



**José Antonio Gonçalves Motta**

**Investigating the Case-Based Reasoning Process During  
Early HCI Design**

**DISSERTAÇÃO DE MESTRADO**

Dissertation presented to the Programa de Pós-Graduação em Informática do Departamento de Informática do Centro Técnico e Científico da PUC-Rio, as partial fulfillment of the requirements for the degree of Mestre.

Advisor: Simone Diniz Junqueira Barbosa

Rio de Janeiro  
February 2013



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To my grandma, who always supported me.

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## Abstract

Motta, José Antonio Gonçalves; Barbosa, Simone Diniz Junqueira. **Investigating the Case-Based Reasoning Process During Early HCI Design.** Rio de Janeiro. 2013. 158p. MSc. Dissertation – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

During the early stages of design, the designer forms an initial understanding about the problem and some ideas on how to solve it, often influenced by previous design knowledge. In order to support HCI design in this context, we investigated ways to use case-based reasoning (CBR) to help designers access and reuse design knowledge to solve new HCI design problems. We conducted interviews with professional HCI designers to collect data about how they deal with design problems, and their motivations and expectations regarding the use of design knowledge aided by a CBR tool. Using this data, we designed and developed a tool called CHIDeK, which has a library containing HCI design cases and provides access to them through faceted navigation, direct links between cases, and search. To investigate the way CHIDeK influences the design activity, we conducted a study that simulated the early stage of HCI design of an online bike reservation system. Some participants could solve the problem while having access to CHIDeK and others had to solve it without CHIDeK. We discovered that the cases from CHIDeK supported the design by motivating the designers' reflective process, triggering their memories of experiences with systems similar to the ones in cases, and helping generate new ideas. We also identified some limitations in the case representation, which offers an

opportunity for further research. When comparing both kinds of design activities, we noticed that designers without the case library used the same solution for one of the issues described in the study scenario, while the designers with the cases varied between two solutions. We concluded that a CBR tool has much potential to aid the design activity, but there are still issues that need to be addressed by further research.

### **Keywords**

Human-computer interaction; interaction design; requirement elicitation; design knowledge; case-based reasoning; Semiotic Engineering

## Resumo

Motta, José Antonio Gonçalves; Barbosa, Simone Diniz Junqueira. **Investigando o Processo de Raciocínio Baseado em Casos Durante o Início do Design de IHC.** Rio de Janeiro. 2013. 158p. Dissertação de Mestrado – Departamento de Informática, Pontifícia Universidade Católica do Rio de Janeiro.

Durante as etapas iniciais de design, o designer forma um entendimento inicial sobre o problema que ele deve resolver e desenvolve suas primeiras ideias, geralmente influenciadas por conhecimentos de design passados. Com o objetivo de auxiliar o design de IHC (interação humano-computador) neste contexto, nós investigamos como podemos usar o raciocínio baseado em casos (CBR) para ajudar designers a acessar e reutilizar conhecimentos de design para resolver novos problemas de IHC. Nós conduzimos entrevistas com designers de IHC profissionais para coletar dados sobre como eles lidam com problemas de design e suas motivações e expectativas sobre o uso de conhecimentos de design auxiliado por uma ferramenta de CBR. Usando estes dados, construímos uma ferramenta, chamada CHIDeK, que contém uma biblioteca contendo casos de design de IHC e fornece acesso aos casos através de navegação facetada, links diretos entre casos e busca. Para investigar como o CHIDeK influencia a atividade de design, conduzimos um estudo que simulava a etapa inicial de design de IHC de um sistema online de reserva de bicicletas. Alguns participantes podiam resolver o problema enquanto tinham acesso ao CHIDeK e outros deviam resolver sem o CHIDeK. Descobrimos que os casos no CHIDeK



ajudaram o design motivando o processo de reflexão dos designers, ativando memórias de experiências com sistemas similares aos descritos nos casos e ajudando a gerar novas ideias. Também identificamos algumas limitações na representação dos casos, o que oferece oportunidade para novas pesquisas. Comparando ambos os tipos de atividade de design, percebemos que os designers sem a biblioteca de casos usaram a mesma solução para um dos itens descrito no cenário do estudo, enquanto os designers com os casos variaram entre duas soluções. Concluímos dizendo que uma ferramenta de CBR tem muito potencial para ajudar na atividade de design, porém existem problemas que devem ser endereçados por pesquisas futuras.

### **Palavras-chave**

Interação humano-computador; design de interação; levantamento de requisitos; conhecimento de design; raciocínio baseado em casos; Engenharia Semiótica

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# 1 Introduction

According to Lawson (2005), ideas formed during the early stages of design activity usually impact the whole design process. This impact can occur in two different ways: a) as an input to the final solution or; b) as a step to help further understand the problem, which might result in discarding the idea itself. Thus, it is during the early stages of design that the designer forms his primary understanding about the problem he needs to solve and develops his first ideas about it.

However, these ideas are usually not created out of nowhere. Oxman (1990) states that it is a well-known fact that the design process relies on knowledge from previous experiences, which are adapted by the designer to solve new problems. In other words, the ideas designers have to solve new problems can usually be traced to previous design knowledge.

Design knowledge is prescriptive, because it is concerned with how things might be, rather than how things are (Lawson, 2004). A designer cannot apply design knowledge directly, like a rule or an equation. Additionally, the designer can only acquire design knowledge by designing, and not by reading a textbook, because each design problem is unique (Lawson, 2004). Schön (1983) reinforces this point when he says that, while the designer is interacting with his a representation of his design and reflects about it, he is able to learn about what he is designing while he designs. Lindgren and colleagues (2001) also say that, when the designer refers to previous design knowledge (in their case, about buildings), it is important that he adopts a critical attitude towards it, evaluating what has worked and what can be improved. According to them, this should happen in the early steps of the design, because if the designer does so, taking into account the current problem features, he “will add considerable value to the client” (chapter 8, page 2). Considering that, by definition, interaction design is also a design activity, just like planning the construction of a building, the same applies to human-computer interaction (HCI) design knowledge.



Acknowledging the importance of the early stages of the design process and of the designer's experience represented as design knowledge, we investigated ways to support the HCI designer during this stage, to benefit the design process as a whole. More specifically, we investigated how designers access and reuse previous HCI design knowledge using a case-based reasoning (CBR) approach (Kolodner, 1993) and whether a CBR tool could support these processes. When we say "design knowledge reuse", we are referring to the activity of consulting previous design knowledge, reflecting on whether this knowledge (or part of it) is appropriate to help solving the problem in question and how it can be adapted to solve the problem.

We decided to investigate the design activity using a CBR approach based on Goel and Crow (2005), who say that CBR is a useful paradigm to be applied in the design task. We assumed that a well-designed CBR tool can be of much help in solving complex HCI design problems.

## **1.1 Goal and Execution**

Our main goal is to support the early stages of HCI design. Following the premise mentioned earlier that designers make use of previous knowledge to solve new problems, we decided to investigate how we can improve the access and reuse of knowledge using a CBR approach. The term "problem" is used here to mean different kinds of situations that trigger a desire for change: it could represent either an undesirable situation or simply an opportunity to achieve an even more desirable situation.

To reach our goal, this work was organized in two stages. The first stage was an interview with professional designers to investigate the usefulness of a CBR tool to support design and to collect requirements for such a tool. We interviewed designers to gather info on the use of existing knowledge in the design activity and their feelings towards the CBR process in their work. We also investigated the professionals' motivations and expectations regarding the use of a CBR tool and elicited unanticipated requirements and constraints.

Having received a positive feedback towards CBR and a CBR tool, we extended the tool we were developing to address the requirements obtained during the interviews and put it to test in an HCI design activity.

After developing the tool, the second stage took place: a series of studies with HCI students that had to solve an HCI design problem with the aid of the CBR tool and without it. Then, we could compare what happened during the design activity in both situations.

## **1.2 Document Structure**

This document is organized as follows. In chapter 2, we discuss the background that grounded this work: CBR and Semiotic Engineering. In chapter 3, we describe the preliminary interviews conducted with professional interaction designers to collect information about their expectations and requirements for a CBR tool. In chapter 4, we describe the CBR tool we developed based on the interviews, called CHIDeK (Computer-Human Interaction Design Knowledge). In chapter 5, we discuss the study we conducted to investigate the design activity with and without CHIDeK and its results. Finally, in chapter 6, we wrap up this work with our conclusions and discuss the threats to its validity and opportunities for future work.

## 2 Literature Review

### 2.1 Case-Based Reasoning

Case-based reasoning (CBR) is a process for exploring the potential of cases to support problem solving. The process can be decomposed in *retrieving* appropriate cases from a case library, *choosing* the cases that might be most helpful, *adapting* the chosen cases according to the problem context, *evaluating* whether the new solution is adequate and *storing* the new case in the library (Kolodner & Leake, 1996).

The CBR process has been vastly explored by AI researchers. Kolodner and Leake (1996) list three kinds of CBR systems:

- a) **fully automated systems**, which can perform the whole CBR process (retrieve, choose, adapt, evaluate and store cases) by themselves;
- b) **human-machine systems**, which require human interference in order to perform some of the steps of the CBR process, usually adaptation and evaluation;
- c) **embedded systems**, which are CBR systems embedded as a component in another system whose objective is not to solve a problem.

Many CBR systems have been developed. Hinrichs and Kolodner (1991) describe a human-machine CBR system called Julia, developed for the meal planning domain. This system was able to create a menu satisfying a set of constraints informed by the user. Julia had the ability to adapt its solution as new constraints were added, but it was not a fully automated system, since it provided interaction with the user, such as asking questions, and depended on the user's evaluation of the solutions provided. Pearce and colleagues (1992) describe their work on a human-machine CBR system called Archie, specialized in the architecture domain. Archie's goal was to support the mechanical tasks of case-based reasoning such as storing, indexing and retrieving cases. It was the designer's job to make all decisions (to compare, to evaluate and to adapt cases). Goel, Bhatta, &

Stroulia (1997) describe a fully automated CBR system called Kritik2, which was capable of materializing functional specifications to structural specifications for the engineering domain. Leake and colleagues (1999; 2001) describe a fully automated CBR system developed for automotive design called Stamping Advisor, which analyzed the design activity during the design process and proactively provided relevant information (such as feasibility data and products information) to support the decisions made by designers and feasibility engineers. Stamping Advisor could also automatically collect data to generate new cases while the designers performed their tasks.

Within HCI, Sambasiva and colleagues (1992) developed a CBR system for interface design called AskJef. Their goals were to help the designer understand the problem he had to solve and to offer an array of past solutions. The designer had the task of analyzing the solutions given by the system and adapting them to solve the new problem. AskJef had three ways to represent a case: graphics, audio and alphanumeric symbols. Kim and Yoon (2005) developed a CBR system for user interface (UI) design, called MCBDS (Multi-level case-based design support), which focused on the case representation to aid the designer's cognitive process. The cases dealt by this system were UI tasks (such as filling a form or finding an item) represented in three abstraction levels: *what the task is about*, *why the task should be executed* and *how the task will be executed*. MCBDS left the tasks of adapting and evaluating the solution to the designer.

However, despite existing research on CBR in HCI, the practical use of a CBR tool for interaction design has not been investigated. In Sambasiva and colleagues (1992), AskJef had its usability and guidelines evaluated by experts and by usability testing techniques, but the work does not describe a study concerning its influence in the interaction design process. The same can be said about MCBDS. In Kim and Yoon (2005), a usage scenario of the system was described, but apparently, no real study on it has been made.

In this work, we describe a human-machine CBR system we developed called CHIDeK, and a study to investigate how it supports early design.

## 2.2 Semiotic Engineering

Semiotic Engineering (De Souza, 2005) is an HCI theory which views human-computer interaction as an act of communication between two humans (the system designer and the user) mediated by a computer (the system itself). The designer uses the system to communicate to the user his vision about the user, the user's goals and how to achieve them. In other words, the designer communicates how, when, where and why the user should make use of the system. The user, in turn, receives the designer's message while interacting with the system and uses what he interprets from the message to perform his task. This communication between the user and the designer mediated by the system (which, according to Semiotic Engineering, is called the *designer's deputy*), is called *metacommunication*. The designer-to-user metacommunication message can be paraphrased as follows:

“Here is my understanding of who you are, what I've learned you want or need to do, in which preferred ways, and why. This is the system that I have therefore designed for you, and this is the way you can or should use it in order to fulfill a range of purposes that fall within this vision.” (de Souza, 2005 – p. 84)

For the metacommunication to take place, the designer can use a variety of representations, or *signs*, which must be interpreted by the user. A sign is anything which conveys some meaning to someone (Peirce, 1958). There is a vast amount of usable signs and it is possible to convey similar messages using different signs. Three kinds of metacommunication signs are described by Semiotic Engineering:

- a) **Static signs:** signs that can convey a meaning without the influence of time. Usually, these signs can be interpreted using one image (a system screenshot, for instance);
- b) **Dynamic signs:** signs that depend on the flow of time in order to convey a meaning. Usually, these signs can be interpreted by a sequence of images (e.g.: Google search text field, for which, as the user types his search term, the system suggests other terms, using the autocomplete UI Design Pattern);

- c) **Metalinguistic signs:** signs that can be either static or dynamic, and whose purpose is to explain another sign (the text on a help file or a video tutorial, for instance).

As mentioned before, the designer makes use of signs to convey his message to the user. These signs comprise a signification system (Eco, 1979), a user interface language, which must be learned by the user so that he can interact with the system effectively. Therefore, the quality of the system depends heavily on how easy it is for the user to interpret the designer's signification system and on how easy it is for the user to make use of this system in order to perform his task.

In section 4.2 we describe the metacommunication message we created to build the CBR tool we used in the study. In section 5.5.7, we also use the concept of metacommunication message to discuss the results of the study.

## 3 Preliminary Interviews

This chapter presents and discusses the results of the interviews conducted at the first stage of our work, before building the CBR tool. This interview provided data to build the first part of the CBR tool's metacommunication message, which guided the development of the tool itself (see section 4.2 for more information).

We describe the goals of these interviews, the profile of the participants we chose for this study, how we conducted the interviews, and our findings.

### 3.1 Methodology

#### 3.1.1. Goals

The interviews had four goals:

- to understand the participants' profile, including their academic background, their professional experience;
- to understand how they deal with HCI design problems. More specifically, we wanted to know how they access and use previous design knowledge;
- to present the CBR process of and gather their feelings towards CBR in their work;
- to gather participants' motivations and expectations regarding the use design knowledge aided by a CBR tool and to elicit unanticipated requirements and constraints for the tool under development.

#### 3.1.2. Participants

In order to carry out this study, we needed to interview people who had professional experience with HCI, either as employees or consultants. We conducted nine semi-structured interviews with participants who were recruited

by sending invitations to three mail groups. However, one of the interviews had to be discarded because the participant's profile did not match the requirements for this study. The participant was a web designer whose focus was on the graphical aspect of the system and not on the interaction aspect.

Since some of the participants lived in other states, some interviews had to be performed via audio chat. Despite this, all of the interviews followed the same script, with only one exception: the presentation about CBR. In personal interviews, this presentation was executed by the interviewer using slides with images following a script. For the online interviews, the participants watched a video of this presentation recorded by the researcher using the same slides and script. Though the format was different, the content of the presentations was the same.

