found in practice, where design is already playing a significant role in the

early phases of innovation [10, 44], and where several researchers from the field of business strategy and management praise the use of design approaches in early phase innovation projects [21, 22].

In Chap. 3, there will be a more detailed explanation of how the different insights and approaches from the design perspective are adopted and used in relation to the workshops and the research, in general. In the following section, however, the focus will be on the theoretical framework.

2.2 Theoretical Framework

As explained in the beginning of this chapter, the theoretical framework is focused on meaning making. In the literature, meaning making is examined in a number of areas for instance in leadership, teaching, organizational learning, religion/spirituality, etc. Meaning making as a phenomenon derives from the hermeneutics; however, in this book, the intention is to view meaning making in relation to the creation, design, and development of new products, processes, and services, and more specifically, in relation to individuals, teams, and physical artifacts involved in this process of creating, designing, and developing.

In the first section, meaning will be reviewed in relation to how the individuals are creating meaning and how this meaning is communicated. This is relevant to the research, because each member of the design team as well as each stakeholder will have their own way of making meaning in relation to the early phase project, which they are working on.

Second, meaning will be reviewed in relation to how teams are creating shared frames. This is relevant in relation to the research, in terms of the need to create a shared project frame or other aspects of 'sharedness' within the team which previous research has shown is important.

And finally, meaning will be unfolded in relation to physical artifacts, in terms of how they impact communication of meaning as well as the creation of shared frames.

2.2.1 Meaning in Relation to Individuals

> One cannot ignore that designers, engineers, business people, politicians, cultural critics, and users all live in different worlds, act according to different conceptions they bring to what they encounter, and create different meanings for what seems from any one perspective to be the same thing ([17], p. 49).

In order to understand the process of meaning making on the individual level, it is important to make a distinction between meaning and sense. Whereas sense is immediate, direct, and almost unconscious gathering of insights from the surroundings, meaning involves conscious reflection and interpretation. Sense happens throughout all of our senses, whereas meaning involves an intellectual molding [17]. The difference between sense and meaning can be explained through

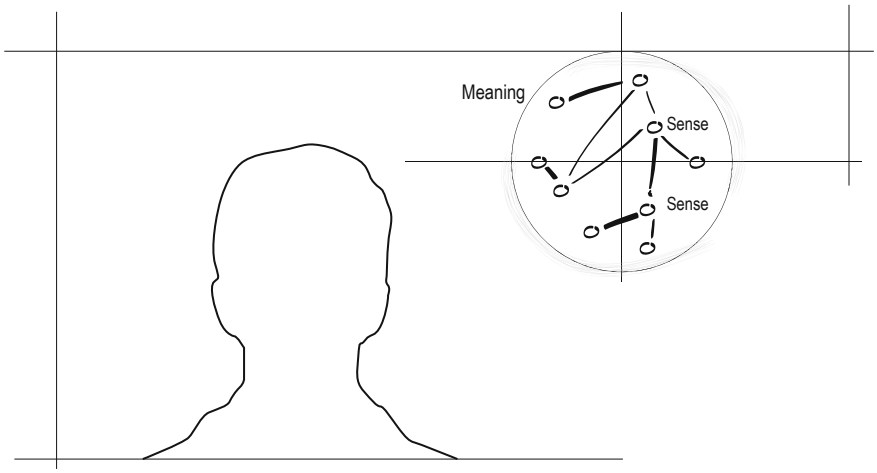

Fig. 2.5 Meaning as a network of senses

the metaphor of a puzzle: sense is the interdependent pieces, while meaning emerges when the different pieces are added together—into something meaningful.

> Sense is the feeling of being in contact with the world without reflection, interpretation or explanation. (…). Sense is the background against which one notices what is unusual, unexpected or different. Sense is the tacit, taken for granted and largely unconscious monitoring of what is ([17], p. 50).

The question of meaning is often brought up when something unexpected is sensed, or when an alternative way to combine senses is introduced, i.e., if you come home and something in your house has changed from its usual position, you will notice it. Likewise, if you see a person staggering toward you, you might think he is drunk—however, after talking to him you may realize that an aggressive-type sclerosis is the reason for the awkward type of walking, and this will probably change your perception and attitude toward him.

