

# A Situated Approach to Systems Based Modeling of Services

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**Abstract**— Situatedness refers to the imagery that conceptualization invokes. The image, as a whole, provides the context for interpreting the relevance of the categories revealed in the image. At a basic level of conceptualization, the causal relevance of an observed category can be historically inspired, empirically informed, rationally thought, or pragmatically focused. From a service-design perspective, the interest in a given phenomenon is limited to its functional organization, which requires taking an exclusively pragmatic view of the world. In this paper, we propose a role-based approach to modeling categories, which requires service-designers assign functional and non-functional roles to categories by making explicit their interpretation of the conceptual relevance of these categories. Staying aware of the design choices will help the service-designer develop an informed model of observed reality, leading to better alignment between the scope and the purpose of the inquiry.

**Keywords**-situational semantics; epistemic principles, functional roles; refinement

## I. INTRODUCTION

Systems is a set of interacting categories, which together exhibit some behavior for an observer, and that this behavior cannot be construed from any subset of these categories [1]. Further, categories are not observed in isolation. They are revealed as part of a conceptualization process, which invokes the image of some earlier experienced situation [2]. The imagistic character of conceptualization is inspired by multiple epistemic considerations, which may assign functional or non-functional roles to the observed categories [3]. From a service-design perspective, the interest in a given phenomenon is limited to the causal organization of the phenomenon. Service-design is an engineering endeavor to enrich some aspect of the real world through a man-made artifact [4]. As a result, a service-oriented systems model of the phenomenon of interest reifies service-systems by admitting only those categories, which have some functional relevance to the phenomenon of interest.

In this paper, we highlight the need for service-designers to critically reflect on the imagery that the phenomenon of interest invokes and reason why one sees the categories that she sees. It is important to note that this paper uses the concept of image to refer to the semantics of a situation and not any specific digital artifact. In that sense, the image as a whole provides the

context for interpreting the relevance of the observed categories. We refer to the four prominent epistemic considerations, described in [3], and demonstrate how they aid in reasoning the conceptual relevance of the observed categories to ascertain if these categories have some functional relevance to the imagined situation.

In doing so we make two recommendations. First, we propose a role-based approach to modeling categories. Existing approach to service modeling [5], reify systems through a stakeholder mapping process. Stakeholders are entities or group of entities that are active in one or more cause-and-effect relationships with the phenomenon of interest. An entity-based interpretation of the observed category does not capture the underlying functional relevance of the category. An entity may contribute to more than one aspect of the phenomenon of interest and the nature of participation may also vary across situations. To ensure that a systems model is a meaningful representation of the observed reality, it is important that we capture the deeper aspects of entities' participation to the phenomenon of interest.

Second, we propose a refinement process to generate additional categories from the ones observed at the basic level of conceptualization. Refinement provides a systematic approach to explore a situation at finer levels of granularity. Nevertheless, for the inquiry to stay relevant, it is important that the refinement process stays tractable. In the context of service-oriented inquiry, an important terminating condition for the refinement process is that the refined situation should be relevant to the purpose of the inquiry. Such a refinement approach situates the inquiry firmly within the scope of the phenomenon of interest, henceforth referred as situated refinement. Situated refinement makes the service-designer's choice - in terms of her selection of non-functional roles to be investigated further, explicit. Staying aware of the design choices a service-designer makes, helps develop an informed model of observed reality, which eventually leads to better alignment between the scope and the purpose of the inquiry.

The remaining part of the paper is divided into six parts. Section II describes the notion of Systems based modeling of services and how a situated approach improves the effectiveness of these models. Section III discusses the

different epistemologies that influence the conceptualization process and how they differ from other form-oriented groundings of conceptualization such as, Gestalt completion. Section IV proposes a role-based approach to modeling categories, which helps highlight the distinction between functional and non-functional roles. It also describes the situated refinement approach, which helps the service-designer develop richer models of reality by exploring the phenomenon of interest at additional levels of conceptualization. Section V presents an application of the approach proposed in this paper in an inquiry into the use of foldable-bike as part of mixed-mode of transport. The paper ends with some future research directions in Section VI.

## II. SERVICE-ORIENTED SYSTEMS MODELING

Systems is a theory of observation [6]. Observations are appreciative judgments that reveal the categories observed in a phenomenon of interest [7]. A Systems approach to inquiry helps the modeler organize these categories into groups such that the behavior exhibited by the interaction between these categories is preserved [8]. In the context of service-oriented inquiry, the service-designer is interested in specifying the behavior required to create value for some particular individual or group of individuals.