The academic background of the eight interviewees is as follows: one has a degree in Computer Science, one in both Computer Science and Industrial Design, one in Data Processing, one in Design, one in Electronic Engineering and three in Information Systems.

All of the participants have some sort of specialization, one being in Artificial Intelligence (M.Sc.) and Human-Computer Interaction (D.Sc.), two in Human-Computer Interaction (D.Sc.) and two in Information Architecture (*lato sensu*). Two of them are undertaking a Human-Computer Interaction M.Sc. programme.

### **3.1.3. Procedure**

The study consisted of a pre-presentation interview to identify the participants' profile, the CBR presentation and a post-presentation interview to discuss the CBR process and the creation of a CBR tool. We recorded and transcribed the interviews with the participants' consent.

The CBR presentation consisted of an explanation of what cases are, the CBR cycle and a scenario in which a CBR tool is used during the design of a mobile system. Appendix A presents all the material prepared for this study.

We analyzed the transcripts using a technique called Template Analysis (King, 2012). Template Analysis is a thematic analysis technique in which the central idea is the development of an initial coding template, which evolves



iteratively and is used as a means to analyze textual data. In our case, the textual data are the transcripts from the interviews. Template Analysis has an interpretative nature, as usual in qualitative research.

As a first step in our analysis, we coded the interviews (attached labels to segments of the interview transcripts). From the recurrence of codes, we identified themes that were relevant for the goal of the interview and, with those themes, we composed the coding template. The question that guided the coding and the selection of themes was ‘what do a CBR tool and its cases need to be useful in HCI design?’

Template Analysis was deemed useful in this study for two reasons: the use of *a priori* themes and the use of an initial coding template. Template Analysis states that the researcher can make use of *a priori* themes, which are defined before analyzing the transcripts, to compose the coding template. However, unlike other techniques that use *a priori* themes such as Matrix Analysis (Nadin & Cassell, 2004) or Framework Analysis (Pope, Ziebland, & Mays, 2000), Template Analysis allows the use of additional themes that are constructed during the data analysis. In our case, considering the research question, we selected two *a priori* themes: *case features* and *CBR tool features*.

The use of an initial template affects the data analysis. As the researcher delves into the textual data while coding it, he can modify the template and re-apply it to the textual data. According to King (2012), the use of an initial template allows an efficient way of conducting the analysis and does not reduce its depth, if carried out properly.

We created the first version of the coding template after going through all interviews and updated it multiple times after successive readings of the transcripts. We reached the final version of the template once it was considered descriptive enough without becoming overly detailed, hindering the interpretation process. In this template, we created a hierarchy in which the higher level themes encapsulate the lower level themes. The result is the coding template shown in Table 1.

As a quality check, Template Analysis suggests that more than one person should do the coding process, so that there can be discussions of similarities or differences, which should result in a revision of the coding. However, this was not

done in this analysis, because it was not possible to request the aid of another researcher to take the time do so properly.

Table 1: Coding template created after the interviews from the first study

First-level themes	Description	Second-level themes	Description
A) Example features	Examples used	A.1) Work material	What designers use as examples
		A.2) Example contents	What they want to see in the examples they look
B) Example uses	How are examples used	B.1) Competitive advantage	To know what competitors are doing
		B.2) Reuse of past solutions	Finding good solutions to be reused
		B.3) Design communication	Using examples to talk to other stakeholders
C) Designer's practice	How designers work	C.1) Usage of a example library	How a library is used
		C.2) Affinity with images	Pexample for images over text
		C.3) Design strategy	Problem-based and solution-based strategies
D) Case library requirements	Requirements for the case library	D.1) Case contents	What should cases have
		D.2) Conciseness	The library and its cases must not be redundant
		D.3) Must contain code	Access to source code
E) CBR tool requirements	Requirements for the CBR tool	E.1) Efficient access to cases	Case recovery must be efficient
		E.2) Integration with other tools	Tool must be able to exchange information with other tools
		E.3) Not time-consuming	Users do not have the time to adapt to a tool's restrictions

### 3.2 Findings

In the next paragraphs, we describe each first level theme according to the second-level themes related to it. Each theme reveals some aspects of an envisioned CBR tool for interaction design. After describing each theme, we relate it to the corresponding requirement we identified for the CBR tool.

The interviews were conducted in Portuguese and the snippets shown here were translated to English.

## A) Example features

These themes are related to the examples (based on prior design knowledge) that the interviewees use when working on HCI design problems, either to understand the problem or to build a solution.

### A.1) Work material

This theme is related to the material used by the interviewees, either as a product of their work or as an example to it. Many types of material were mentioned in the interviews: artifacts (such as wireframes and prototypes), other systems (mainly from competitors), documentation (describing the domain or business rules) and experiences (either from other people or their own). Many interviewees mentioned the use of wireframes.

“(...) and even develop the wireframe, design (...)” (P3, line 29)

“(...) also wireframes are used a lot, I think it’s most frequent, a site wireframe is more common, because it helps the people from design, from technology, the clients sometimes like to see how the process is going. So, I’d say that the most frequent is the use of wireframes.” (P7, lines 31-35)

“Yes, models, wireframes too and also many textual documents.” (P8, line 29)

Prototypes were also mentioned quite often.

“(...) I talk to users and stuff, then I build a prototype, an interface design (...)” (P1, lines 12-13)

“(...) then now my job will be to create it visually, its visuals, how it’d be and work on its professional prototype in the final form.” (P4, lines 63-65)

Other systems usually are referred to when the interviewees need aid in understanding the problem they want to solve.

“(...) mainly when it’s a domain I don’t know, then I look for references [examples] about that area, and I look around web sites, systems.” (P1, lines 50-52)

“So, the first thing I do is research, do a market research, try to see what’s the newest state of art in that area (...) check the profile of that system, that web site and check everything, the competitors in general, check what they are doing (...)” (P3, lines 49-53)

Some interviewees also mentioned the use of documents (such as a requirements document) in their jobs.

“(...) I prepare a requirements document, like, I try to describe minimally the [problem] spaces, as if they were use cases, umm, putting the business rules, at least the least restrictive ones.” (P1, lines 27-29)

“(...) depending on the situation, I evaluate some available documentation (...)” (P5, lines 31-32)

Some of the interviewees also said that they tend to rely on personal experiences and hearing other people’s opinions.

“(...) the personal experience is what I take into account when I’m looking... and also looking at what other people are talking about.” (P4, lines 106-108)

“If it’s finding information on a web site, then I go by my feeling too that it’s working.” (P7, lines 86-88)

“Especially if you are in a group, the more people you are sharing it [an experience], the more you learn, because the exchange [of experiences] ends up being better.” (P7, lines 284-286)

From this, it is possible to assume that an HCI design CBR tool needs to be able to deal with a variety of means in order to satisfy different users and the companies they work at. The requirement associated with this theme is “cases should be able to deal with design artifacts, such as wireframes.”

### *A.2) Example contents*

According to Tseng and colleagues (2008), one of the factors that affect problem solving is the similarity between the examples and the problem. They state that examples that have more similarities to a problem are usually considered more relevant and have an impact even before designers start dealing with the problem.

An interviewee’s statement illustrates this:

“What’s the client’s business? So, what I said before, if it’s sales, if it’s services, what’s his business? If it’s a bookstore, shoes, I don’t know what... (...) the more specific [examples], the more immediate is the use.” (P6, line 281-285)

One could assume that examples within the same domain can somehow be useful to designers. But some designers also said that cross-domain examples can be useful to them.

“(...) yesterday’s case which... was to create the concept of a new menu for a new system. This new menu, umm, I started studying that... with games (...)” (P4, lines 51-53)

“(…) nowadays, actually, it’s really interesting if I take a solution for a bookstore and apply it to shoe [store]” (P6, lines 283-284)

P8 mentioned that the best examples are the ones about systems he had worked with previously or examples from similar systems.

“For my work environment, due to the restrictions I have presently, it’d be more interesting if I could consult my previous work or just from similar systems, you know (…)” (P8, lines 188-191)

To P5, technology is an important issue that is considered when labeling a example as relevant or not. He says that technology-related examples that he cannot have access to are useless.

“A tool like this [a CBR tool] needs to be contextualized for the kind of system we develop there. It’s no use speaking of a tool which has cases which needs to use some technology for that interface to be built and \*\*\*\* does not allow the use of such technology.” (P5, lines 203-207)

These different perspectives on the examples’ contents hint that a CBR tool must give support to a variety of contents. If the user simply needs a quick and dirty solution or if the user’s company does not allow him to explore different possibilities, the cases must be from a domain similar to the problem the user needs to solve. On the other hand, if the user is looking for creative solutions or if he feels that only cases with different domains will be helpful, the tool should also support this option. If the user’s task has some restrictions, like technology, the tool must not show examples which ignore these restrictions. The requirements we associated with this theme are: a) “cases should be flexible enough to describe experiences from a variety of domains”; and b) “cases should also deal with the restrictions the designer has.”

## **B) Example uses**

The themes under this category aim to elucidate the way the interviewees view how cases can be useful to them.

### *B.1) Competitive advantage*

Some interviewees stated that they use examples in order to obtain ideas to develop their design solutions. Usually, they look into the competitors’ products so that they can learn about the trendy solutions for similar design problems.

“(...) I asked to download the software, to access it and began to use it, look at it, and try to understand how that software’s users were used to work.” (P1, lines 56-58)

“(...) in this case, since it’s an interface for a client, we check the profile of that system, that web site and check everything, the competitors in general, check what they are doing, try to get a new idea.” (P3, lines 51-54)

“I try to see how other players, how the competitors are dealing with the same problems, the same scenarios and I try to see what, let’s put it this way, what we can normally do, like... the internet market is very competitive, so we try to see what can we make which is better than the competition...” (P6, lines 94-98)

As it is possible to see, interviewees tend to investigate competitors to find out the strategy that they will use to solve a design problem. This tells us that cases from a CBR tool must be able to reveal its users about systems that deal with similar problems. The requirement we associated with this theme is “cases should help the designer to know more about the state of art of web systems related to a domain.”

### *B.2) Reuse of past solutions*

Some interviewees stated that, when dealing with similar problems, sometimes they turn to existing systems or artifacts in order to reuse past solutions. They do this to save time, to keep the system they are working on consistent or to ease its implementation.

“(...) in this web site, we have a ‘contact us’ form, for example, and on \*\*\*\*’s web site itself there’s already a ‘contact us’ form which is from the ombudsman. Then I said well, I’ll reuse it, because it’s something which is available for years, which is used, uhh, the users are used to it and it’s all information I need.” (P1, lines 105-110)

“(...) every time we’ll make something which looks like a filter, we try to use this same solution [a filter solution].” (P2, lines 292-294)

“(...) we, generally, aim for consistency, so we use examples more in the case of, we already already have another ‘search by name’ module, okay, so it’d be good if this module was really similar as much as possible with this for the sake of consistency for the user, because he already knows how to use that module which exists.” (P8, lines 45-49)

From this theme, we can say that a CBR tool must have some way to help its users to access the artifacts that compose the problem or solution of a case. This way, the user can reuse the artifact as is, or he can adapt it the way he sees fit. The

requirement we associated with this theme is “cases should ease the reuse of previous design solutions.”

### *B.3) Design communication*

Some interviewees said that they use examples to explain to their clients (or users) the way they see the problem and how they plan to solve it.

“So, I found an example of a really interesting menu and in the iPad itself I started showing it to some users, ‘look, the concept I’m thinking about is this way, but adapting some things.” (P4, lines 53-56)

“For the client, it’s [the usage of examples is] more to explain the solution or the problem.” (P5, lines 65-66)

This means that a case in a CBR tool should also aid in the communication between various stakeholders. The requirement we associated with this theme is “cases should be useful to help communication between various stakeholders.”

## **C) Designer’s Practice**

The subthemes here help uncover how a CBR tool can fit more easily in the designers’ work customs. This is important because, if a CBR tool is suited to the designers’ practice, the probability that it will be successful increases.

### *C.1) Usage of an example library*

Two interviewees said that they work with a library with examples, which they consult when doing their work. However, the kinds of library and the way they use them differ between the two. On the one hand, there’s P2, who has an engineering background:

“So, we know some interaction types have some things that work, that... that style guide which we usually follow, and they are things which we know that ‘oh, for you to do this, it’s better to, you know, way to interact is this, you know?’ So, there are things which we already know and we use the patterns. (P2, lines 148-152)

The example library P2 and the designers use works like a source of knowledge, which is ready to use. For each interaction style, the library explains when that style should be used, why, how, and so on. This kind of library aids the reuse of design knowledge which was mentioned before in the *reuse of past solutions* theme.

On the other hand, we have P3, who has a design background, said:

“I have a reference database, like, mine, which I maintain myself, image database, like website examples...” (P3, lines 98-99)

“I even saved, uh, layouts from many frames, because I thought it was interesting how it was “laid out”...” (P3, lines 124-125)

“(...) sometimes I use [examples] as ideas, sometimes I use parts of it as... like, for example, if it’s an image, it’s easier to use a... sometimes I even use an image gradient and change something on it, sometimes I use a button I found interesting, a field type, style used in a field form. I keep many styles too, stylesheet, Javascript scripts, stuff like that...” (P3, lines 142-146)

“But sometimes I even use parts of it [a previous solution], for example, Javascript itself, many things I take and change and use, stylesheet, right?” (P3, lines 150-152)

It is possible to notice here that P3 uses his example library in many different ways, depending on what he wants to do. Sometimes he uses an example just to have new ideas, but sometimes he uses examples as material resources, adapting them, to solve new problems. P3’s library is also different from P2’s in a sense that the kind of content it stores is much more diverse than P2’s, ranging from images to programming scripts.

From this, we can deduce that the cases from a CBR tool must be flexible to adapt to many different kinds of user needs. A case must be able to describe problems and solutions in a more structured way, as in P2’s library. However, it is also important for a case to be flexible enough so that the user can create it any way he thinks will be useful to him. The requirement we associated with this theme is “the tool should be able to serve as a library of examples (cases).”

### C.2) Affinity with images

Two interviewees mentioned their predilection for images rather than the use of text when working. P3 said that he prefers working with images because of his academic background and professional experience.

“My focus is on the visual area, work with images, of course, always looking at interaction issues, but since I’m a designer, so I always focus on visual, a lot on images.” (P3, lines 137-140)

P4, who has an Information Systems background, said he prefers images, because they make it easier to understand ideas..

“I really like images, so I think the more images, like, easier it is to understand stuff. I look at an image and I understand it more easily. Maybe image and text, and text complemented the image...” (P4, lines 270-273)



Therefore, a CBR tool must have a way to easily deal with images, enabling the user to express what he wants with images, if he wishes to do so. This is in line with what was said in the previous theme, *usage of example library*, in which it was concluded that cases must have the flexibility to be created the way the tool user needs to. The requirement we associated with this theme is “the tool should integrate images.”

### *C.3) Design strategy*

Some interviewees mentioned that they usually adopt a problem-driven strategy, meaning that they first focus on defining the problem and, then, on generating a solution. It can be an iterative process, so while the designer is building a solution, he discovers that there are some aspects of the problem which remain unclear to him.