> Meaning is a structured space, a network of expected senses, a set of possibilities that enable handling things, other people, even oneself. They guide action much as a map shows all the possible paths from where one stands ([17], p. 56).

This connection between sense and meaning is also illustrated in Fig. 2.5. Each of the black dots represents senses and the whole figure illustrates the meaning.

2.2.1.1 The Links Between Sense and Meaning

As it has been revealed above, meaning can be seen as an explanation of how a sense is embedded in the context of other senses, and the senses' role in this context. Krippendorff [17] argues that meaning manifests itself in different ways:

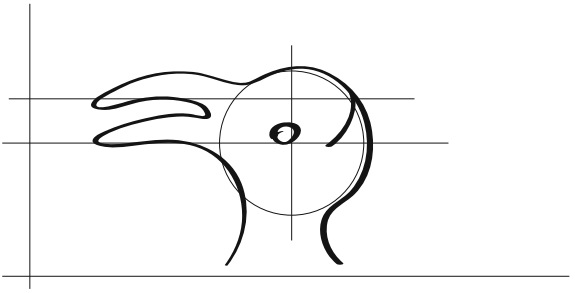

Fig. 2.6 The Duck-Rabbit [48]

in perception, in reading, in language, in conversation with others, and in re-representation. In relation to this book, the manifestations in perception and in conversation with others are especially interesting.

In perception, meaning arises in the awareness of the possibility of different ways of seeing [17]. So, when we notice that something can be perceived in more than one way, we become aware that we are making meaning of things in a certain way or from a certain perspective. A very simple and well-known example of this is the Duck-Rabbit created by Wittgenstein [48]. It can be seen in three ways: as a duck, as a rabbit, and as a line drawing (Fig. 2.6).

When looking at the drawing, it seems as if it is shifting from a duck to a rabbit, depending on how we perceive it. However, nothing in the drawing—as such—is changing. It is in our perceptions or meaning making that the changes occur.

In conversations with others: questions of meaning can also arise when we become aware that others seem to see things differently, when others use words or handle artifacts in ways we would not, or when others account for their world in terms different from our own. Experiencing such discrepancies challenges the obvious of our own perceptions, and accepting the possibility of versions other than our own calls for explanations of these apparent differences [17].

This implies our personal meaning making becomes challenged, when we realize that other people see the world differently, and it sharpens our consciousness in relation to how we construct meaning of our own.

In Fig. 2.7, perception and conversation with others are illustrated as links between sense and meaning, or as manifestations of two different meaning-making processes.

2.2.1.2 Second-Order-Understanding

Sense and meaning are both 100 % personal: they can never be completely shared with others, because they are based on personal experience.

However, in the early phases of innovation, it is important for the interdisciplinary team to obtain an understanding of the meaning, which stakeholders apply to the situation or activity in question as well as to understand how the other team

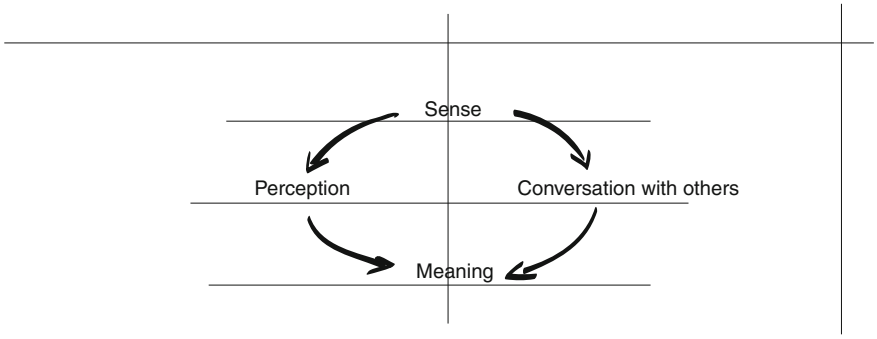

Fig. 2.7 The link between sense and meaning

members apply meaning. This kind of understanding is often referred to as second-order-understanding.