Value is experiential in nature. In a world rich in variety, to ensure that some target subject undergoes a certain experience, it is important that the design of the behavior intended to deliver that experience, internalizes, as much as possible, the real world uncertainties that may influence this behavior [9]. As a result, Systems based approach to services, adopts a dichotomous approach to categorization. For a given phenomenon of interest, it first identifies the category corresponding to the target subject, henceforth referred to as the *Focal-element*. All other categories identified as relevant to the phenomenon of interest are grouped together into one system, commonly referred to as the *Service-system* [10]. The independent standing of the Focal-element is to emphasize the subjectivity of the experience that the behavior of the Service-system creates for the target subject. On the other hand, Service-system conveys the notion of functional unity - everything that can influence, either intentionally or unintentionally, the creation of the intended experience for the Focal-element is seen as functionally-joined in their interaction with the Focal-element. Figure 1 provides a visual depiction of the service as the behavior exhibited by the Service-system and the experience it creates for the Focal-element.

Since the design of a service is an engineering activity, a service designer is inclined to specifically model only those aspects of observed behavior whose causal linkage to the phenomenon of interest has been exposed. As a result, to fully realize the potential of Systems approach to service-oriented modeling, it is important to disambiguate the process of identifying Service-systems, which have functional appeal, from amongst systems with general behavioral appeal. In the following sections, we focus on understanding the distinction between functional and non-functional participation of

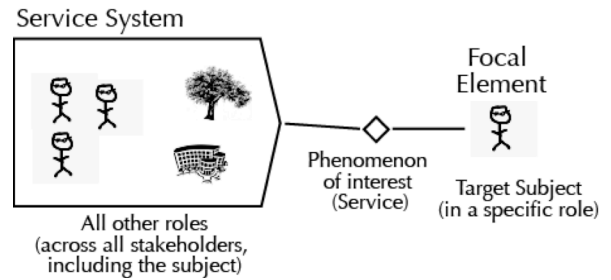


Figure 1. Service-oriented systems model of phenomenon of interest

categories and some guidelines on how to identify them by critically reflecting on the situations available to the service-designer.

## III. THE IMAGISTIC NATURE OF CONCEPTUALIZATION

Cognitively, conceptualization is situated [2]. Situatedness refers to the imagery that conceptualization invokes. It is the reenactment of a combination of prior experiences that together simulate a perceptual experience in the form of a situation - experienced or imaginary. The imagistic nature of conceptualization is enabled through different epistemic considerations. The four prominent epistemological theories that are considered relevant from an information science perspective include historicism, empiricism, rationalism and pragmatism. It is the contribution of these different epistemological views in activating an imagined situation that lends semantics its encyclopedic nature [11].

For example, consider the case of a bike manufacturer conducting an inquiry on the use of bike to go to school. One popular image of a person biking to school is where she carries a bag. The inclusion of bag in the 'bike to school' conceptualization may be grounded in historicism, as historically we, as students, have been exposed to the act of carrying reading, writing instruments and lunch box to school. From a bike manufacturer's perspective, the role of 'bag-carrier' undertaken by the person biking to school is not, by default, relevant. This, initially historicism inspired, role gains significance for the inquiry only when it is shown to have some functional relevance to the 'bike to school' phenomenon; say, increased tiredness of the biker due to the weight of the bag on the shoulder, reduced maneuverability in traffic, ergonomic considerations, etc. Figure 2 highlights the different epistemic groundings that may contribute to the popular imagery of an individual biking to school. In the following we refer to [3] in providing a detailed account of these epistemological groundings.

### A. Empiricism

Empiricism is that epistemic influence on conceptualization, where judgment is based solely on observations. It is considered a bottom-up approach where knowledge is created by virtue of the observer being exposed to a certain sample set and patterns of association formed based on repeated occurrence of a category. In the absence of any theoretical base, the associations are purely symbolic in nature. For example, the popular image of bike, depicted in

Figure 2, models bike as having two wheels. Historically, we are aware of bikes with one wheel. Also, rationally speaking there is no logical reason for only having two wheels in the bike. Pragmatically too, the need to stay put with two-wheel bike configuration is not a necessary one - be it in terms of balancing or maneuverability. Nevertheless, our exposure to bikes with two wheels has been considerably higher amongst our overall experience of the bike as a concept. Such number-of-exposure based reinforcement of a concept is referred to as grounded in empiricist consideration.

#### B. Rationalism

Rationalism is that epistemic influence on conceptualization, which is grounded in the tradition of logic. Rationally inspired conceptualization exposes the mental model of the modeler who builds the logical argument to deduce a specific inference. For example, the inclusion of liability insurance as an element of the popular image of bike, depicted in Figure 2, reveals the authors' mental model of biking in a country like Switzerland where all risks are appropriated.

#### C. Historicism

Historicism is that epistemic influence on conceptualization, which is based on social contexts and historical developments. It relies on culturally grounded experience that is accumulated overtime. For example, in Figure 2, the inclusion of bag in the 'biking to school' conceptualization may be grounded in historicism, as historically we have been exposed to the act of carrying reading, writing instruments and lunch box to school. This may not necessarily hold today as adoption of IT based teaching methods have made stationary redundant and home-packed lunch has made way for cafeteria food.