“Generally, I spend a lot of time trying to understand the problem. (...) Generally, the solution sort of comes naturally, you know?” (*P1, lines 126-129*)

“Yes, it’s more like analysis [of the problem] than the development [of a solution]. But, obviously, when you go draw [the solution], you see that some stuff are missing or you review the requirements.” (*P5, lines 79-81*)

However, the style guide P2 uses focuses more on a solution-driven design strategy. When he was showing the library to the interviewer, he said:

“It’s like this. There’s an interface element, like... What is being used? Why is it used? What is it used for?” (*P2, lines 161-162*)

And later, he showed an example with the wizard UI pattern.

“Look, the wizard. How will the wizard be? Why is it and when should you use it?” (*P2, lines 182-183*)

Here, P2 shows us that the examples he and the developers use are composed of interface elements (or UI patterns) and, for each of those, there’s a description of what those elements are, why and when they should be used and so on. The user of the guide must look for an element (the solution) and, when he finds it, he is given an explanation of its uses (the problem).

This hints that a CBR tool must have the possibility of aiding both problem-driven and solution-driven strategies (Kruger & Cross, 2006). In a problem-driven design, the designer focuses on gathering information in order to understand the problem he needs to solve. He focuses exclusively on the problem he needs to

solve in an attempt to solve it as soon as possible. In a solution-driven design, the designer focuses on creating solutions. Not much time is given to frame and refine the definition of the problem and the designer only looks for information when needed to develop his solution. The requirement we associated with this theme is “cases should be amenable to different design strategies (problem or solution-based).”

#### **D) Case features**

The following themes describe the features of the cases a CBR tool must have.

##### *D.1) Case contents*

According to what was said in the interviews, cases from a CBR tool must detail the problem, its solution and the evaluation of the solution.

If what P2 said is taken into consideration (see P2’s statement on the *design strategy* theme above), it would be interesting for a case to describe the solution (an interface element or UI pattern) and the problem (why it should be used, when it should be used).

When P4 was answering a question about what a case should have to be useful, he said:

“What the problem was, first. And the solution given. If it worked or not.” (P4, lines 261-262)

And while P6 was commenting on the CBR process, he said:

“And that’s just like how we work. As I said, we go, take a problem and search everything that has to do with the problem. Then, we see if it works or it if doesn’t work and then we can reuse that knowledge later.” (P6, lines 206-209)

Also, considering the previous theme (*design strategy*), in which it was discovered that designers use both problem-driven and solution-driven strategies to solve a problem, the case should be flexible enough to reflect the user’s strategy. If it is a problem-driven strategy, the case must describe the problem and its solutions. But, if it is a solution-driven strategy, the description must start from the solution and then describe the problem(s) it solved. The requirement we associated with this theme is “cases should describe problem, solution and evaluation.”

### *D.2) Conciseness*

According to the interviewees, there must be some criteria as to which cases are added to the library. For example, P2 said that a CBR tool must have a library without redundancies and its cases must not be overly descriptive in order to be useful. He also places part of the responsibility of keeping the library organized on the user.

“I think it [a CBR tool] gets in the way [of work] if you put anything there without questioning what’s already in there. For example, if you add a more advanced case and start adding ten subcases for it, I don’t know if it’s useful or not. I think we also must have the attention to be very generic, so there won’t... you know? So there won’t be an unnecessary case.” (P2, lines 313-318)

When P5 was answering a question about how the tool can frustrate his job, he said that user must not waste too much time to find what he wants. This is statement is in line with a theme that will be mentioned ahead, which states that the tool must not be bureaucratic.

“(...) like, to have many layers until he finds information that I need. (P5, line 182)

While answering the same question, P7 draws attention to two problems a library can have: lack of variety and redundancy. He also places the responsibility on the user.

“Stuff repeating a lot. (...) if there’s not a lot of variety, a lot of similar references show up, things become sort of alike, I don’t know. But I think it depends a lot on the person. I think people know how to filter.” (P7, lines 312-316)

These statements point out that there must be some control over the quality of the library, but it is mostly up to the user. However, the CBR tool should offer some guidance to help the user avoid adding useless cases to the library. For example, there could be an option to find similar cases as the one which the user wants to add to the library. The requirement we associated with this theme is “the set of cases should avoid redundancy and cases themselves must be succinct.”

### *D.3) Cases must contain code*

The interviewees also stated that it is important for them to have contact with the source code of previous works. Code can also be used as example or as a way to help the reuse of that knowledge. P3 said he stores code snippets in his personal library which can be used later in new situations.

“I keep many styles too, stylesheets, Javascript scripts, stuff like that...” (P3, lines 146-147)

“Yeah, I use them as inspiration. But sometimes, I use parts of it, edit, like, for example, Javascript itself, I take a lot of things, edit and use...” (P3, lines 150-151)

When P4 was answering a question of how cases could be to be useful, he said that, in the example shown during the presentation, he missed the step in which the CBR tool user makes his solution real. In the example described in the presentation, the designer does not develop a concrete interface for the problem he needs to solve and this bothered P4. This shows the importance something concrete (e.g., a prototype) is important to this participant.

“That format there [what was shown in the presentation]. I just didn’t see him [the designer described in the presentation example], from there [the mental solution he developed in the CBR process], going to the final solution [a concrete interface]. I think that’s missing.” (P4, lines 201-202)

“But I didn’t see that going to the creation [an interface creation stage], you know? To the interface building.” (P4, line 208)

P8 stressed the importance of code in his work. He said that some design decisions are made according to what is already implemented. In other words, what is already implemented takes part in the design problem’s constraints.

“It’s code. We are very dependent on the development, sometimes. Either development to create or to reuse things.” (P8, lines 89-90)

“And many times, what motivates the reuse of some things is exactly that sometimes it’s already developed, there’s already a module there which does this.” (P8, lines 92-93)

In conclusion, cases must not be only descriptive. They must also provide access to concrete elements of the solution they refer to (code). That way, users can make use of it either as a source of inspiration, like P3 said, or as a way to understand the problem’s constraints, like P8 said. Lastly, concrete artifacts can speed up the creation of a new solution. The requirement we associated with this theme is “cases should contain some sort of source code.”

## **E) CBR Tool features**

This section describes subthemes related to features a CBR tool should have in order to be useful.

### *E.1) Efficient access to cases*

The interviewees showed some concern related to how the cases would be accessed in a CBR tool. Case recovery must be effective and efficient.

“So, first, I think the base has to be very well structured in that sense to allow a quick recovery more or less exact of what I want.” (*P1, lines 177-179*)

P6 also showed concern regarding the quality of the search results of a CBR tool.

“(…) but then, how would I search for that [previous knowledge]? (…) how do you search, like, how do you say what do you want so that the system can return you something relevant is what, for me, is the most important thing for it [a CBR tool] to be useful.” (*P6, lines 224-229*)

P7 stated that the quality of the search results would encourage him not only to continue using the system, but also to add new cases to the library.

“But if I made a search or two and had an answer somewhat interesting, certainly, I’d keep searching and even contributing, adding stuff, I think.” (*P7, lines 294-296*)

According to the interviews, the CBR tool can use tags as a way to search cases.

P3 currently uses tags to index his personal example library.

“And I catalog with tags (…) the references I receive from lists [mailing lists], then normally I try to tag so that I don’t get lost, because there’s a lot of stuff I receive.” (*P3, lines 108-112*)

Later, P3 adds that even tags sometimes are not enough to help find something due to the great amount of examples he has.

“I tag, but sometimes it’s hard to find some things, because there’s a lot of reference.” (*P3, lines 115-116*)

P4 also mentioned tags when he was talking about what is necessary for a case to be useful.

“And I think it could have tags, too, dude. So, I’ll… I could imagine my tags. There’s… this case here could be classified as menu and combos and other fields or something like that. That makes things easier later during the search.” (*P4, lines 262-265*)

Other than tags, the interviewees talked about different kinds of manners to access cases more easily. P3 mentioned the use of bookmarks.

“(…) since I tag them [online mailing lists], I can find something. And bookmarks too, lists, you know.” (*P3, 132-133*)

P5 mentioned the use of recommendations to help designers find an interesting case. He justified it saying that sometimes designers are not sure about what they need.

“Look, there’s a lot of people looking for these combinations [of case characteristics], if your problem is one of these combinations, you can go here straight. Because, sometimes, not even the designer knows what he searching is for.” (P5, lines 155-158)

P6 says that it would be interesting to have access to past experiences according to the context of the current task.

“But if I had something that, for example, brought me like “no, \*\*\*\* [P3’s name], you worked on this project four years ago and it is related to everything you’re talking about and you didn’t remember it.” I think it’d be great. It’d help me search for something more relevant than what I’d be able to search in my memory.” (P6, lines 260-263)

All these statements imply that a CBR tool must be as accurate as possible when searching for cases. It also needs to provide ways for its users to access useful cases. It can be either through tags, which can be used as filters, but also through shortcuts like bookmarks and recommendations. The requirement we associated with this theme is “the tool should provide an efficient way to find cases.”

### *E.2) Integration with other tools*

Some interviewees suggested that the CBR tool should have some kind of integration with other tools that are currently used in their work. Doing so will allow the tool to fit better in the designer’s workflow.

“And another thing which is really interesting nowadays, for anything in our area of informatics, is to integrate stuff. So if I have this tool, if it’s great, but if it’s not integrated, it becomes a little limited. Now, if I start to integrate it, I don’t know, with the Google search, if integrate it to my e-mail, I don’t know...” (P1, lines 244-248)

“(…) I make the documentation using, I don’t know, Word or Google Docs, then the interview, I record the interviews, I edit the video, I edit the audio. Then, later, when I start the wireframe, I go to Visio. I mean, I use a many different tools. So, if I had something which enabled some integration, I think that... if I had an environment, like, that I could always be in that environment, I think it’d be cool.” (P6, lines 175-180)

The requirement we associated with this theme is “the tool should have some sort of integration with other tools to fit into the designer’s usual workflow.”

### *E.3) Not time-consuming*

Some interviewees said that they usually have to deal with time restrictions in their jobs.

“For example, over there at \*\*\*\*, they have a very tight schedule. If I start making surveys and make documentations and a bunch of stuff that they won’t use now because they have a tight schedule, then I won’t be helping. (...) We go and do something really agile.” (*P2, lines 221-225*)

Sometimes, time is so scarce that users might not have much to invest in learning a new tool. For instance, P5 defined that the maximum amount of time he would invest in the initial learning of a CBR tool is ‘two hours’.

“(...) ok, the tool is here, take a look. I’d use it for two hours. Oh, ok, it’s useful and from now on, I’ll use it in all the projects. If it’s not useful, I’ll never open the tool again.” (*P5, lines 198-200*)

P7 mentioned an experience he had with software he tested called Serena Prototype Composer. He found the software bureaucratic and concluded that it could not be used in the work environment.

“The software, I think, it’s called [Serena] Prototype Composer. And I installed once or twice, I think and used it a little and I couldn’t do much. I think the idea is nice. I thought it was a little, a little bureaucratic, because it tries to mix a little of prototyping, with project stuff, with requirements, project management stuff and that’s why I thought it was a little hard to be used in practice.” (*P7, lines 231-236*)

In conclusion, for a CBR tool to be useful, it must not let users waste time doing whatever they think they will not need in their work. Just like what was found out under other themes, a CBR tool has to be flexible enough to adapt to the user’s workflow. Users do not have the will nor time to adapt to a tool’s restrictions, so too many impositions will cause the tool to be discarded. The next section presents the requirements based on these findings, and describes the CHIDeK tool. The requirement we associated with this theme is “the tool should not make the designer spend a long time using it.”

## 4 CHIDeK

This chapter describes CHIDeK's (Computer-Human Interaction Design Knowledge) development. We review the requirements we collected during the interviews described in the previous section. We also show the metacommunication message created from the requirements and how it was used to build the tool.

### 4.1 Tool Requirements

We related the themes listed in the template (Table 1) into requirements for the CBR tool. Table 2 lists the themes extracted from the interviews and a description of how each theme translates to a requirement. Out of them, just the integration with other tools requirement (E.2) was not taken into account in this work.

### 4.2 Metacommunication Message for CHIDeK

Using the requirements listed above, we created the first part of the metacommunication message of CHIDeK. To do that, we used the metacommunication message template and replaced its first sentence (in bold, below) with the information we have collected during the interviews.

**“Here is my understanding of who you are, what I’ve learned you want or need to do, in which preferred ways, and why.** This is the system that I have therefore designed for you, and this is the way you can or should use it in order to fulfill a range of purposes that fall within this vision.”



Table 2: List of themes and their corresponding requirement

Theme	Requirement
A.1) Work material	Cases should be able to deal with design artifacts, such as wireframes.
A.2) Examples contents	a) Cases should be flexible enough to describe experiences from a variety of domains. b) Cases should also deal with the restrictions the designer has.
B.1) Competitive advantage	Cases should be able to help the designer to know more about the state of art of web systems related to a domain.
B.2) Reuse of past solutions	Cases should ease the reuse of previous design solutions.
B.3) Design communication	Cases should be useful to help communication between various stakeholders.
C.1) Usage of a example library	The tool should be able to serve as a library of examples (cases).
C.2) Affinity with images	The tool should integrate images.
C.3) Design strategy	Cases should be amenable to different design strategies (problem or solution-based).
D.1) Case contents	Cases should describe problem, solution and evaluation.
D.2) Conciseness	The set of cases should avoid redundancy and cases themselves must be succinct.
D.3) Must contain code	Cases should contain some sort of source code.
E.1) Efficient access to cases	The tool should provide an efficient way to find cases.
E.2) Integration with other tools	The tool should have some sort of integration with other tools to fit into the designer's usual workflow.
E.3) Not time consuming	The tool should not make the designer spend a long time using it.

The message, after the replacements, is detailed below. We linked some of its parts with the themes listed in Table 2 to inform the source of its content.

You are an HCI designer who works with a variety of artifacts, such as wireframes, prototypes and documents, (A.1) and deals with multiple domains (A.2a) and restrictions (A.2b). To make your job easier, you turn to examples to find out what competitors are doing (B.1), to reuse previous solutions (B.2), or to talk about

design ideas with other stakeholders (B.3). Also, you prefer to work with images rather than text (C.2). Depending on the situation, you can adopt either a problem-based or a solution-based strategy (C.3). You would like to have a library where you store existing design knowledge (C.1). To be useful, the description of that knowledge must explain the problem that had to be solved, the solution developed and its evaluation (D.1). You want your library to have lots of cases, but you don't want redundancy (D.2). Since you often deal with code, cases should provide access to source code for a solution (D.3). You don't have much time to spare, so the tool must speed up your progress (E.3). Therefore, you don't want to spend a long time to grasp the idea behind a case (D.2). In the same way, you don't want to spend a long time looking for an interesting case (E.1).

As we designed and developed CHIDeK, the second part of the tool's metacommunication message was incrementally built and refined. Doing so helped us not to deviate from the requirements we discovered previously, because in order to create the second part of the message, we had to pay attention to the first part to keep the whole metacommunication consistent. So, in this section we report how we filled the second part of the metacommunication template, completing the whole metacommunication message.

“Here is my understanding of who you are, what I've learned you want or need to do, in which preferred ways, and why. **This is the system that I have therefore designed for you, and this is the way you can or should use it in order to fulfill a range of purposes that fall within this vision.**”

Just like before, we used the themes from Table 2 to explain which requirement was addressed at each part of the metacommunication message.