> Understanding someone else's understanding is an *understanding of understanding*, an understanding that recursively embeds another person's understanding in one's own, even if, and particularly when, these understandings disagree, contradict one another, or are thought by one to be wrong or appallingly unethical. This recursive understanding of understanding is a second-order-understanding. ([17], p. 66, original emphasis)

Narratives and stories are typical strategies to gain a second-order-understanding, because these already play an important role in people's understanding, explanations, and representations of life. On the basis of previous research, Cochran [9] has summarized the following links between the narrative and its influence and importance to human life.

> First, we live in story. In human experience there is always before and after, memory and anticipation, without which the present is unintelligible. (…)
> Second, we represent life in story. (…) In telling jokes, giving anecdotes, describing an event, writing a life story, or planning the future, we tell stories. (…)
> Third, we explain through story. (…) explanation is not concerned with one time or another, but with the change over time represented by the two contrasting states. (…). An explanation takes the form of a story, because it already has the story's form, with a beginning, middle and end.
> Last, we understand and comprehend through story. (…) To comprehend, we seek larger patterns and syntheses in which parts fall into place ([9], p. 73).

However, when looking at the situation in the early phase of innovation, for many stakeholders it is simply impossible to narrate or explain how they apply meaning to a situation or activity, either because they have done it so many times that they do not think of it anymore, or because they find it hard to define or articulate.

Likewise, in the interdisciplinary team it can be difficult to understand the meaning which the other team members apply, because each team member has a certain perspective, professional language, and set of experiences.

In many cases it is therefore relevant to enter into a dialog and re-examine how each individual experiences, senses, feels, and behaves in certain situations and investigate how these small pieces of information are provided with meaning in their 'worlds'.

> While stories can never capture all the meaning that informants bring into a narrative, especially their feelings and tacit understandings, conversation provides a window into the understanding that others have (…). The key to this understanding is unprejudicial listening, avoiding our own categories, and being careful rearticulating these stories in our own terms ([17], p. 55).

2.2.1.3 Metaphors

According to Lakoff and Johnson, metaphors provide another way for people with different values, experiences, and perspectives to gain second-order understandings. In their book 'Metaphors we live by' they state that:

> A metaphoric presentation skill is essential to create contact and communicate experiences, which are not shared ([18], p. 257).

This means that metaphors become a way to explain values and meanings, as well as a way to frame and restructure understandings. It is therefore interesting to look more closely at present research on metaphors. It is evident that metaphors function by explaining something about an object, activity, or relation in terms of something else. For instance in the metaphor: "there is chemistry between them", the world of chemistry tells us something about how to understand the relationship between the two people in question. On the more operational level this can also be explained like this:

> Metaphors operate across two logically independent domains, an absent but familiar domain of experience, the source domain, and a present domain in need of understanding or restructuring, the target domain ([17], p. 157).

In relation to the example 'there is chemistry between them', this means that the source domain is chemistry, and the target domain is the relationship between two people. It is further found that metaphors transfer a way or understanding or a pattern of understanding between the two domains:

> Metaphors carry (…) patterns of understandings embedded in the vocabulary of source, from the source domain along the structural resemblance into the target domain, which becomes reorganized regardless of what it was previously ([17], p. 157).

In the example used above about chemistry between two people, the patterns of understanding in chemistry are transferred to the domain of human relationships. However, metaphors are not just interesting in relation to communication and the creation of second-order-understandings, they also have a very significant influence on our cognition. Lakoff and Johnson argue that:

> (…) most of our ordinary conceptual system is metaphorical in nature ([18], p. 4).

This means that we use metaphors as a way of mapping our experiences into our cognition and thereby making meaning of them. Their research shows that we perceive, understand, and structure things in terms of other things. Even if we do not use the conceptual metaphors directly, it is revealed in the way we think and talk about things. For instance, the conceptual metaphor, Love is Magic, can be found in a number of everyday expressions like:

> She cast her *spell* over me. The *magic* is gone. I was *spellbound*. She had me *hypnotized*. He has me in a *trance*. I was *entranced* by him. I'm *charmed* by her. She is *bewitching* ([18] p.62, original emphasis).

The use of metaphors as a tool to structure our experiences becomes particularly important, when it comes to comprehending things, which cannot be comprehended totally like feelings, moral practices, and spiritual awareness [18]. But the argument that our conceptual system is metaphoric in nature also emphasizes the value of communicating through metaphors.