#### D. Pragmatism

Pragmatism is that epistemic consideration which is driven by the purpose of the conceptualization. It promotes a functional view of reality where categories are acknowledged by virtue of their relevance to explaining the causal organization of the phenomenon of interest. For example, in Figure 2, the inclusion of ball bearings and gear as part of popular imagery of the bike as a means of transport, exhibits the bike manufacturers' purpose of conducting the inquiry - to come up with new bike designs.

Thus, the categories revealed in a conceptualization may not always undertake a functional role. They may also undertake non-functional roles that contribute to the imagery at the structural level [12]. For example, the mere acknowledgment of the category 'school-bag' as part of the 'bike to school' conceptualization does not suggest that 'school-bag' has some causal relevance to the phenomenon of biking to school. At this level of conceptualization, 'school-bag' undertakes a more structural role, helping construct an image that has conceptual relevance for the modeler. May be in this case, what distinguishes the image of a 'general bike ride' from the 'bike to school' phenomenon is the inclusion of school bag in the popular imagery of an individual biking to

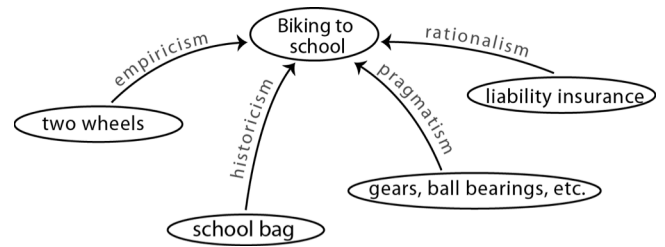


Figure 2. Epistemological grounding of an example conceptualization

school. Base/profile is a typical non-functional role that interests the image processing community. At the level of conceptualization depicted in Figure 2, the 'school bag' undertakes the role of a cognitive reference point, which helps to profile a category, 'bike to school', by referring to a cognitively related category 'school bag'. This is not to suggest that 'school bag' does not have any functional relevance to 'biking to school' phenomenon. Its relevance to the causal organization is revealed when the scope of the 'bike to school' activity is refined to the 'bike-ride to school'. The 'bike-ride to school' has a reduced scope in terms of focusing only on the riding experience of the rider but has a higher resolution in terms of revealing categories like tiredness, maneuverability in traffic etc. It is in this context that 'school bag' undertakes a functional role, as it is part of the cause-effect relation whose relevance to the refined scope of the phenomenon of interest is easily demonstrable.

#### IV. CRITICAL REFLECTION: WHY-YOU-SEE WHAT-YOU-SEE

As discussed in Section II, Service-system is an abstract concept that is aimed at organizing the observed reality in a way that helps specify the design requirements of the behavior required to create value for the Focal-element. Categories are observed in relation to other categories that together invoke the image of some earlier experienced situation. Instantiating the Service-system from observed reality presents two main challenges.

First, the causal relevance of each observed category to the behavior exhibited by the entire set of observed categories, also referred to as the phenomenon of interest, has to be established. In the following part of this section, we propose an approach that requires service designers critically reflect on the reasons why they see what they see. This helps reveal the cause-and-effect relationship that the observed category may have with the phenomenon of interest. Second, given the situated nature of categories, the categories identified to have a causal relevance for the phenomenon of interest do so in the context of the image/situation through which they were invoked. As a result, any reification of Service-system should be done in a way that retains the binding that a category enjoys with the image through which it is invoked. The traditional approach built around the notion of stakeholder is to map these categories to entities in the physical world - ontological categories like a person, group of people, institutions, etc. Nevertheless, the mapping between categories and entities is not one-to-one. Entities may participate in multiple cause-and-effect relations constituting a phenomenon of interest and representing each of these instances based on their shared body

form, i.e. the entity itself, overlooks important information regarding the cause-and-effect relation through which they contribute to the phenomenon of interest. Towards this end, we recommend that Service-systems be instantiated by qualifying entities with the functional roles they undertake. Roles reveal the semantics of an entity's participation to a situation and should not be seen as truth-conditional labels [13]. Since the end objective of service design is to identify the design requirements of the intended behavior, knowledge of the functional roles that an entity undertakes helps in identifying the activities that need to be undertaken to engineer that behavior.