To help you in your work, I developed a case library called CHIDeK, where you can store past design knowledge in the form of cases, which you can use to solve new problems (C.1). When you create your case, you must give it a title and a description. To create the description, I provide you with a rich text field with many formatting options and other functionalities, such as adding links or images (C.2). I opted for this, because it gives you freedom to describe your case regardless of the domain (A.2a) or other restrictions (A.2b). In order to create a good case, I suggest you answer a few questions regarding the problem you needed to solve, how you solved it and how the solution fit the problem (D.1). However, you are free to ignore the suggestions and describe the case in any way you want (C.3). You can also attach any kind of file to your case. For instance, if you developed a prototype to solve a design problem, you can attach the source code to the case, in the event you want to reuse it later (A.1, B.2, D.3). After that, you must select the tags that describe the case. I have already created many tags of different types for you. There are tags focusing on the problem you need to solve, such as the action tags, and focusing on the solution you might already have in mind, such as widgets and UI patterns tags (C.3). If you do not find any tag that suits you, you

can create your own tags. However, you cannot create duplicate tags. Also, if you create a tag that is similar to an existing one, I will warn you so that you can be wary of any redundancy that might occur if the tag is created (D.2). In addition, if you create a case which is tagged the same way (or almost the same way) as another tag, I will warn you, so that you can check whether both cases are similar (D.2). You can also specify how the new case is related to other cases in the database. To do so, you can create a list of related cases. For each related case, you can specify the kind of relation it has to the new case. To populate the related case list, I give you some options to speed up the search such as using the new case tags as a filter or searching only for cases you created (E.3).

The case library shows the title of the cases and a small thumbnail to help you have an idea of what the case is about (C.2). To find a case, you can browse the library, use the search function or use the tags as a filter. Tags can help you to quickly have a general idea of the cases stored at the database. They can also help you find interesting cases in case you see a tag that seems important to you. If you know the word you are looking for or if none of the tags helped you, you can use the search box to look for cases (E.1). Once you select a case, you can click on it to examine its details. Depending on how the case was created, you can use it in many ways such as an input to a new solution, to communicate ideas with other people or to have an idea of how similar systems deal with the same problem (B.1, B.2, B.3). At the bottom of the case details, you can see the attachments, if any. These attachments can speed up your work if you want to reuse previous solutions (B.2, E.3). If you attached images, I show a thumbnail of each of them so that you can quickly preview its contents (C.2, E.3). After those, I list all cases that are related to the current one. I expect that, if the case you are looking at interested you, some of the related cases might also be helpful somehow (E.1). I also list all the tags related to the current case, so that you can use them to refine your search through tags. Finally, I offer some space for other users to comment on cases. With this, you can share knowledge with other people, such as other designers or clients (B.3).

### 4.3 CHIDeK Design

The metacommunication message described in section 4.2 guided the development of a case library tool called CHIDeK. We built CHIDeK using PHP and MySQL. Since all the participants for the following study would be Brazilian, the tool was developed in Portuguese, so that the degree of proficiency in English would not become a requirement for recruiting participants. CHIDeK provides faceted navigation and semantic relationships to help with case library exploration. Faceted navigation is a popular way to allow users to browse a collection of items. Hearst and colleagues (2002) show that faceted navigation is an effective method that can be helpful during a design activity.

CHIDeK's facets are based on: a list task types based on the work of Gonzalez-Calleros and colleagues (2009); design artifacts; a list of widgets; and a

list of UI patterns extracted from UI pattern libraries.<sup>1,2</sup> The task types facet was created in order to give the designer an option to browse cases adopting a problem-based approach or using a more abstract representation than widgets. The UI patterns and widgets were used to provide a more concrete representation for the designer to browse cases. Table 3 lists all facets used in CHIDeK, and their corresponding values.

Table 3: CHIDeK's facets

Task types	Artifacts	Widgets	UI patterns
Analyze, Communicate, Control, Create, Search, Inform, Filter, Insert, Move, Navigate, Distinguish, Remove, Edit	Screenshot, Code Snippet, Wireframe, Document	Progress bar, Button, Checkbox, Drop-down list, Image, Link, Map, Radio button, Slider, Spin box, Table, Text box, Tooltip	Tabs, Autocomplete, Breadcrumbs, Carousel, Collapsible panels, Country selector, Coupon, Date selector, Directory navigation, Drag and drop, Fly-out menu, Form, List builder, List entry view, Pagination, Pull-down button, Rating, Search results, Search box, Slideshow, Table sorter, Thumbnail, To-the-top link, Wizard

We briefly define the task types below:

- a) **Analyze**: examine an item set (compare, evaluate, decide);
- b) **Search**: identify a specific item in a set;
- c) **Communicate**: exchange information with the system;
- d) **Control**: control the flow of an action (e.g., play, stop);
- e) **Create**: create a new item;
- f) **Inform**: provide an information to the system;
- g) **Choose**: pick an item in a set;
- h) **Filter**: filter items in a set;
- i) **Insert**: include a new item in a set;
- j) **Move**: change the position of an item in a set or across sets;
- k) **Navigate**: find one's way through pages;
- l) **Choose**: select an item from a set;
- m) **Remove**: remove an item from a set;
- n) **Edit**: change an item.

CHIDeK's semantic relationships are based on Janeiro and colleagues (2010), who proposed a set of semantic relationships for UI patterns. We use semantic relationships to connect cases, as an alternative to help find interesting cases for

<sup>1</sup> van Welie's pattern library (last accessed on September 14<sup>th</sup>, 2011): <http://www.welie.com>

<sup>2</sup> UI Patterns pattern library (last accessed on September 14<sup>th</sup>, 2011): <http://ui-patterns.com>

the current design problem. When the user sees the details of a case, he can navigate to other cases using these relations. The relationships used in CHIDeK are described as follows:

- a) **X is (often) used with Y**: this is used when X and Y describe aspects of a system that are usually present together. For example, X can be a case describing the search feature of an online store selling theater ticket and Y can be the seat picking feature of the same kind of system (it does not need to be the same system described in case X, though);
- b) **X is similar to Y**: this is used when cases X and Y have similar characteristics. For example, the case describing a search feature of a ticket online store can be similar to a case describing a search feature from an academic paper database;
- c) **X conflicts with Y**: this is used when the feature described by case X must not be used with the one described by case Y;
- d) **X implements Y**: this is used when case Y describes a system in an abstract way (e.g., using models or scenarios) and case X is an implementation of the system described by Y;
- e) **X abstracts Y**: this is the opposite of the ‘implements’ relation;
- f) **X enhances Y**: this is used when case X describes a feature which is an improved version of the one described in case Y. For example, cases X and Y describe ways a user can find a computer in online stores. In case Y, the user must use drop-down lists to pick the model, the manufacturer, price range or generic features of the computer (such as processor speed or memory capacity). As for case X, the user can look for a computer using a search box with autocomplete or faceted navigation, being able to refine his search as he goes on. In this case, since both case X and Y talk about the same goal, but in case X the search functionality is an improvement from the one described by case Y. We can say then that case X enhances case Y;
- g) **X simplifies Y**: this is the opposite of the ‘enhances’ relation.

We created CHIDeK’s cases based on web systems from multiple domains: online stores, airplane and movie ticket sales, maps, car reservation, and calendars. We inspected a variety of web systems and created 30 cases. To do so, we performed

a thorough inspection to collect the information needed for each case, such as who the targeted system's user is, what he intends to do and how the system tried to help him.

As we show each part of CHIDeK, we also describe a fragment of the metacommunication message we intended the users to receive as they interacted with that part of the system.

Below, we show a few screenshots of CHIDeK, describing its features. Figure 1 shows CHIDeK's main page. The user can search for cases using keywords on the upper left box. He can search in case titles, descriptions, or both. Below that box lies CHIDeK's faceted navigation feature. Each checkbox represents one facet value. The numbers between parentheses next to the facet value names represent the amount of cases that will be listed once that value is chosen. The tool facets are: task types, artifacts, widgets and UI pattern (as shown in Table 3). To the right, CHIDeK shows the cases according to the search criteria on the left. If the user does not search for anything, CHIDeK shows all cases. They are listed using the title and a thumbnail, so that the users can have an initial idea of what the case is about. The metacommunication message fragment we intended users to receive here was:

“The case library shows the title of the cases and a small thumbnail to help you have an idea of what the case is about. To find a case, you can browse the library, use the search function or use the tags as a filter. Tags can help you to quickly have a general idea of the cases stored at the database. They can also help you find interesting cases in case you see a tag that seems important to you. If you know the word you are looking for or if none of the tags helped you, you can use the search box to look for cases.”

Figure 2 through Figure 4 show how we decided to represent cases in CHIDeK for the study we conducted later. To make a case title descriptive, we adopted a verb + object + system name structure (e.g. Search Tickets – Ingresso.com, Buy Plane Tickets – Azul). Figure 2 shows the first part of the case with the case problem and the beginning of the solution. We described the case problem in a paragraph, introducing the intended system user along with what we believe he wants to do with the system and how. We represented the case solution with a short introductory text and pictures with text balloons describing some aspects of the system that are important for the user to perform his task.

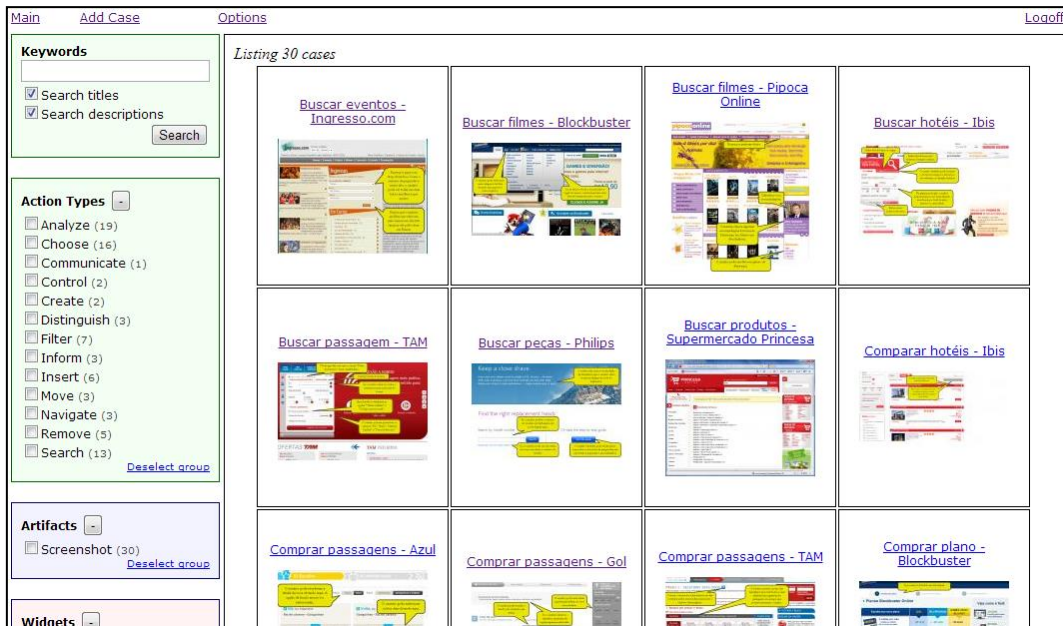


Figure 1: CHIDEK's main page

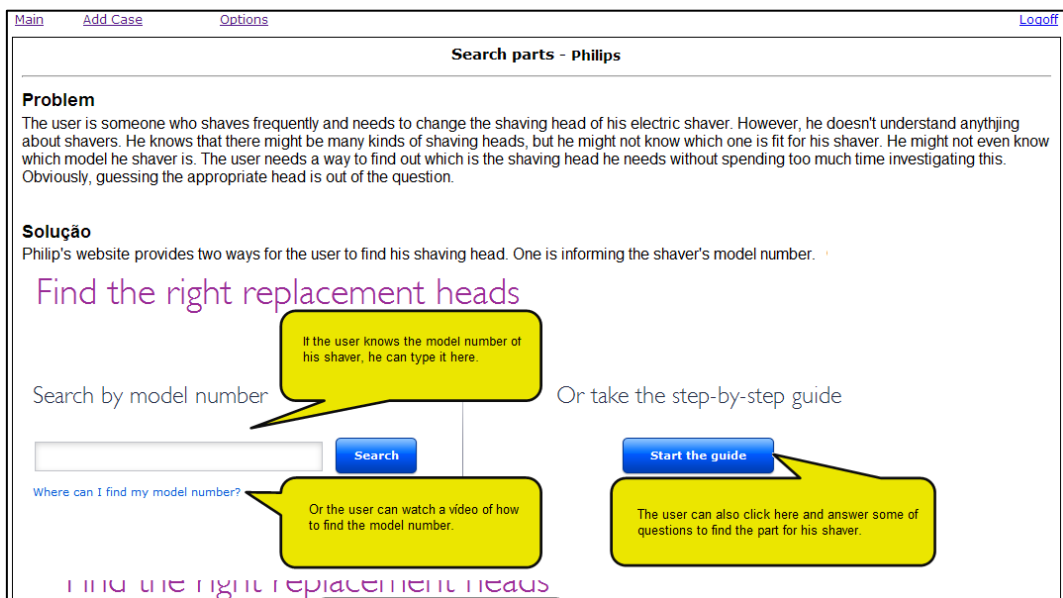


Figure 2: Case description (problem and solution)

Figure 3 shows the evaluation part of the case, which is a paragraph describing the good and bad aspects of the solution.

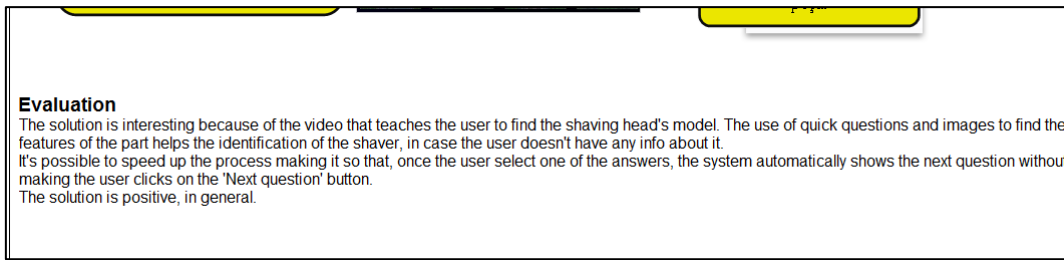


Figure 3: Case description (evaluation)

Figure 4 shows case attachments, case images, case relations, list of tags and comments. The attachments section lists the files the user attached to the case, such as source codes, models and so on. The images section lists all the images attached to the case. The relations section shows the case's links to other cases via the aforementioned semantic relationships. The list of tags is used to describe the case. Users can also make comments about the case, such as suggestions or criticisms.