2.2.1.4 Summary With Respect to Individual Meaning Making

In the section above it has been reviewed how individuals are making meaning and how this meaning making can be communicated to others. It was found that sense is immediate, direct, and almost unconscious gathering of insights from the surroundings, whereas meaning involves conscious reflection and interpretation. It was further found that meaning arises both in perception and in conversation with others.

In relation to the communication of meaning, it was found that when meaning is communicated, it is only possible to create a second-order-understanding of the meaning shared. And that conversation and metaphors were identified as possible ways of creating this second-order-understanding, because both of these are able to capture feelings, moral practices, and tacit understanding, which are very hard to communicate. And finally, metaphors were especially highlighted because we structure our senses and make meaning of things via the use of metaphors or metaphoric features.

The theoretical framework on individual meaning making, which has been reviewed in the section above, is relevant in relation to this study, because:

1. It creates insights into how each team member in the design team is making meaning in relation to the project.
2. It creates insights into how each stakeholder or user is making meaning in relation to their everyday life and
3. It provides insights into how this meaning making can be communicated.

2.2.2 Meaning in Relation to Teams

One of the main findings in relation to meaning making is that both sense and meaning are 100 % personal. Therefore, it does not really make sense to talk about shared meaning within the interdisciplinary team. Instead, it is possible to work with 'sharedness' in terms of shared frames. Framing as a concept has received attention from the fields of sociology, urban planning, engineering, linguistics, cognitive science, management science, and organizational behavior. Still, there is no comprehensive or definite definition of it [39]. The presentation of team or project framing will be preceded by a brief review of framing in general, which often is defined in relation to the individual. However, even if frames can be understood in relation to individuals and organizations, this book will mainly use the understanding of frames in relation to teams or projects.

2.2.2.1 Framing

Framing as a phenomenon originates from perception psychology and refers to the organization of experiences [12]. All individuals build their own set of framings based on their everyday experiences. However, the framing does not only function as a means to organize information, but also as a filter for screening of all incoming information. This means that the already existing frames shape the 'rules' or guidelines in relation to the perception of upcoming situations [36]. Accordingly, to change an individual's understandings and thereby actions taken, one has to change the person's frames. Argyris [1] explains the creation and use of framings through his ladder of inference viewed in Fig. 2.8.

On the first step of the ladder the observable data or experiences are placed. This is then going through a selection process on the second step of the ladder. The selected data and experience are then structured into meaning and processed to assumptions. On the basis of this it now becomes possible to draw conclusions and at some point adopt beliefs about the world. These beliefs are the basis of actions, but also an active player in the data, which is selected next time. Going through the ladder of inference also means that a frame is created.

In her thesis, Valkenburg defines framing as a device for sense making, which settles the parameters of the problem [45]. This perspective on the frame is identifiable in the work of Weick [47], whose research has been focused on sense making in organizations.

One of the most comprehensive studies and discussions on frames and framing has been developed by Schön. He has described frames as:

> underlying structures of belief, perception, and appreciation ([32], p. 23).

And framing as an activity, in which the aim is to construct meaning. He further concluded that frames include implicit assumptions about what issues are relevant, what values and goals are important, and what criteria can be used to evaluate success.