#### A. Critical Reflection

The categories observed in the real world can have several different cognitive groundings. A category can be perceptually relevant to the observer due to its role in form-oriented completion of the imagery. Form-oriented synthesis of reality is widely studied as part of the Gestalt movement in psychology [12]. Gestalt refers to the unity of human experience. The claim of Gestalt Theory is that humans experience wholes not parts, and the whole is more than the sum of its parts. For example, when looking at a complex arrangement of individual elements, humans tend to first look for a single, recognizable pattern. There is, therefore, a constant effort to categorize observed reality at a level of granularity that provides a cognitive closure of sorts and thus lead to unity of experience. For example, Figure-ground organization is a type of perceptual grouping, which is vital for recognizing objects through vision. Elements are perceived as either figures - distinct elements of focus, or ground - the background or landscape on which the figures rests. Other prominent patterns of Gestalt completion include Base-profile for uniformity-oriented completion and Cognitive reference for proximity-oriented completion. Gestalt formation is a functional activity as far as the synthesis of experience is concerned but does not contribute functionally to the cause-and-effect relationships that constitute the semantics of the phenomenon.

To ascertain if the observed category has an exclusively Gestalt role or is also influencing the observed behavior through some cause-and-effect relationship, we recommend the service-designer reflects on the nature of the conceptual relevance that the observed categories may have for her. The questions that she can pose to herself are:

Why do I see, what I see? How is this relevant to my inquiry?

- Is it because I am used to seeing this aspect in this situation, but don't know why?
- Is it because I am used to seeing this aspect in this situation, and that is because of my social or cultural exposure to a specific kind of world, which includes beliefs/upbringing/atmosphere?
- Is it because that is how I think it should be? Whenever you see this one thing, there has to be this other thing, whether explicitly mentioned or not – its logical.

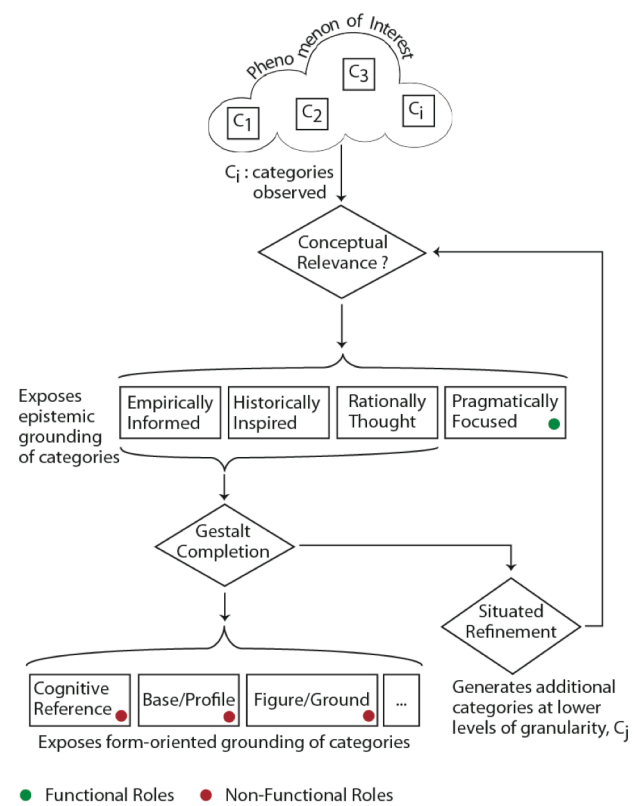


Figure 3. Cognitive grounding of observed categories

- Is it because this has some relevance to the purpose of my inquiry? And the relevance can be explained in terms of a cause-and-effect relation.

These questions help the service-designer identify the epistemic groundings of the observed categories by reflecting if the conceptualization of the category is empirically informed, historically inspired, rationally thought or pragmatically focused. As is evident from these questions, it is only the pragmatically grounded category that contributes to the causal understanding of the phenomenon of interest. Figure 3, provides a process-oriented overview of the approach suggested to identify the cognitive grounding of categories and thereby assign functional or non-functional roles.

#### B. Situating Refinement

To recall, conceptualization is situated and invokes the image of some earlier experienced situation. During critical reflection, the service-designer tries to understand the relevance of an observed category in the context of the invoked image. It is quite possible that an initial acknowledgement of a category may be embedded in a situation that does not readily reveal the causal relevance of the category. In that case, the service-designer can imagine new situations, which further situate the category in an image of higher resolution and reduced scope. The service-designer then undertakes, once again, the same process of identifying the causal relevance of the category, but now in the context of this new situation. The process of generating new situations from the old one is essentially a process of moving from a higher level of abstraction to a lower

level of abstraction, and is commonly referred to as the refinement process [14].

For example, as shown in Figure 2, the category of ‘school-bag’ – as part of the ‘bike-to-school’ imagery, is assigned a non-functional role based as it is reported to have conceptual relevance by virtue of its historical grounding. Nevertheless, when refined to the situation of ‘bike-ride to school’, the causal relevance of the category ‘school-bag’ can be more readily interpreted in terms of the physical tiredness it brings to the bike-rider, etc. Here the image of ‘bike to school’ is seen as representing a higher-level phenomenon that includes host of categories, such as the traffic on the road, the biker, the parking place. Where as, the image of ‘bike-ride to school’ is seen as a refinement, which focuses exclusively on the bike-rider’s physical experience of riding the bike.