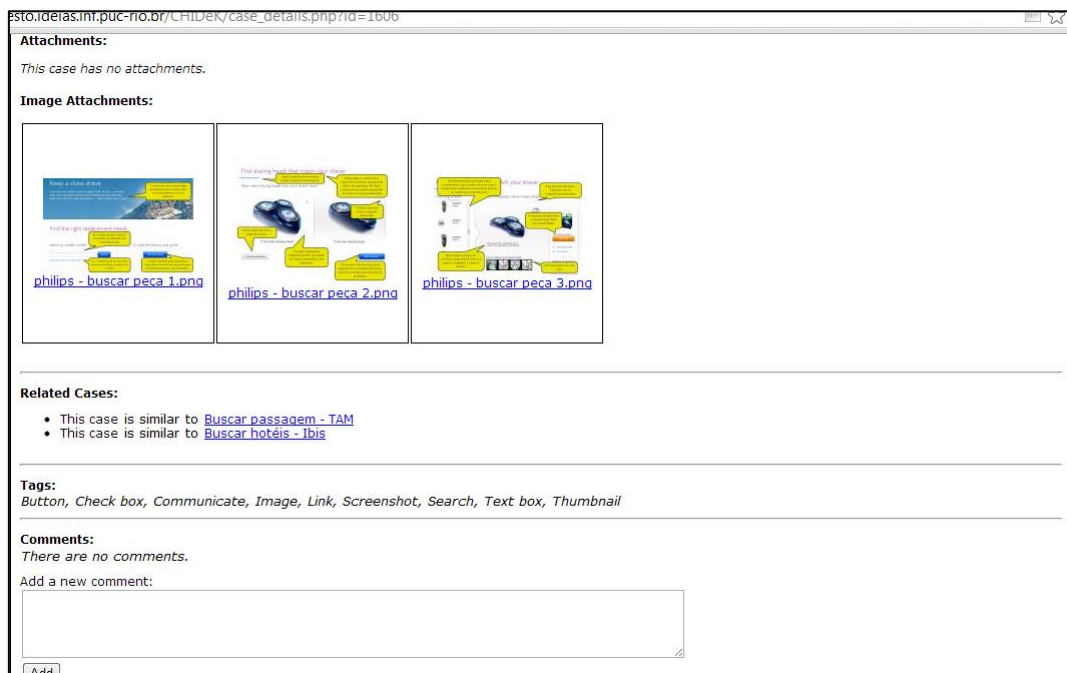


Figure 4: Case description (attachments, images, relations and tag list and comments)

Our metacommunication message did not contemplate the message concerning how a case is designed and what its content should be, because this is a responsibility of the user, since he is to decide the content he wants to communicate and how it will be organized. The message does tell the user our



vision of how he can create his message, and that is detailed in the next paragraphs. But since, in this case, we also had to create the cases ourselves to conduct the study, we did so taking in account our vision of the users as described in the first part of the metacommunication message.

“You are an HCI designer who works with a variety of artifacts, such as wireframes, prototypes and documents, and who deals with multiple domains and restrictions (...) To be useful, the description of that knowledge must explain the problem that had to be solved, the solution developed and its evaluation. You want your library to have lots of cases, but you don’t want redundancy (...) you don’t want to spend a long time to grasp the idea behind a case”

Although we used this case representation for the study we wanted to perform, CHIDeK allows users to create cases in different formats. Figure 5 through Figure 8 show how the user can add new cases to the database. Figure 5 shows the first part of the case creation page, where the user can inform the case title and its description. The case description field is a rich text field that gives the user some flexibility. Not only does it have text formatting options, but it also allows the user to add images and links to the case description. CHIDeK provides a few questions to help the user describe the case. We defined these questions based on the CBR process, on the metacommunication template and on the interviews. They are grouped in questions related to the problem, to the solution, and to the evaluation of the case.

- a) Problem-based questions: Who is the user? What does he need to do? How does he need to do it? When? Why?
- b) Solution-based questions: What is the solution? When should it be used? How? Why? How does this solution fare when compared to others?
- c) Evaluation-based questions: What worked with this solution? Why? What did not work with this solution? Why? What is the solution’s general evaluation (success or failure) for the given problem?

The metacommunication message fragment that guided the development of this part of the system is:

“you can store past design knowledge which you can use to solve new problems. When you create your case, you must give it a title and a description. To create the description, I provide you with a rich text field with many formatting options and other functionalities, such as adding links or images. I opted for this, because it

gives you freedom to describe your case regardless of the domain or other restrictions. In order to create a good case, I suggest you answer a few questions regarding the problem you needed to solve, how you solved it and how the solution fit the problem. However, you are free to ignore the suggestions and describe the case in any way you want”

The screenshot shows a web application interface for creating a new case. At the top, there are navigation links: 'Main', 'Add Case', 'Options', and 'Logout'. Below this is a section titled 'Create new case'. Underneath, there is a 'Case Description' section with a 'Case Title' input field. A 'Text Editing Tools' toolbar is present, featuring various icons for text formatting such as font name and size selection, bold, italic, underline, text color, background color, undo/redo, alignment, paragraph style, indenting and lists, and insert item. The main content area is divided into three sections: 'Problem', 'Solution', and 'Evaluation', each with a list of guiding questions.

Figure 5: Case creation (case description fields)

Figure 6 shows the next part of case creation, which deals with attachments and tagging. As said before, the user can attach any kind of file to the case, such as source codes or models. We did this according to the following metacommunication message fragment:

“You can also attach any kind of file to your case. For instance, if you developed a prototype to solve a design problem, you can attach the source code to the case, in the event you want to reuse it later”

Tagging is related to associating facet values to a case. CHIDeK refers to facet values as ‘tags’, because this was the word used by the interviewees. Tags will be used to make the new case available through the faceted navigation feature in the search page. We intended to have users receive the following message at this part of the system:

“you must select the tags that describe the case. I already created many tags of different types for you. There are tags focusing on the problem you need to solve, such as the action tags, and focusing on the solution you might already have in mind, such as widgets and UI patterns tags”

**Attachments** (Only the files with checked boxes will be uploaded. File size limit is 10 MB.)

File:  No file chosen

---

**Tags**

Select the tags which best describe this case from the list below:

**Action Types**

<input type="checkbox"/> Analyze	<input type="checkbox"/> Search	<input type="checkbox"/> Communicate	<input type="checkbox"/> Controlar	<input type="checkbox"/> Criar
<input type="checkbox"/> Delete	<input type="checkbox"/> Distinguish	<input type="checkbox"/> Edit	<input type="checkbox"/> Escolher	<input type="checkbox"/> Filtrar
<input type="checkbox"/> Inform	<input type="checkbox"/> Insert	<input type="checkbox"/> Move	<input type="checkbox"/> Navegar	<input type="checkbox"/> Parar
<input type="checkbox"/> Remove				

**Artifacts**

<input type="checkbox"/> Document	<input type="checkbox"/> Screenshot	<input type="checkbox"/> Code snippet	<input type="checkbox"/> Wireframe
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**Widgets**

<input type="checkbox"/> Directory tree	<input type="checkbox"/> Progress bar	<input type="checkbox"/> Status bar	<input type="checkbox"/> Button	<input type="checkbox"/> Check box
<input type="checkbox"/> Combo box	<input type="checkbox"/> Drop down box	<input type="checkbox"/> Group box	<input type="checkbox"/> Image	<input type="checkbox"/> Link
<input type="checkbox"/> List box	<input type="checkbox"/> List view	<input type="checkbox"/> Map	<input type="checkbox"/> Context menu	<input type="checkbox"/> Menu strip
<input type="checkbox"/> Radio button	<input type="checkbox"/> Rich text box	<input type="checkbox"/> Slider	<input type="checkbox"/> Spin box	<input type="checkbox"/> Splitter
<input type="checkbox"/> Table	<input type="checkbox"/> Text box	<input type="checkbox"/> Masked text box	<input type="checkbox"/> Toolbar	<input type="checkbox"/> Tooltip
<input type="checkbox"/> Tree view				

Figure 6: Case creation (attachments and tags)

Figure 7 shows the field that allows users to create a new tag. In an attempt to avoid facet redundancy, CHIDeK uses Levenshtein's string distance algorithm to check whether the new facet is similar to an existing one. If the new facet matches an old one, CHIDeK does not allow its creation. If the new facet is similar to one or more facets, CHIDeK warns the user so that he can check whether the facet he needs is already created and asks him whether he really wants to add the new facet. We did this part of the system following this metacommunication message fragment:

“If you do not find any tag that suits you, you can create your own tags. However, you cannot create duplicate tags. Also, if you create a tag that is similar to an existing one, I will warn you so that you can be wary of any redundancy that might occur if the tag is created. Also, if you create a case which is tagged the same way (or almost the same way) as another tag, I will warn you, so that you can check whether both cases are similar”

Figure 7: Case creation (new tag field)

Figure 8 shows the last part of case creation, where the user defines how the new case relates to the others. They can look for cases in the database and create a relation between an existing case and the new one using the aforementioned semantic relationships. The metacommunication message fragment that helped us build this part of the system was:

“You can also specify how the new case is related to other cases in the database. To do so, you can create a list of related cases. For each related case, you can specify the kind of relation it has to the new case. To populate the related case list, I give you some options to speed up the search such as using the new case tags as a filter or searching only for cases you created”

Figure 8: Case creation (relations)

Once CHIDeK’s development ended, we conducted a study whose goal was to help us evaluate the design activity with and without CHIDeK. The next chapter describes the planning and execution of the study, and the results.

## 5 Evaluating the Design Activity

This chapter describes the study conducted after developing the tool. The study was divided in two stages: a design activity using CHIDeK and a design activity without CHIDeK. Both stages were conducted in the same way, with the same scenario. The only difference was the presence or absence of CHIDeK and the interview questions we used after the study.

### 5.1 Goals

Each stage of the study had a specific goal. With the first stage, we intended to observe the HCI design activity with CHIDeK. With the second stage, we intended to observe the design activity without CHIDeK and compare the HCI design under both circumstances (with and without CHIDeK).

### 5.2 Participants

Unlike the preliminary interviews, we selected twelve participants for this study, who were HCI students at PUC-Rio, one being an undergraduate student and the others graduate students. We could not select participants with the same profile as the participants from the interviews because this study had some restrictions which made it very hard for HCI professionals to participate. Due to the fact that most professionals willing to participate had tight schedules or lived in other states, the interviews had been done either during the participants' lunch break at work or via online chat. However, in the study we needed participants with more flexible schedules to be present at our laboratory at PUC-Rio. In section 5.5.7, we show that, despite the difference in the participants' profile, our research results remain valid.

The twelve participants were randomly divided into two groups: one group participated in the first stage of the study, the activity with CHIDeK, and the other participated in the second stage, the design activity without CHIDeK. One participant from each group was used in a pilot study we conducted to calibrate the scenario and the questions used in the interview. Every participant signed an informed consent document agreeing to have their data recorded for analysis. The participants from the first stage will be referred to as P1, P2, P3, P4, and P5. The participants from the second stage will be referred to as P6, P7, P8, P9, and P10.

### 5.3 Procedure

All study sessions were performed in a laboratory at PUC-Rio. The standardized environment allows us to observe the participants' behavior during design in a more suitable way (Gunther, Frankenberger, & Auer, 1996). The only people who were present at the place were the participant and the researcher.

The study consisted of three steps: first, the researcher explained what the participant had to do and gave him the scenario for a first read to clarify doubts; second, the design activity itself took place; third, the researcher conducted a brief interview to obtain more information on the participants' design process. All the material prepared for this study can be seen in Appendix B.

The design activity was to follow a given scenario. We needed a scenario that was not very easy so that it could motivate some reflection by the participants. However, it could not be very complex because, otherwise, the participants would not be able to finish their task in a reasonable amount of time (about one hour). The participants had to sketch a bike reservation web system on a piece of paper. The scenario is described in section B.1. They were asked to deliver something they considered good enough to discuss with a client. Appendix D presents some of the participants' sketches.

To obtain the data from the participants' design activity, we used the think-aloud protocol (Ericsson & Simon, 1993). At the beginning of the session, the researcher asked the participants to speak what came to mind without worrying about what it was, as if they were alone in the room. On the sessions with CHIDeK, at first, there was a warm up step when the participants were asked and

explore CHIDeK while saying everything that came to their mind. The goal was to make them get used to thinking aloud and to reduce the impact of first-time use of the CHIDeK when the design activity started. However, this impacted the study, because during the activity, some participants referred to cases they saw during the warm-up session, which was not being recorded. On the sessions without CHIDeK, we decided against performing a warm-up step. This decision can be considered a threat to the study's validity. However, it did not seem to have an impact on the study, because the participants who did not have a warm-up session did not have trouble thinking aloud.

During the sessions, the researcher sat behind the participant and avoided making eye contact or noises. The only exception was when the participant had a doubt and explicitly expected an answer from the researcher (e.g. turning to the researcher or saying his name) or when the participant stopped talking. In this case, the researcher asked them to continue talking by just saying “keep on talking”.

We collected the following kind of data during the sessions: video of the participants' interaction with CHIDeK (only in the sessions with CHIDeK), video of the participants' sketching activity, audio of the participants' discourse (both during the task and during the interview) and a log generated by CHIDeK recording the users' interaction with the system (only in the sessions with CHIDeK). Both audio and video were transcribed.

## 5.4 Findings

We analyzed the data from both stages using Thematic Analysis (Braun & Clarke, 2006). It is a flexible method for analyzing patterns (themes) within data. While transcribing the audio and videos, we started analyzing the data creating themes that described the participants' design activity. The themes we created were:

- a) **New**: the participant comes up with a new problem or solution;
- b) **Add**: the participant extends a previously conceptualized problem or solution;
- c) **Change**: the participant changes a previously conceptualized problem or solution;

- d) **Alternative:** the participant comes up with an alternative to a previously conceptualized problem or solution;
- e) **Discard:** the participant discards a previously conceptualized problem or solution;
- f) **Implement:** the participant implements a previously conceptualized solution (puts it on his proposal);
- g) **Reflect:** the participant ponders over one or more problems or solutions;
- h) **Recall:** the participant makes a generic example to a previously conceptualized problem or solution;
- i) **Explore:** the participant is using CHIDeK (first stage only);
- j) **Direct:** the participant used a knowledge from a case directly (first stage only);
- k) **Adapt:** the participant adopted the knowledge he acquire from a case (first stage only).

For the first stage, we also classified the actions logged in CHIDeK to discover what the participant did in CHIDeK during each design step. The logged actions were:

- a) **Check/uncheck facet:** the participant selected or deselected a facet (tag);
- b) **Search with keyword:** the participant made a keyword search;
- c) **Switch tab:** the participant selected another browser tag;
- d) **View case:** the participant opened a case from the case list on the main page;
- e) **View main page:** the participant viewed the main page (usually after logging in or after returning from a case);
- f) **Use relation:** the participant opened another case navigating via a semantic relation.

For both stages, we identified the following problem items each participant addressed during their design:

- a) **Reservation type:** how the system user will choose the reservation type;



- b) **Reservation place:** how the user will choose where the bike will be reserved;
- c) **Delivery time:** how the user will inform the system when he will deliver the bike;
- d) **Delivery place:** how the user will inform the system where he will deliver the bike;
- e) **Procedure:** how the reservation process will be organized;
- f) **Reservation history:** a list of all of the user's previous reservations;
- g) **Reservation date:** how the user will inform the system the day he wants his bike to be available;
- h) **Delivery:** the merging of the delivery time and delivery place items;
- i) **Not qualified:** the design step was not related to any specific problem (e.g.: the designer was randomly browsing the tool).

The reservation history and reservation date were addressed only by P1. The delivery item was addressed only by P4.

After the themes were created, the video transcript was split into pieces in such way that each piece described one step of the design activity. Each step was associated with one or more themes and one problem item.