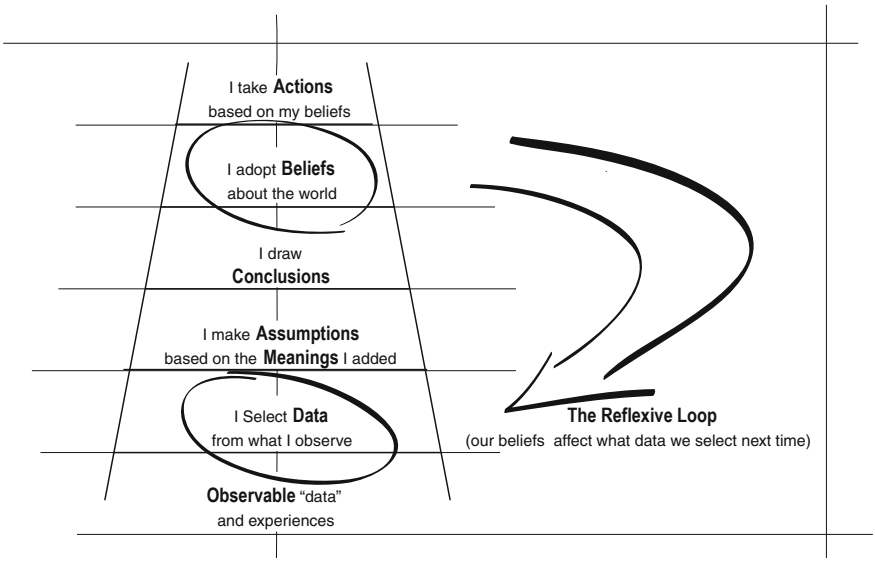

Fig. 2.8 Ladder of inference (Illustration from [34] p.243)

> Problem setting is the process in which we name things to which we will attend and frame the context in which we will attend to them ([31], p. 40).

In his book The Reflective Practitioner, Schön [31] describes the contrasting frames a design student and his mentor bring into play in a design review, and how their interactions with each other and the framing of the problem produce the final design. In the review, the names of the design strategies were highlighted in particular as well as the importance of shifting frames, when a problem becomes problematic to handle within one framing. Furthermore, Schön found generative metaphors as a means to frame situations—and thereby also frames as a way of 'seeing as' [31]—that is, seeing something through a lens of something else. He gives an example of this in terms of a framing used in an urban planning project, where a slum area either can be framed as a 'blighted area', which needs to be cured or as a 'natural community', which should be preserved. Both frames represent a significant view of the design situation and evoke different understandings of the problem.

2.2.2.2 Team Framing and Negotiating Shared Frames

Valkenberg and Dorst [46] attempted to apply the thinking in Schön's book: The Reflective Practitioner to team design situations. In practice, it involved a study of industrial design students working on projects in teams. When comparing the successful team with the unsuccessful team, it was found that the team's problem framing played a significant role. In the successful teams, it was possible to

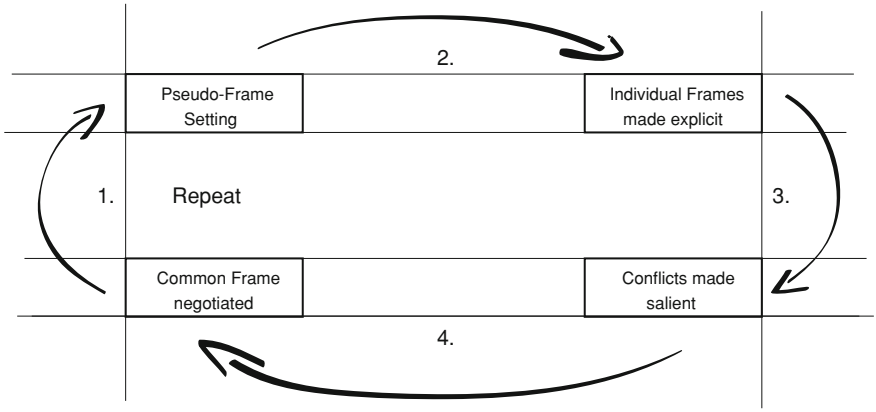

Fig. 2.9 The four phases of the framing cycle [15]. Own illustration

identify five different frames used sequentially, whereas in the unsuccessful team only one single frame was used.

In relation to teams, the project frames can be defined as the basis upon which the team pairs problem with solutions [31, 46] this means the selection of a desired end state or goal, which implicitly includes the problem, need, or opportunity, or the identification of the problem, need, or opportunity, which implicitly includes the desired end state or goal.

In 2007, Hay et al. studied the creation of framing and reframing in design teams working in the early phases of product development projects. They found that project framing and reframing in design teams happen in four different phases. The four phases illustrated in Fig. 2.9 are reviewed below.

Pseudo-frame setting
Pseudo-frame setting creates an initial understanding of the design situation, the goals, important features, boundaries and evaluation criteria, in this case upon the initial presentation of the project proposal to the class. The proposal sets boundaries around the problem and solution domains and, in some cases, implies strong solution directions. (…) The use of broad, abstract language leads members to believe that they are on the same page. However, the vague nature of these initial agreements can mask deep-level disagreements in goals, assumptions, values and understandings. Individual frames are still hidden ([15], p. 93–94).