Refinement of a conceptualization alters the scope of the situation that the conceptualization invokes. Theoretically, any role can be mapped to a functional role by changing the scope of the underlying situation. Nevertheless, refinement adds to the semantic distance between the original situation and the resulting situation. Constraint-free refinements, though eventually, reveal a lower-level functional role corresponding to some higher-level non-functional role, the semantic gap between the functional role revealed and the phenomenon of interest may become so large that it may render the entire refinement chain conceptually intractable; for example, the scope degenerating to sub-atomic levels of matter.

Thus, situated refinement is the idea to make the service-designer aware of the choices it makes by requiring her to make the process of generating additional categories more transparent. By doing so the service-designer is made to reflect on the reasons why she thinks a specific refinement is justified in relation to the purpose of the inquiry, and that she is not extending the scope of the inquiry beyond relevant issues.

## V. CRITICAL REFLECTION IN ACTION : AN ILLUSTRATION OF A SITUATED SERVICE-SYSTEM

In this section we develop a service-design scenario, which is representative of the real world problems that a modeler has to address while specifying a service. The objective is to illustrate the process of critical reflection and demonstrate how it helps in identifying service-systems.

### A. Case Description

The purpose of inquiry we undertake is *to study the impact of the use of foldable-bike on the adoption of mixed-mode of transport*. Mixed-mode of transport refers to mobility solutions that involve the use of more than one mode of transport. For the purpose of this study we restrict ourselves to the combination of bike and train. Foldable-bike refers to those bike designs, which have a collapsible frame, whereby when not in use their form-factor can be reduced to a shape and size comparable with a conventional luggage-bag allowed on board most public transports. The idea is to model the behavior that a foldable-bike manufacturer intends to realize for the people using these bikes. For the purpose of exposition, we limit the

scope of our model to include only those users of foldable-bike who avail mixed-mode of transport for their commute to the workplace. More concretely, we assume the Focal-element here to be the *user* in her role as an *office-worker*. It is important to note that there is no loss of generality here due to this simplifying assumption. Our focus here is on identifying the service-system, which intends to realize a behavior that creates value for the user, possibly in several different ways – one of which we highlight as being an office-worker.

### B. Experimental Setup

The process of critical reflection assumes a phase of informed imagination that provides the basic-level conceptualization, and thus acts as a starting point for the service-designer to reflect and identify which categories revealed therein are relevant for specifying the intended behavior of the service. Informed imagination can be facilitated through brainstorming sessions, interviews, field visits and other forms of environmental scanning techniques. In the context of this study, we highlight three situations that were identified, amongst several others, during a brainstorming session amongst a community who themselves have not had first hand experience of mixed-mode of commute involving travel with a foldable-bike in the train. Nevertheless, they are well aware of the experience that travelling in a train and riding the bike entails. The selection of such, seemingly under-informed, subjects is to stay representative of the conditions in which a service-design activity is undertaken in the real world. As indicated in our definition of service-design – “as an engineering endeavor to enrich some aspect of the real world through a man-made artifact”, the reference to enrichment suggests that the focus is on realizing a novel behavior, which by definition excludes the possibility that the service-designer may have access to a subject who can completely specify the intended behavior a-priori. A well-informed imagination phase can, at best, specify the behavior of the constituent activities, from which the intended behavior needs to be constructed.

### C. Situated Role Assignment

The three situations we consider here are depicted in the Figure 4 below.

Figure 4(a) depicts the outcome of the modeler’s inquiry into the epistemic grounding of the image of *a person boarding the train with a bag*. Based on the semantics the service-designer assigns to this image will reveal the epistemic grounding of the categories *bag*, *person* and *train*. As explained in the figure, the semantics of this situation could well be inspired due to cultural influences, such as considering carrying personal belongings in a bag as part of a social norm enforcing civilized behavior. In that context, the categories do not seem to have any causal relevance to the phenomenon of mixed-mode of transport, unless we assume that conforming to social norms is also part of the design objective, which is a completely justified design constraint. Nevertheless, for the purpose of this illustration we discard that possibility. On the other hand, if we interpret the bike-in-the-bag imagery to convey the need to comply with local transport regulation, which requires bikes stored in the passenger area to stay in a