To help the analysis, we organized the coded protocols in tables. Each table represents one participant's design activity. Figure 9 shows, as an example, the table representing P3's protocol. The table is separated horizontally in groups, the first one listing his actions on CHIDeK captured by the log (this only appears on the tables related to the first study), and the others the items he addressed to during the activity. Each group is separated in rows. The first row shows the step number and the examples to previous steps in a slightly smaller font. The other rows are the themes related to the item. Each column represents a step.

For example, at step 1, P3 came up with a **new** item related to reservation type. At step 8, P3 came up a **new** solution related to the **new** item he came up at step 2. At step 9, P3 came up with an **alternative** to the solution from step 8. At step 49, P3 **reflected** on reservation time at the same time he was reflecting on reservation place. At step 31, at the same time P3 was **exploring** CHIDeK, he came up with an **alternative** to the solution he **reflected** on during step 30. Notice that this column is wider than the others. This does not mean that this step took

longer than the others. It means that during this step he performed more than one action in CHIDeK. This is shown in the first group “CHIDeK Usage”, where we can see that during this step he opened a related case and selected a new tab (in this case, he opened the related case in another tab and then selected it to view the case).

In the next sections, we describe the data we have collected after the study. The activity of each participant was described in a separate section, where we describe its most relevant parts. The study was conducted in Portuguese and the quotes shown here were translated to English. When suitable, we also show parts of the activity table to illustrate the description. We will also describe the most relevant parts of the interview. The full table of all of the participants’ protocols can be seen in Appendix C.

During the analysis, based on the observed data and the participants’ explicit utterances during the interviews, we recovered fragments of the metacommunication message<sup>3</sup> about CHIDeK that, in our interpretation, was received by the participants. Each fragment is identified by the participant number X, in the form PX.Y, where Y is a sequential number used for referencing the fragment.

We contrasted these fragments with the metacommunication message we used to build CHIDeK. This gave us an insight of how HCI students received our vision of the system, which was created based on the opinion of professional HCI designers.

At the end of the section related to the group of studies, we discuss the results of the analysis.

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<sup>3</sup> “*This is the system that I have therefore designed for you, and this is the way you can or should use it in order to fulfill a range of purposes that fall within this vision.*”

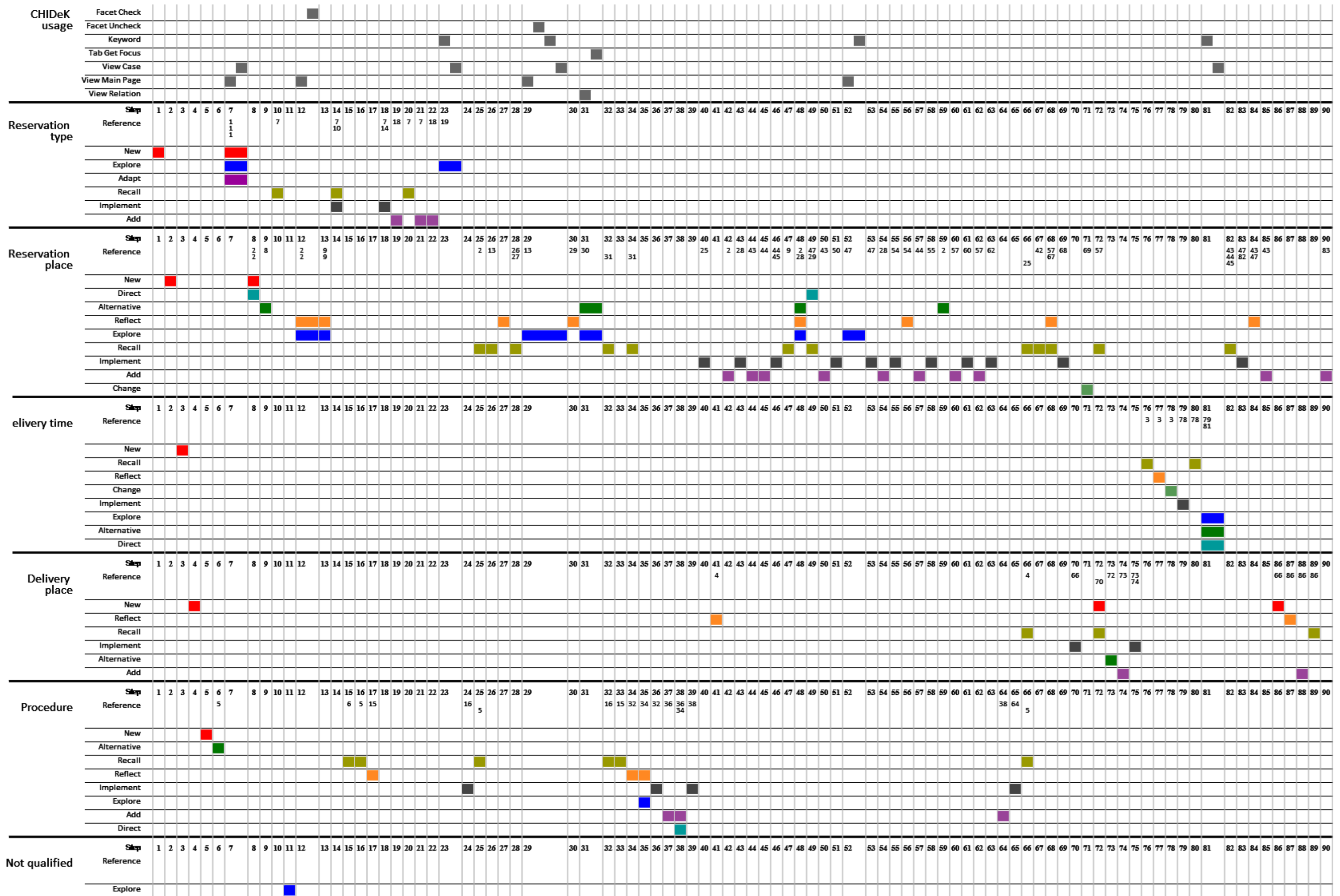


Figure 9: Example of table used to analyze the data collected on the design activity using CHIDeK

## 5.5 First Stage: the Design Activity with CHIDeK

This section describes the sessions with the design activity using CHIDeK. We wanted to know how the tool affected the design activity, whether it helped access previous design knowledge and whether it fit in the activity or not. So, we collected the design iterations done during the task while the participant could make use of the tool and analyzed them. For the rest of this chapter, we will mention facets as “tags”, since this is the term used by participants.

### 5.5.1. P1

#### 5.5.1.1. Activity

P1’s session was the one that took the longest. He did not use CHIDeK’s faceted navigation, search box or semantic relations. He browsed the case list and selected the cases he wanted to see.

Figure 10 shows a part of P1’s table related to the *reservation type* item.

Step	1	2	3	4	5	11	54	79	114	126	132	138
Reference		1	1	1	1	2	5	1	1	5	4	5
New	■	■										
Reflect			■	■	■							
Recall						■	■	■	■	■		■
Implement											■	

Figure 10: Part of P1's table related to the reservation type item

P1 did not resort to CHIDeK to solve this item nor did he mention this item while using CHIDeK. P1 identified this item at step 1, and at step 2 he came up with a solution and did not change his mind until the end. At step 132, he added it to his proposal. During the course of the activity, he made quick references to this item when dealing with other items, but nothing that resulted in reflection or changing the way he approached with this item.

“Umm, he will give me three reservation type options. So, this always reminds me combo box. Combo box? No, no, no. Radio button. Radio button that will only be able to choose one from the three options.” (*lines 4-6*)

“So, the reservation type will have the three of them here in the combo box. This is pretty simple. Not combo box, this is a radio button.” (lines 675-676)

P1 identified a problem item that involves a list of all the user’s current reservations. We called it the *reservation history* item. Figure 11 shows part of P1’s table related to it. This came from a P1’s interpretation of the scenario in which he thought that a user could make more than one reservation at a time.

Step	6	7	8	9	10	11	12	13	14	15	50	51	52	53	67	68	137
Reference		6	7	7	7		7	7	7		6	6	7	52	52	52	7
New	■	■															
Reflect			■								■		■			■	
Add				■	■		■	■									
Change												■	■				
Explore															■		
Recall																■	
Discard																	■

Figure 11: Part of P1's table related to the reservation history item

However, at step 50, P1 continued addressing the item and, at step 51, he changed his mind and decided to consider that the system should only accept one reservation per person. Then, at step 52, he decided to change his “reservation list” into a “reservation history”, meaning that the user would be able to check a list of all reservations he has made. At step 68, P1 reflected about a new way of displaying the reservation history based on Google Calendar case he had seen in CHIDeK during step 67. However, when he accessed this case, he did not mention he was looking for anything related to the *reservation history* item. At the time, he was looking into the *reservation place* item. Here is part of what he said during step 68:

“This is interesting too, I haven’t thought about this. He is showing another way of showing a scheduled event. But, since I can only make one reservation at a time, I don’t see much need for this. Unless that, in this reservation history, I want to, ah, to appear the history organized in a calendar. Then, it would be interesting.” (lines 258-262)

This could be an instance of opportunistic behavior by P1. Guindon (1990) classifies as opportunistic behavior the unexpected shifts of focus throughout the design activity. For instance, the designer can discover new requirements as he is working on one problem. He can also recognize a solution for a different part of the problem he is working on.

The observed behavior can be viewed as corresponding to the following metacommunication message fragment:

“You can use the cases to help you reflect about the issue you are dealing at the moment or other issues you need to solve to complete your design.” (P1.1)

The reservation place item was the one of the most time-consuming items for P1.

Figure 12 shows part of P1’s table related to the reservation place item.

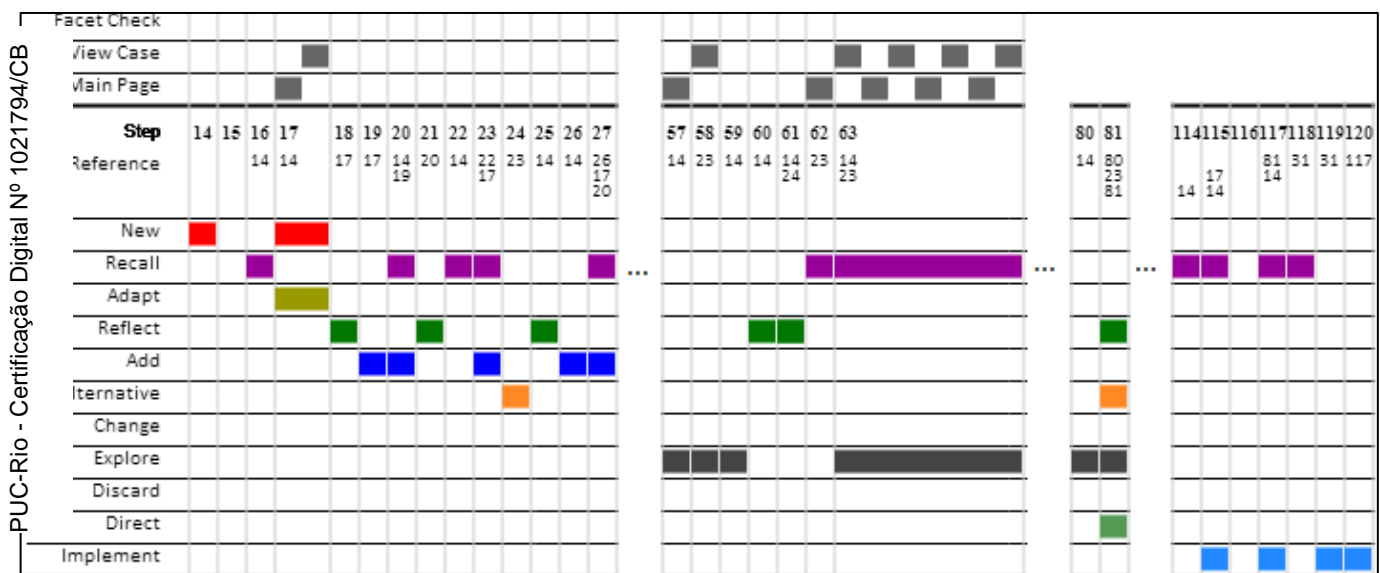


Figure 12: Part of P1’s table related to the reservation place item

At step 17, he came up with a solution based on Ingresso.com (event ticket purchase system) case he saw during the warm-up session: a drop-down list with a list of all stations).

“(…) I could do it like the… I had even looked here before starting the… using the system [starting the activity]. On ticket search [case], the person chooses the district and the theater. I could add something like it here. I could add a combo box [drop-down list] with the places, the stations for the person to choose.” (lines 45-50)

“You can use parts of the cases’ solutions in your design.” (P1.2)

At steps 23 and 24, he considers a map and a GPS solution based on the scenario specification that says that the user might not know the location of the bike stations. These solutions did not seem to have any relation with the cases seen in CHIDeK. At step 80, he stumbles upon another solution for the item while looking at Unidas (car rental system) case.

“If the user doesn’t know where the agency is located, he could see a map clicking here [reading a note on a case image]. Look! This is pretty cool! The map from “know how to get there”. It’s not simply what he asked [points to the scenario]. (...) Let me see. But this is interesting, the “know how to get there”. (*lines 367-372*)

At steps 57, 58 and 59, P1 explored CHIDeK to find cases that could help solve the reservation place item. Although this did not yield a solution for the item, looking at one of the cases made him reflect on the item. After that, he decided that to use a map to solve the item.

“The TAM [system], it helps me choose the airport, I remember. Let me see here [click the case “Search Tickets – TAM”]. It helps me, when I click here in the edit box [text box], he autocompletes for me, giving me suggestions of similar names. But it forces me to have some knowledge. Let me see again this part, because it intrigues me [goes back to the scenario]. (...) Well, some info he [the user] will have to give, even if it is the GPS signal so that he can know what’s close. Not all computers have GPS nowadays. Hmmm. Then, how is it going to find something near [goes to CHIDeK’s main page]. I want a map, I want an interface with a map, that’s what I want. I want to find something with map, not TAM.” (*lines 188-206*)

At steps 62 and 63, P1 also explored CHIDeK looking at a few different cases. However, this exploration did not seem to have an impact on the reservation place item.

At step 115, he decided to add the drop-down list solution he considered at first to his proposal. He decided for this solution because he also saw it being used in the Unidas case.

“Ok. Then the parson is here and he will choose in a combo box [drop-down list]. Exactly how it’s like at the site [Unidas website], like I thought before.” (*lines 613-614*)

“Cases can also help you be sure whether a solution you have in mind is appropriate to solve the problem.” (P1.3)

He also added a map to his proposal based on the Unidas case.

“I could put this address and the map to help the person [like in Unidas’s case]. Trying to address to the requirement that was written in the scenario of helping the person to find himself or to reach the place.” (lines 625-628)

P1 did not have much trouble coming up with solutions for the *delivery time* and *delivery place* items. He did not seem to consult CHIDeK looking for cases for the delivery time items. The solution he proposed for the delivery place was the same one he used for the reservation place item (drop-down list and a map).

The procedure item was also time-consuming for P1. Figure 13 shows part of P1’s table related to this item.

Figure 13: Part of P1's table related to the procedure item

Step 78, where the tool is present, was important for P1’s proposal, because it was when he first stumbled upon the idea of separating the reservation process in three steps. Step 79 shows that he approves the three-step process idea because it would be easier for the user to understand the process itself. He also decided to read the case in detail to understand it more.