Individual frames made explicit
The process of interacting with and collecting data from users breaks down designers' preconceptions by informing their point of view and challenging their assumptions. (…) In the process of making these decisions, members often discover their own implicit ideas regarding the project. The consequent sharing of expectations through team interaction makes each member's implicit frame more explicit, and thus tractable material for discussion and debate ([15], p. 94).

Conflicts among individual frames made salient
Several activities make individual frames explicit, and thus conflicts among them salient, e.g. building a group vocabulary through defining terms, writing mission statements and

> other textual artifacts, labeling user needs and other concepts, prioritising user needs, categorising ideas and dimensioning users. Once conflicts between individuals' frames are made salient, common frames can begin to be negotiated ([15], p. 94).
>
> *Common frame negotiated*
> Teams that made individual frame conflict salient used a combination of user data, discussion, and listening to negotiate a shared frame. Dedication of the team to the user-centered design gives the team a common anchor against which to tether constantly evolving individual frames, thus enabling the eventual arrival at a shared frame ([15], p. 95).

Often it was found that the four phases of framing were repeated in the projects. Still, it was found very useful to go through a full iteration as soon as possible in the project:

> The sooner the team was able to 'get on the same page', as many students described it, the sooner they were able to focus on addressing the needs of their users without differences in understanding and assumptions getting in the way ([15], p. 95).

2.2.2.3 Summary With Respect to Meaning Making in Teams

In the section above, meaning has been reviewed in relation to teams. It was found that it did not really make sense to talk about shared meaning within a team, since both sense and meaning are 100 % personal. Instead it was found possible to work with 'sharedness' and meaning making in terms of shared frames. The review showed that framing can be seen as a device for sense making, which settles the parameters of the problem, and that a frame can be described as underlying structures of belief, perception, and appreciation. It was furthermore found that framing can be seen as an activity, the aim of which is to construct meaning.

In relation to team or project framings it was found that frames include implicit assumptions about what issues are relevant, what values and goals are important, and what criteria can be used to evaluate success. And finally, it was found that project framing and reframing in design teams happen in four different phases: (1) Pseudo-frame setting (2) Individual frames made explicit (3) Conflicts among individual frames made salient and (4) Common frame negotiated.

The review on frames and shared framing is relevant in relation to the book, in terms of the need to create a shared project frame within the team working in the early phases of innovation as well as a means to create the 'sharedness' within the team, which previous research has shown is important.

2.2.3 Meaning in Relation to the Creation of Physical Artifacts

The last area, which is reviewed in relation to meaning, is physical artifacts. Physical artifacts—including models, mock-ups and prototypes—are typically used throughout the development process as a tool to visualize the problem, the solution or parts of these. In other words, physical artifacts are playing significant

roles, when it comes to combining insights and meaning making in design and development teams.

Some researchers even describe product development as a modeling activity, where the progression between models with different purposes drives the development process, and where the models become an important tool to describe, visualize, and sculpture one's thoughts as well as designing or communicating with others [5].

Schön [31] has also studied modeling and prototyping as part of the design and development process. He argues that when a designer works on the model, he encounters a number of unexpected challenges in the model and responds to these immediately, by using his tacit knowledge-in-action, which is based upon previous experiences. This is done in a process of trial and error, or what Schön has named reflection-in-action.

Michael Schrage [33] has studied modeling and prototyping in teams. In his book "Serious Play" he argues against the common assumption that 'great teams make prototypes' and suggests instead that 'prototypes make great teams'.

> In this sense the values of prototypes reside less in the models themselves than in the interaction—the conversations, arguments, consultations, collaborations—they invite. Prototypes force individuals and institutions to confront the tyranny of trade-offs ([33], p. 20).