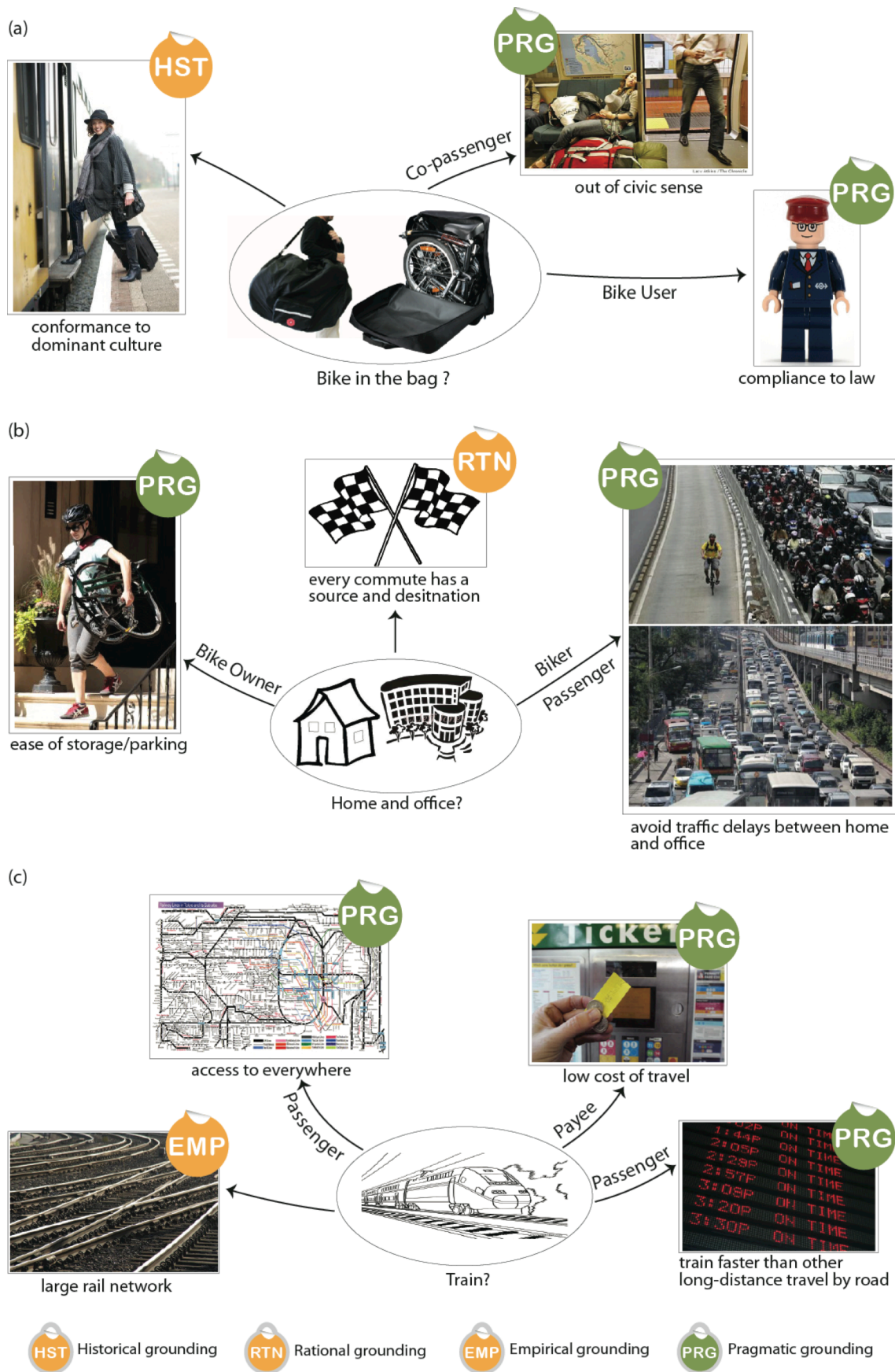


Figure 4. Critical reflection in action



## Service System

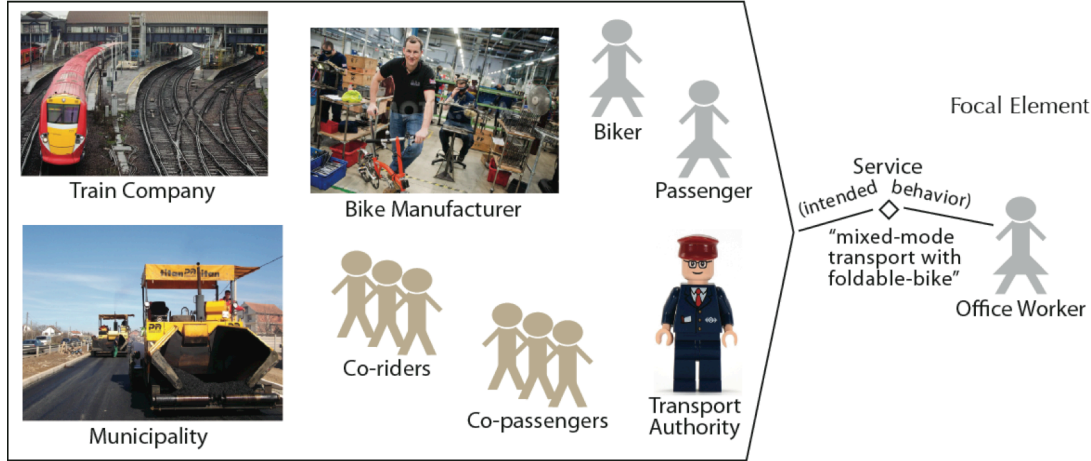


Figure 5. An example Service-system as an outcome of situated modeling

bag at all times, then it does reveal the pragmatic basis of the imagery and, hence, assigns the categories a functional role. For example, in this case the person undertaking the role of the *Bike User* responsible for the outcomes arising out of the usage of the bike, as in storing the bag while on board the public transport. Another, pragmatic reasoning could be grounded in the person's concern for the inconvenience of the fellow passengers. In that case, the person may store the bike in the bag out his civic sense to avoid any injury to fellow commuters from the exposed sharp edges of the bike or the grease on the mechanical parts of the bike leaving stains on their clothes. Here the person can be modeled as undertaking the functional role of a *Co-passenger*.

Figure 4(b) depicts the outcome of the modeler's inquiry into the epistemic grounding of the image of *home to office commute*. The three possible semantics explored for this situation are included here. First is a rationally oriented conceptualization, which is based on the logic that the categories of source and destination are always present whenever there is any reference to commute. Second is a pragmatic orientation, which reveals the issue related to the storing/parking of bike at home, thereby highlighting the role of the person as a *Bike Owner* concerned about the safety of her bike. Third is another pragmatic orientation, which reveals the issue of the person being able to avoid both the intra-city and inter-city traffic. In this case the semantics of the situation highlight the role of the person as a *Biker* and *Passenger*. It is important to note that some of the above pragmatically oriented interpretations of a situation required several refinements.

Figure 4(c) depicts the outcome of the modeler's inquiry into the epistemic grounding of the image of the *train as means of public transport*. An initial interpretation of this situation could be grounded in empirical consideration, which is based purely on the observations that there is a *large rail network in the area*. Nevertheless, in the absence of any judgment it remains unclear how this rail network provides means of transport for people. It could be the case that the region has a large rail network to support freight movement, as