“Oh, interesting. It’s like a... a small wizard for you to go step by step. Let’s take a look at the details here, let me see [scrolls through the case]. Ah, I see, he separated it in three parts. Ah, cool! This is pretty interesting to have on the interface. So that it can be clear to the person. Look, first you have to select the reservation type that you want, for example. Then... or not. Sometimes, it can be the last step, the reservation



type. Ok, then after the person decides... ah... the place to take out the bike. Let's go, I'll have to read the parts to in yellow [the notes in the images] to help me." (*lines 356-365*)

P1 found the Ibis case (online hotel room reservation system) at step 90. Although the reservation is also made in three steps, the steps are shown in separate pages, unlike in Unidas case, where the whole reservation process takes place in one page. P1 stated his disapproval to this new idea, saying he preferred the other one.

"Here, he uses a step by step, with a wizard style, that you keep pressing next [the next button, to go to the next step]. He says in which step of the reservation you are, of the purchase. Reservation confirmation. I like the other style more [clicks on the Unidas tab]. I like more this Unidas car rent, where I have the steps on the same screen." (*lines 434-440*)

Steps 98 and 99 show that, in the end, P1 decided to combine the cases he saw at steps 79 (Unidas case) and 90 (Ibis case).

"I can mix both things. This [Unidas case] with the Ibis reservation [Ibis case], because the Ibis reservation has something I found... that I liked, which is the fact that he makes it clear each step. This on Unidas doesn't make it clear. He calls them first step, second step, third step. Now, he doesn't say what the first step, the second step and the third step are." (*lines 515-523*)

"CHIDeK has many cases, which help you analyze tradeoffs or create new solutions by combining previous ones." (P1.4)

While trying to solve this item, P1 had trouble figuring out some of the case's images. The images illustrate Unidas's car reservation process, which is displayed on a single page. The participant had the correct interpretation, but at step 91, he was not sure whether it was the case. He explored the case trying to figure out the process. However, he felt the case was not enough to clarify his doubt, so he asked the researcher whether he could visit Unidas's site. The researcher allowed him to do so. Step 92 describes the moment he understood the process when he saw the system and started exploring it.

"[on Unidas site] Aaah! Now I see how it is. Let's see [goes back to Unidas case on CHIDeK] (...) According to CHIDeK, I can go back to any step I want [goes back to Unidas site and starts filling some fields on the first step of the reservation]. (...) I will put here, to test, I'll put Rio de Janeiro [he is filling out some fields]. (...) I'm still on the first step." (*lines 481-490*)

During step 94, P1 reiterated his understanding of the reservation process after looking at the website. He said that, although it was just like he thought it was after reading the case description, he was only certain after looking at the website itself.

“This is what it meant with everything being on the same screen. Indeed, it’s like I imagined, but I was not sure in CHIDeK, that everything is on the same screen. You keep scrolling. Now, how does this car [a car near the wizard steps list] work? It’s as I fill out the fields, the way I understand it.” (*lines 495-498*)

“The description of the cases is not meant to help you understand the interaction of the systems described in the solution.” (P1.5)

Step 97 shows P1’s view on the website’s and the case’s importance in understanding Unidas’s car reservation process. According to him, although the case was not enough to help him understand whether the process was separated in pages or not, it provided a summary that gave him an idea whether the solution as a whole could have been useful or not.

“[goes to CHIDeK] It’s what CHIDeK said. If I hadn’t read here on the solution, the person does not know that the website has this kind of behavior. I can’t skip this information that the system [CHIDeK] gives me. Because just looking at the picture [the case image], obviously I won’t know without interacting. But this solution summary [the small text at the beginning of the solution section of the case]... it helps me know that it [Unidas’s website] has this interesting behavior.” (*lines 509-514*)

“Cases provide a small summary of the solution to give you a general idea of how the system’s designer decided to address the user’s needs. You should use this information to decide whether the solution can be useful to solve your problem or not.” (P1.6)

### 5.5.1.2. Post-Activity Interview

P1 did not pay much attention to the evaluation section of the case. During the activity, he compared a case that was badly evaluated with his draft. When questioned about this, he said that, at first, it was good to know that both solutions were similar, but it was “scary” to realize that the solution in the case had had a bad evaluation. This reinforces fragment P1.3.

“Fortunately, after I copied this part, the agency from the other one [Unidas case]... but, yeah, it scares a little (...) knowing that there are so many criticisms \*laughs\*. But, yeah, my first impression was that it was good to know that there was a similar solution.” (*lines 164-169*)

P1 did not read the evaluation section of the cases, because there was too much text there.

“Too much text. I confess that, despite Reading stuff the whole day, researching on the internet... aah, when you speak about interface, I think about looking at the interface straight away, I didn’t think about reading stuff a lot...” (*lines 184-187*)

P1 liked the way case solutions were represented. According to him, the use of images makes it easier and quicker to have an idea of what can be interesting or not.

“the simple fact of having the screenshot already helps a lot. We see images much more quickly, at least I think the human, he looks at an image and already has an idea of what he wants and what he doesn’t want. And it’s quick, it’s easy for me to... to access things that already exist and see more or less where do I want to look for more details, which path to follow...” (*lines 362-367*)

“The solution section of the cases make heavy use of images to help you quickly grasp the idea of the solution implemented by the system designer.” (P1.7)

However, he said that the notes on the images got in the way.

“many images gives better detail of the interface, these small yellow things, the balloons [the notes], they help understand... although I get... when I look [at the image], I want to look more at the screen and not for the yellow balloons.” (*lines 441-444*)

He said that he ignored many of the notes on the images because the images themselves were enough for him to understand the solution.

“No, I ignored many (...) because... I liked doing stuff by myself. I mean, with the image showing the interface and some things being common [common elements on the interfaces shown by the images]. Then, I skipped some of those notes.” (*lines 135-139*)

P1 did not use either the tags or keyword search. During the interview, he said that he could have a general idea of the case base contents scrolling through the page since, according to him, 30 cases were not too many. However, the case titles played an important role in finding interesting cases.

“I saw it had... that each case in the case list, they have the verb in front, I thought it was to help me to... what I’m searching, what I need. It’s a search, it’s a purchase, it’s a reservation. Then, when I saw the reserve, I said “wow, I think I need to stay around here”. I think it helped me in that sense. I don’t know if it was bad, but I think it helped me in that sense.” *(lines 96-101)*

The thumbnails on the case list helped P1 have an idea of what he would find in the case.

“It helps me to know more or less what I would find in there [in the case]. For example, the Google Maps one has a small map, so it called my attention, the calendar one, I can see some sort of calendar, it looks like an Excel worksheet, so I said ‘hmmm, interesting’.” *(lines 555-558)*

“To find cases, you can use the tags on the left side. However, you can also browse the case list on the right side. To help you identify interesting cases, we titled them with names that gave a general idea of the problem they deal with. Furthermore, the case list shows a thumbnail picturing an example of what you will find in the case.” (P1.7)

P1 also said that both the case title and the images in the description helped him decide which cases and which parts of the cases he should have paid more (or less) attention to.

“Because it was one time that called my attention, I liked it. Because, since it was about reservation... the ones about reservation, I don’t know if I read them all, but... I did [read all of them]. (...) I read the ones that interested me, which were the ones about reservation, because I thought it had a lot to do [with what he was doing]. I started focusing more there [on the cases about reservation]. I guess that I laid my eye on the image and when I thought it [the case] was interesting, I started Reading more.” *(lines 121-126)*

“The solution section of the cases make heavy use of images to help you quickly grasp the idea of the solution implemented by the system designer.” (P1.8)

P1 reinforced the importance of visiting Unidas's website during the interview. He said that, thanks to it, he could be sure that the entire reservation process was displayed in one page. Additionally, he saw that the car icon on the top left side of the screen moved according to the current reservation step. This reinforces fragment P1.5.

“Well, it helped me to see the scroll, to be sure that everything was on only one page, ahh, it helped me check that car [a car image next to the wizard steps], showing the steps that he is at, which way it [the system] updates the car, and I understood that, at the while I fill out the fields, the car walks by itself over there.” *(lines 240-243)*

However, he liked the fact that, before the images describing the solution, the case offered a short text describing the general idea. It was after reading this text that P1 became interested in Unidas's solution. This reinforces fragment P1.6.

“Look... the solution, I liked reading this [the small text description about the solution], because in general, it's small and straight to the point. It talks exactly about... a special thing about that solution, an interesting feature, which was the case of, for example, Unidas, which is pretty small the solution [the text description] and it makes it clear.” *(lines 371-375)*

P1 said that using CHIDeK helped him have better ideas to add to his proposal and to discard bad ideas. The tool also gave him confidence on his proposal by showing cases with similar solutions. According to him, if it were not for CHIDeK, he would not have seen many of the examples he did, such as Unidas's system. This statement reinforces fragments P1.1, P1.2, and P1.3.

“Like, for example, this step by step thing... I wouldn't necessarily have put the step by step, which I think it's an interesting thing... ahh, these ideas of putting a “know how to get here” is interesting too, it's an idea that I wouldn't have had, I didn't think about that matter... I was thinking about some crazy things, like GPS, or showing a map on the same screen, which also isn't good, it's make it polluted. I had to see something that exists and Works... a solution. Aah, and I also guess that looking at the website gives more confidence to my solution. Knowing that I'm not doing something that is so absurd and that, maybe, more people are used to use.” *(lines 472-481)*

“I would have to remember these websites... websites that I already knew that had something like it. I probably wouldn't see many cases, I'd see a few cases, I'd go, for example, to Ingresso.com, I'd go to an airplane thing [airplane ticket website], I'd go to Google Maps, maybe Apontador [a system which allows the user to find places such as restaurants and hotel] and I would end up not seeing many examples... I wouldn't

have seen this Unidas thing, this Localiza thing, I wouldn't have thought about car rent. And I wouldn't have seen these examples." (*lines 537-542*)

P1 did not understand the action type tags. We have here an explicit breakdown in the communication between us, CHIDeK designers, and P1.

"I didn't understand some things... action types... there could be something to put the... a tooltip, to put the mouse on, to say what is each action type, for example. Analyze, search, choose, insert... for example, I can remove... that's weird. Why is that? I can remove something? Remove is... remove... up to now, I didn't understand, but it's okay." (*lines 491-496*)

## 5.5.2. P2

### 5.5.2.1. Activity

P2 had trouble thinking aloud. He had to be constantly probed by the researcher to speak. Therefore, as a result, most of his speech was either retrospective or vague. He also finished his activity without delivering an interface proposal, but only a few sketches and notes regarding his rationale. Therefore, the code "implement" was not used, because we could not be certain which parts of his rationale would actually be used in a final proposal.

P2 only resorted to CHIDeK once when solving the reservation type item. He wanted to filter cases using the "choose" tag. However, this did not yield desirable results. P2 also had a pessimistic opinion before filtering the cases, because he thought the action type tags lacked a relation with a domain.

"I'm taking a look at the menu to see if there's anything that can be interesting, but... [clicks on the "choose" tag]. Yeah, I'll click here on "choose", but I'm not very optimistic, because I think that the domain is too loose..." (*lines 96-99*)

"Tags are domain independent. Therefore, to effectively use of them, you must consider more generic aspects of the problem or solution you want to explore."  
(P2.1)

P2 resorted to CHIDeK mostly when trying to solve the reservation place item. Figure 14 shows part of the P2's table regarding the reservation place item.



trajectory. He would usually think about a “trajectory between the station where the user would get the bike and the station where the user would deliver the bike.”

He did not refer to CHIDeK in order to solve the procedure item.

### 5.5.2.2. Post-Activity Interview

P2 did not find CHIDeK very helpful to solve the reservation type item, because he had difficulties to formulate a query to find useful cases. At one time, when he was thinking about the reservation type item, he used the “choose” tag. However, when he saw the results, he was not assured that any of them would be helpful and decided to follow his own experience to solve the item.

“I guess I couldn’t make up more queries that I would like, that I would think would be useful for it, like... there was a time that I even thought, while I was philosophizing about the matter of the radio button and the box to... choosing between the standard radio button and pick a plan, those two examples I had in mind. Ah, I thought about using CHIDeK, like, filtering by choice, by the action type “choose”... but, for some reason, I thought... I don’t know exactly why, but I thought ah, no, this is a bunch of things that are not exactly what I want. Then, I gave up and started thinking about anything I had seen” (*lines 4-12*)

At first, the “choose” tag seemed like a good choice, but then he thought “choose” was too abstract, since it is not associated with a domain. When P2 checked it, CHIDeK returned many results that, in his opinion, had nothing to do with what he was searching for. And since he could not find a way to refine the results, he lost confidence that he could find something helpful. Both this and the previous statements reinforce fragment P2.1.

“Choose is too vague in my head, you know? Then, I won’t... at the first time I was testing the system, that I selected that action type and I saw the results that were returned, like, I don’t know... you know? There was search, and search hotel, and search food at the market, search... there were a bunch of things, you know? And I thought I wouldn’t be able to filter enough from the ‘choose’, which was the verb I was looking, got it?” (*lines 27-33*)

According to him, to solve the item mentioned above, he needed a very specific query, but he could not explain what it was.

“I think I couldn’t be specific... I had the impression that I needed a very specific query to find something on CHIDeK,” (*lines 14-16*)



“Ah, I don’t know, I don’t know if I could formulate like this, at this moment... I don’t know if I could formulate exactly the query that I needed to make. The fact was that I had the impression that I wouldn’t be able to explain the kind of thing that I was looking, you know?” (*lines 18-21*)

P2 found it easier to find cases when he had a more concrete need in mind, such as “cases that contain a map”. In other words, P2 had less difficulty in finding cases when he adopted a solution-based strategy. He quickly selected the “map” tag to find them.

“about the maps, I said like, I want to use a map and let’s see how have other people used map for this kind of thing, or if they have used it, or if they haven’t used at all, got it? I don’t know, I felt more confident to make a query based on the widget then on the action type.” (*lines 36-40*)

“If you are adopting a solution-based approach and has a concrete need in mind, the widget and pattern tags can be especially helpful.” (P2.4)

CHIDeK provided some help when dealing with the reservation place item. P2 said, that after seeing two cases, he got the gist of how to organize the map and some input fields for finding stations in the map. However, he had to adapt the solutions saw in the cases for this item.

“I read exactly the whole case and see which were the similar things and the things that weren’t so similar to the TAM case and the bike case [described by the scenario], and so... yeah. Basically see... not exactly how to adapt the solution, but which good things I could take from that solution for the bike case, I guess.” (*lines 59-63*)

“... I don’t know, I guess it was more... basically, it was the Google Maps case too, not only the TAM case, but it’s exactly you being able to see here on the field [the input fields on the panel on the side of the map] the map things and from the map to over here [the panel], got it? In the end, the thing was different (...). So, like, on a high level, this kind of thing can help me, but I have to adapt these things and change these things.” (*lines 65-79*)

“CHIDeK offers many cases from which you can extract a solution and adapt it to solve your problem.” (P2.5)

Although the tool was not needed for P2 to have an initial idea about the solution for the reservation place item, he said that the tool served as a connection between this first idea and how that solution was implemented in other systems.