Schrage further argues that prototypes can promote the awareness and empathy between collaborators within cross-functional and cross-disciplinary teams and work as a shared medium of communication and collaboration in the innovation process. In his perspective, prototypes can be seen as a tool, which minimizes the competition and discussions within the team and instead creates a place for collaboration [33]. This is supported by Henderson, who argues that prototyping is more than communication and coordination, and that it plays an important role in terms of the 'social glue':

> The analysis reveals that visual representations, including prototypes, are not only devices for communal sharing of ideas but are also a ground for design conflict and company politics, exactly because they facilitate the social organization of workers, the work process and the concepts that workers manipulate to produce a collective product ([14], p. 10).

2.2.3.1 Definitions: Models, Prototypes, and Mock-ups

The term model can be seen as the overall umbrella in which other more specific definitions can be found, such as prototypes and mock-ups. According to Schrage [33]:

> A model can be anything from a mathematical equation scribbled on a napkin to a full-scale version of a Boeing 777 (p. 7).

Within the definition of a model there are the definitions of prototypes and mock-ups. These will be reviewed below.

2.2.3.2 Prototypes

Prototypes can—just as models—take many different forms. A prototype can for instance be a scale model of a house or product, a piece of software, a paper-based outline of one or more screens, a video-simulation of a work task, or a three-dimensional mock-up of a workstation [26]. According to Preece et al. [26]:

> A prototype is a limited representation of a design that allows users to interact with it and to explore its suitability (p. 241).

Furthermore, prototypes can be used in a variety of ways. They can support designers and stakeholders to choose between different design alternatives, they can be used to test technical aspects of an idea or concept, and they can help to clarify requirements, test usability, or check if a certain design direction is in line with other parts of the design [26].

Preece et al. have divided prototypes into two categories: low-fidelity prototypes and high-fidelity prototypes. Low-fidelity prototypes are often made of simple and cheap materials like paper and cardboard. They are often cheap, fast to produce, and modify. As a result, low-fidelity prototypes are different from the final design, and therefore they are not to be kept and integrated into the final product.

High-fidelity prototypes look more like the final design, and they are made of the same materials as the final design. High-fidelity prototypes are more time-consuming and hereby more expensive than low-fidelity prototypes.

In relation to collaborative design, Bødker and Buur [6] stress the importance of tangible prototypes as tools to try out future use situations, because one can interact with them and get hands-on experiences. However, there is a limit to the meaning they convey, or as Shaw expresses it:

> Prototypes make very definite statements about the precise nature of what is envisioned and allow these to be tested in the context of use, but do not by themselves convey the reasoning behind any particular feature or alternatives that may have been considered ([35], p. 70).

2.2.3.3 Mock-ups

Mock-ups belong to the low-fidelity category and have been described in relation to various design and developments contexts. According to Merriam Webster's dictionary a mock-up is:

> -a full-sized structural model built to scale chiefly for study, testing, or display, or
> -a working sample (as of a magazine) for reviewing format, layout, or content. [25]

Carroll [8] has studied the use of mock-ups in scenario-based design, and Binder [2] has studied how users with simple cardboard mock-ups as props can create improvised scenarios in their own environment.

2.2.3.4 Boundary Objects

Many models, prototypes, and mock-ups can also be described in terms of boundary objects. The concept of Boundary Objects is described by Carroll [38], defining objects that are shared and sharable in different problem solving contexts, that is objects which work to establish a shared context or which 'sit in the middle'.

> Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in common use. These objects may be abstract or concrete. They have different meanings in different social worlds, but their structure is common enough to more than one world to make them recognizable as means of translation ([38], p. 393).

Star and Griesemer [38] identified Boundary Objects in a museum context, where, in the beginning of the 1900s and onwards, scientists and amateur collectors used Boundary Objects to create a shared collection of Vertebrate material, which could be useful to both communities. Based on this study Star and Griesemer found that:

> The creation and management of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds ([38], p. 393).

According to Henderson, the most important aspect of Boundary Objects is that they make it possible for different groups to see and understand different meanings in the objects. Boundary Objects shall thus be understood as objects that can give meaning to different participants, even though they have different professional practices and professional languages—different competencies.

> (…) Boundary Objects allow members of different groups to read different meanings particular to their needs from the same material. This is possible, because the material remains flexible in group use and more focused in individual site use [13].