is often the case in a port city, manufacturing hub, or an area rich in minerals. In an effort to identify the causal relevance of this observation, the service-designer might be inclined to explore other refinements of this situation. For example, further reflection may reveal the existence of a transport network that takes advantage of this large rail network to provide people *access to everywhere* in the sense of universal coverage. It is then easy to accept the causal relevance of train as a public-transport, which the user can take as part of the mixed-mode transport thereby assigning the functional role of *Passenger* to the user. This role is also discovered as part of critical reflection on the situation in 4(b). As it will be clear in the following subsection, we are using the role *Passenger* to refer to all the cause-and-effect relations the user will participate to by virtue of her using the train as a means of public-transport. Figure 4(c) includes another grounding – of the train being faster than other means of long-distance travel, which is considered to enforce the earlier role of user as a *Passenger*. The final refinement included here, with reference to the interpretation of the *train as a means of public transport* imagery, exposes its pragmatic grounding in the low cost of travel that the train may provide to commuters. In that case it highlights the user playing the functional role of the *Payee* of public-transport travel cost.

## D. Service System

Based on the situations that were admitted during the informed imagination of the phenomenon of *use of foldable-bike as part of mixed-mode commute*, including the three situations specifically discussed above, we present the service-system that specifies the behavior that the foldable-bike manufacturer should realize to create value for the user in her role as an office-worker. Figure 5 provides a visual depiction of this service-system. The Service-system specifies all the roles that the participating entities play in realizing the intended behavior. Thus, the inclusion of the Train Company, Bike Manufacturer and Municipality refers to all the functional roles that each of them undertakes as part of their participation to the phenomenon of *mixed-mode commute*