According to Miller [24] it is not only important that the Boundary Objects are created, but that they are co-invented, developed in neutral territory, have a reasonable lifespan, and have real use and meaning to all the participants. Carlile [7] have studied the difference between good and bad Boundary Objects or, in other terms, the difference between 'Boundary Roadblocks' and Boundary Objects. On the basis of this he has identified the characteristics of a good Boundary Object as follows.

Good Boundary Objects:

1. Establish a shared syntax or language for individuals to represent their knowledge.
2. Provide a concrete means for individuals to specify and learn about their differences and dependencies.
3. Facilitate a process where individuals can jointly transform their knowledge.

However, as Subrahmanian et al. argue:

> Boundary Objects can inhabit several communities of practice and satisfy the information requirements of each of them. This does not mean that use of Boundary Objects requires participants to have shared understandings to establish coordination ([40], p. 186).

2.2.3.5 Summary of Meaning Making in Relation to Physical Artifacts

In the section about meaning in relation to physical artifacts it was found that models and prototypes are playing significant roles, when it comes to combining insights and meaning making in design and development teams.

It was further found that prototypes can promote the awareness and empathy between collaborators, work as a shared medium of communication, minimize the competition and discussions within the team and function as the 'social glue'. The definitions of models, prototypes, and mock-ups were reviewed as well as some of the more individual characteristics.

It was further found that models, prototypes, and mock-ups can play the roles of Boundary Objects, which makes it possible for different groups to see and understand different meanings in the same objects. Boundary Objects as a phenomenon was also further elaborated and defined, in terms of objects that are shared and sharable in different problem solving contexts. And further research reviewed showed it to be important that Boundary Objects are co-invented, developed in neutral territory, have a reasonable lifespan, and have real use and meaning to all the participants.

2.2.4 Connecting the Theoretical Framework to the Empirical Setup

In the review of the theoretical framework, which has been presented in this chapter, it was necessary to divide the meaning making into three directions: individual, team, and artifacts. However, in the workshops, on which this book is based empirically, the different types of meaning and the communication of meaning will happen simultaneously. That is: both individual meaning making, communication of meaning, creation, and negotiation of shared frames will happen at the same time.

On top of this, the workshops will also include the creation of physical artifacts. As explained in the preface, this book builds on the initial assumption that the creation of physical artifacts can help team-members, users, and stakeholders to overcome the boundary of not being able to define, express, and communicate how they frame a given project or make meaning in relation to their everyday life. And that this clarity will help the creation of a shared frame. The literature in the theoretical framework seems to underline this assumption, and it indicates that the

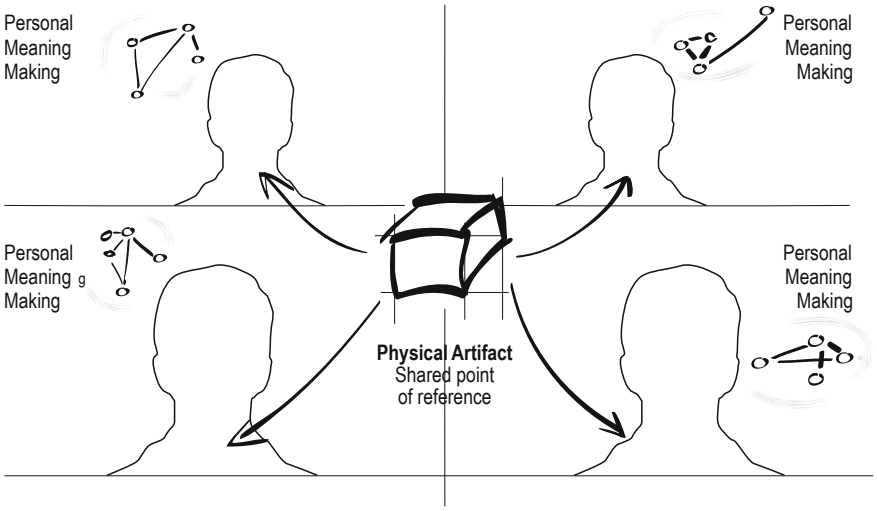

Fig. 2.10 Initial understanding of the workshop setup

physical artifacts created by the team members, users, and stakeholders could perhaps function as boundary objects, or at least function as a shared reference point for the team. This is also illustrated in Fig. 2.10.

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