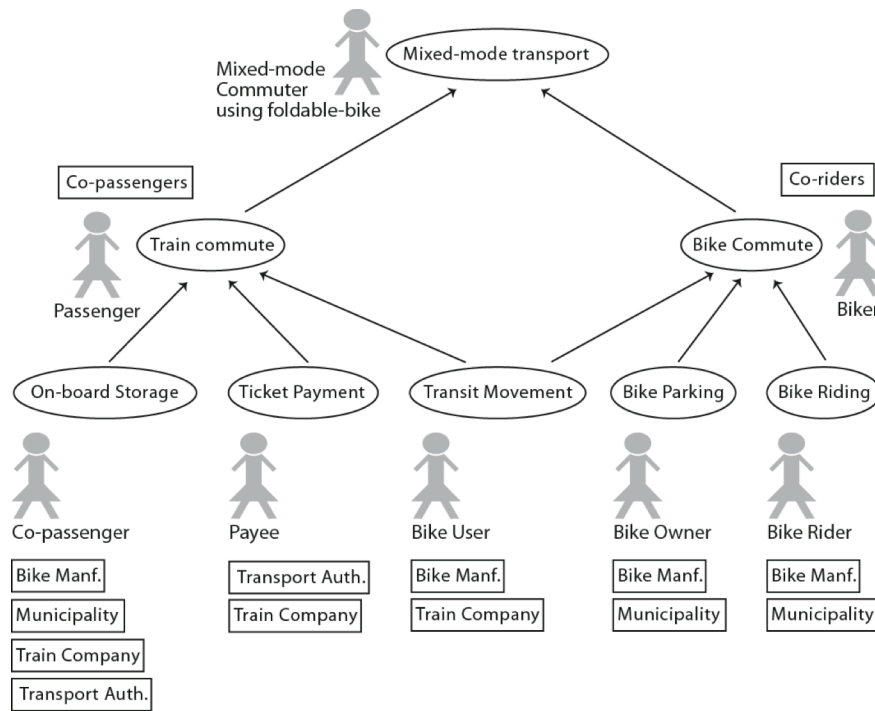


Figure 6. Hierarchically organized functional composition of the service behavior

using foldable-bike. Train Company here refers to the agency managing all aspects of the railways as a means-of-public transport, including rail network, rolling stock, commercial operations such as ticketing and legal compliance to relevant civil code. Bike Manufacturer refers to the company that designs, develops, produces and sells bike as a physical product. Municipality refers to the agency that is responsible for city infrastructure, including roads and parking places. In addition, we also highlighted two other roles undertaken by human actors other than the user. Co-rider refers to the group of people, excluding the user, on the road in their role of being part of the city commuter traffic. Similarly, Co-passenger refers to the group of people, excluding the user, in their role of being on board the same train as the user, or in general using the same rail transport network. As for the user, we represent her only in two roles – as a Biker and as a Passenger. These roles are higher-level roles, which together subsume all other functional roles that the user was shown to undertake in the three situations that we analyzed earlier. Detailed information about the functional relevance of the different entities found to be participating to the phenomenon of interest is presented in Figure 6. Organizing the functional composition of the phenomenon as a hierarchy helps clarify the relation between roles. For example, the role Biker as being composed of the roles Bike Owner, Bike Rider and Bike User. Note that the role of Co-passenger undertaken by the user in relation to her fellow commuters on the train, and the role of Co-passenger undertaken by other people on train in relations to the user, can be distinguished in the figure by taking note of the different body shapes used to model different entities. The observant reader will notice an

additional role at the highest-level in the compositional hierarchy - *mixed mode commuter using foldable-bike*. This is a special role in the sense it represents what the user becomes by virtue of her adopting the service or, to put it differently, what does the realization of the intended behavior make of the user. In this case, she becomes a mixed-commuter who uses a foldable-bike for short distance intra city commute and train as the means of public transport for long distance inter city commute.

It is important to note that the process of identifying the functional role a category undertakes, applies to all observed categories. In this illustration, we have restricted our focus on the functional roles undertaken by the user, i.e. the entity corresponding to the Focal-element, henceforth referred to as the Focal-entity. There are two motivations for this choice. First, we wanted to keep the depiction of service-system simple to ease comprehension. Second, by focusing on the focal-entity we wanted to highlight a frequently used simplifying assumption in services modeling, which advocates modeling focal-entity exclusively in its role as the adopter of the service, i.e. only as the focal-element. While this may seem to work for simple cases, it surely is not universal in its appeal. The approach that focal-entity undertakes at least two roles – one as the focal-element and the other as part of the service-system, is theoretically grounded in the end-to-end view of services, which includes the process of consuming the service as part of the service-offering. This, in fact, is one of the primary features that distinguish service-oriented approach from other traditional approaches of economic exchange.

Further, a role based modeling of the service-system not only identifies all the relevant activities required to realize the



intended behavior, often referred to as the lifecycle of the phenomenon of interest, but also reveals the precise activities through which the user interacts with the service. Knowledge of these interface points provides important insight to the service designer in terms of identifying the new features that she can include in the design to enrich the existing behavior.

## VI. CONCLUSIONS AND FUTURE WORK

A complete service specification requires answering the how, what and why of the service. How corresponds to the behavior that is to be realized as part of the service offering. What corresponds to the potential this behavior has to induce change. And why corresponds to the experience that is created by virtue of this change, thereby justifying why the service should be adopted. Identifying the service-system is the first step in this three-staged process of specifying the service.

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