“Yes, it was a good starting point, I guess. I mean, I don’t know if it was a starting point, because when I looked at the problem I sort of said ‘map!’ The starting point was me saying map. But like, I guess it helped me do something from this starting point, you know? I guess it was a good start, like, what has been done and which were the problems, how these things are done...” (*lines 105-110*)

“The cases can help you visualize how a solution you came up with was implemented in other systems.” (P2.6)

He missed a more abstract representation, because he wanted to focus on the flow of the solution (the interaction) and not on details such as widgets (the interface).

“Yeah, right on the beginning, I said that one thing I missed was that... to be able to navigate better through the solution, you know? The solution at a higher level, I guess. I missed being able to see... because, in some cases... I don’t know if all of them, because I didn’t see many cases, but, in some cases, the solution was a bit lengthy. (...) I was more concerned with the flow exactly than to see how these were in the interface.” (*lines 132-146*)

“CHIDeK’s description of the solution focuses on interface issues and does not mention interaction aspects in detail.” (P2.7)

He also observed that if the activity had been done in a non-controlled environment, he might have done things differently, such as look more into the domain. Consequently, there would be a chance that he might have had ideas about the solution before he looked at CHIDeK.

“maybe in a non-controlled environment, I would have paid more attention to the domain and maybe things would have emerged before the time I went to CHIDeK.” (*lines 164-166*)

P2 avoided reading most of the text. He said he wanted something more interactive, because he would rather see the system for himself than reading a description about it. When asked about why he did not visit any websites during the activity, he answered that he did not know he could do it.

“Yeah, I skipped the... I skipped the problem, I skipped all the text, basically Always. Sometimes, I’m at home and... or I’m at work, whatever, and there’s something I need to do and I say, ah, I’ve seen something like this and I go to the website and I start clicking on the things and seeing what happens and there’s no explanation. I guess I missed something more interactive, like that.” (*lines 189-194*)





To solve the reservation place item, P3 said that, at first, he thought about using something related to address, such as Google Maps. After seeing the Blockbuster case at step 8, he also had the idea of searching addresses by zip code. But in the end, the zip code idea was never mentioned again.

“it ends up me... being influenced by seeing this solution too... this idea of making a search by zip code, because I would have thought first a search more with address than with zip code, like Google Maps.” (*lines 10-13*)

“Cases can help you explore different solutions for the same problem.” (P3.3)

At step 26, P3 mentioned his experience with Google Maps and knowledge about Bike Rio system (a bike reservation system) and decided to use those to develop a map solution for the reservation place item.

“Like, I would think too (...) about putting a solution like Google Maps, embed Google Maps and since I have already gone to Bike Rio, I know that it’s more or less like this how they work (...) So, I would be influenced by this map thing, a solution more like a map.” (*lines 67-71*)

P3 knew CHIDeK had a Google Maps case, so, at step 29, he decided to take a look at it. However, the case was focused on the trajectory search in Google Maps and P3 said that this was not what he was looking for.

“Here since the... I had already seen that there was Google Maps [a Google Maps case in CHIDeK], I will try to get this [goes to CHIDeK case]. Here, there’s only search trajectory... which is not exactly what I wanted.” (*lines 71-74*)

In the end, P3’s solution for the reservation place item was heavily based on his experience with Google Maps, as said before. It included features that were not described in Google Maps case, such as map zoom and a “where am I?” button. The delivery place item solution was similar to this one.

P3 dealt with the delivery time item rather quickly. Figure 17 shows part of P3’s table regarding the delivery time item. At step 79, P3 solved the delivery time item by adding a textbox that the user could fill with the time he intended to deliver his bike. But right after doing it, at step 81, he checked CHIDeK’s Google Calendar case looking for a better solution. He said that he knew that Google Calendar had a way that the user can inform time to the system.

“and I am biased and know that Google Maps... on Google Calendar, you have how to say the time... [types “Google” on CHIDeK search box and clicks on “Set detailed appointment – Google Calendar” case] but I think it is a drop-down, a... [scrolls through the case and finds the field where the user informs time] like a drop-down with 15 to 15 minutes... Maybe I can do something like it.” (lines 157-163)

“Cases can also help you remember how systems you know solve a problem.”  
(P3.4)

Facet Check						
Facet Uncheck						
Keyword						■
Tab Get Focus						
View Case						■
View Main Page						
View Relation						
<b>Step</b>	76	77	78	79	80	81
Reference	3	3	3	78	78	79 81
New						
Recall	■				■	
Reflect		■				
Change			■			
Implement				■		
Explore						■
Alternative						■
Direct						■

Figure 17: Part of P3's table regarding the delivery time item

P3 did not have much trouble to solve the procedure item. Figure 18 shows part of P3's table regarding it.

<b>Step</b>	32	33	34	35	36	37	38	39
Reference	16	15	32	34	32	36	36 34	38
New								
Alternative								
Recall	■	■						
Reflect			■	■				
Implement						■		■
Explore				■				
Add						■	■	
Direct								■

Figure 18: Part of P3's table regarding the procedure item

P3 mentioned a case in CHIDeK regarding this item when he saw some breadcrumbs on the Apontador (online system to find places, such as stores or restaurants) case. He mentioned that, having looked at the breadcrumbs on the case image, he remembered Amazon.com (online store), making him decide on a wizard solution for the procedure item.

“I have a doubt if I do something like... a wizard, with many windows or a form, like... an idea came from the depths of my mind about the Amazon system as an example, like... which is something more step by step, but has the Breadcrumbs. Now, since I’ve just stumbled upon this [points with the mouse to the note which mentions Breadcrumbs on a case image], it pointed out that... Reading this, it seemed like a cool idea which I think it’s positive, so I think it’d be good to have it here, you know? (...) I will consider that I will do a wizard solution.” (lines 79-87)

“Cases can offer solutions that help you remember your own experiences with similar systems *or help you remember about how different systems implement similar solutions.*”

### 5.5.3.2. Post-Activity Interview

P3 did not use CHIDeK while he was thinking about the optional fields (bike delivery time and place), because he did not know how to look for cases that dealt with optional fields, which he called “very specific”. During the interview, he tried a few words, such as “optional”, but quickly gave up.

“what I want is something about optional... (...) No, I guess because I wasn’t being able to formulate my doubt well... this thing about the... ah, how to make an optional step. But for me, it was a thing so optional, it was a problem so specific, that I think I didn’t (???) and, for example... even now, having this idea, this thing... oh, I’ll make a search, but I wouldn’t know which search term should I use.” (lines 37-44)

“You can only search for cases using make broad queries.” (P3.5)

P3 suggested that cases had relations at a more specific level. For example, CHIDeK could compare different solutions for selecting time.

“one thing that could be pondered is this thing about you having links on the level of the notes [links to other cases at the level of the notes in the case images]. You could have something here like, ah, he uses a text box as a drop-down, see how in other solutions, other solutions for this problem. So, it wouldn’t be about the solutions, the thing... something more specific. I don’t know if this makes sense or not.” (lines 66-70)

The cases helped P3 remember other systems he used before and they were important in building his proposal. The breadcrumbs shown in the Apontador case reminded him of how the shopping process is organized in Amazon. Also, the Blockbuster case reminded him of Netmovies. This reinforces fragment P3.1.

“I think that like, more than once, it [CHIDeK’s cases] influenced on what I did. (...) This think about the Breadcrumbs would have been ignored if I hadn’t revised. The thing about the table here [to solve the reservation type item], maybe I wouldn’t have made the link to... (...) Blockbuster, which like, also made me remember of Netmovies. But, for me, they are practically equivalents.” *(lines 73-79)*

P3 suggested a rank on the case list to help the designer know what he would see in the case before he saw its details. He also said it would be interesting that the tool displayed a quick description of the main feature of the solution implemented. Otherwise, according to him, it is hard for the designer to know where to start looking if his search returns many results.

“here something that is interesting that could be more clear is the good solution, bad solution... to have some kind of ranking for you... when you are on this screen [the case list], you already know what you’ll find... once in a while, I don’t know, if I put ‘choose’, it shows me 16 cases, but so what? I will have to see one at a time to see... so, if I had some sort of highlight about this solution...” *(lines 125-129)*

“So, here I miss having a way to compare these results, some way to have that ranking. I guess I already miss a way of guiding myself of where should I start. Here, I’d guess that there should be something like an alphabetic order” *(lines 181-184)*

P3 complained about the fact that the case evaluation is described at the bottom of the case. He said it would be more useful if the evaluation is embedded in the description of the solution. For each part of the solution, there would be an evaluation.

“One thing that, like, to me it was a little out of place was this evaluation at the end. For me, it would make more sense, since it is something more step by step, to have some sort of comment while you read [the solution text and notes] and not waiting for everything to happen and only at the end to have an evaluation.” *(lines 145-148)*

“I guess that I only missed this analytic thing while you are reading [the case].” *(lines 164-165)*



P3 acknowledged CHIDeK's role as a case repository and its influence in changing solutions he conceived before looking at it. He gave an example of when he was reading about the reservation type item in the scenario, he thought about using a drop-down list. After looking at the Blockbuster case, he was reminded of his experience with Netmovies and this gave him the idea to adapt its table to select DVD rental plans for his solution. Since P3 stated that the cases from CHIDeK impacted his design in different ways, this reinforces fragments P3.1, P3.3, and P3.4.

“I thought the tool acted like a repository. And it was what I said before, this, I had already seen on Blockbuster website, I had already seen on Netmovies website and reading this [the scenario], I imagined a drop-down, but because I had seen this repository, I felt that I was influenced. And, to me, it was something like, ah... for me, that information that the table was very fitting, because I have to compare many plans, so I judged that the solution was good and wanted to use it too, you know?”  
(*lines 152-158*)

#### **5.5.4. P4**

##### **5.5.4.1. Activity**

P4 viewed the system described in the scenario as an online store, as in you had to buy a bike reservation online. He said the he has a lot of experience with online stores and this could be the reason why he was one of the participants who used CHIDeK the least. With the exception of the procedure item, P4 solved all the items using his own knowledge.

CHIDeK seemed to be useful only when P4 was solving the procedure item. Figure 19 shows part of P4's table regarding it. He spent most of the time describing what he was seeing in the cases while browsing CHIDeK. He only stopped a few times to give a brief evaluation of what he had seen up to that moment, such as at steps 5, 9, 13 and 15. He picked three cases related to online airplane ticket and the Blockbuster case. During this exploration, he noticed a pattern in the order of the purchase options in the airplane tickets systems and used a similar order in his proposal.

“But it seems like... it seems that this paradigm [interaction sequence: select flight, personal data, payment, confirmation], this sequence is always followed.” (*lines 19-20*)

“And here, inspired... inspired in this paradigm, it needs a sequence thing here, I'll add it here” (*lines 60-61*)

“You can use multiple cases, compare their solutions and identify a pattern of how different systems solved the same problem.” (P4.1)

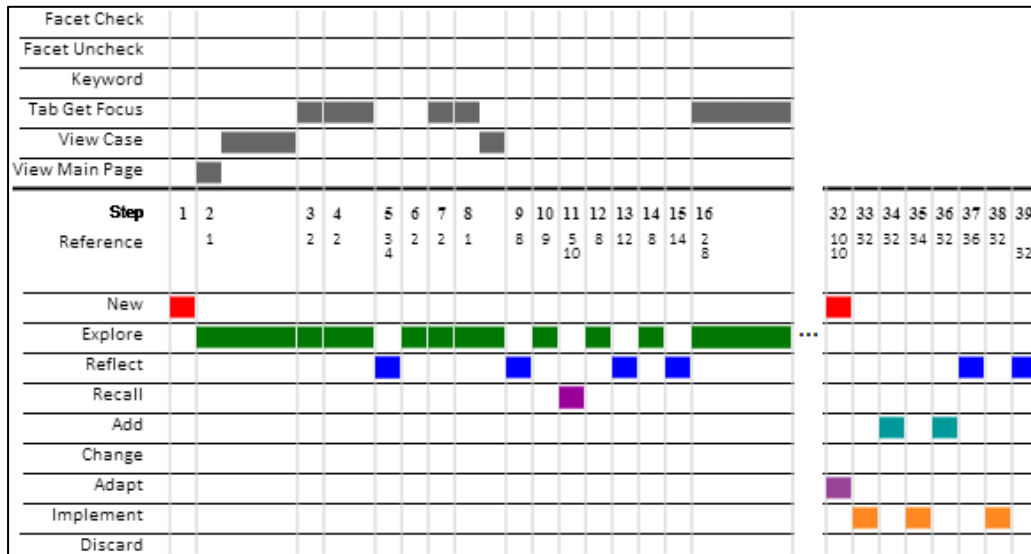


Figure 19: Part of P4's table regarding the procedure item

#### 5.5.4.2. Post-Activity Interview

P4 began the interview saying that he intended to start off with his own idea, but after remembering that he had a system with design examples available, he changed his mind and decided to take a look at it.

“Yeah, actually, when we are given a system like this [referring to CHIDeK], when a system is present, at least to me, the tendency is to take a look at it. I already had the idea, I started making it [the proposal], but I said, hmm, there are cases that work. And more, the system... even the cases that are not so good, someone has added them [to the library], made his evaluation and stuff. So I thought, like, why not give it a look?” (lines 5-9)

P4 said that, since he had never designed an online store, the cases helped him to quickly remember some details, such as the wizard steps, which, otherwise, he might have taken a while to consider.

“I started with an idea more or less mine, but actually in some details like the menu... I won't say I'd forget, but I wouldn't remember it as quickly if I hadn't seen, like, four cases about purchase that has the menu, this one with the steps [the wizard steps]. It's not like I'd forget it, but since I never... in my work, I've never made a purchase system, maybe I'd take little longer to remember it. Then, in this case, using the

system as a support was good, because these are solutions that work. They are websites widely used. There's even an evaluation and it helped me." (*lines 9-17*)

"Cases help you remember interface details more quickly." (P4.2)

P4 viewed the cases in a different way than the previous participants. Since he already knew about the domain (online airplane ticket purchase), he scrolled through the cases, quickly looking at the pictures as he passed by them. He said that, if the scenario was something he was less familiar with, he would have viewed the cases more thoroughly.

"Yeah, doing a quick scroll, I can get this thing [the idea]. Because it's not a domain that is very far from me, for example. If it was any domain far from me and I had a case repository on that domain, I would make a more detail analysis about the workings of that domain. But in this domain that is more close to me, I only got a few ideas, based already on my experience, on my knowledge and connected them and reading them [the cases], basically." (*lines 25-30*)

However, the evaluation section of the cases motivated him to go back to the pictures and inspect them with more attention.

"And the evaluation [the evaluation section in the case] get to the evaluation the evaluation of a case], made me get things in the evaluation and go back there to the case images]." (*lines 31-33*)

P4 liked the way the cases were displayed. Since he wanted to look at them quickly, the balloons with notes pointing to specific parts of the images guided him to pay attention to parts he found important. He also liked the possibility of commenting cases.

"I really liked the... everything is guided, everything is well explained. Yeah, this helped me a lot, because since I went by very quickly, I was looking at the stuff really... focused on what was being pointed at. Because, if it's being pointed at, I consider it important. I liked that it was separated in problem, solution, evaluation and comments. These comments surprised me, I didn't imagine that there would be someone else's evaluation." (*lines 89-96*)

He said that images are a good way to visualize the systems. Although he did not feel the need to watch videos, he claimed that the possibility of embedding videos in cases can be helpful.

“Ah, I guess that like, screenshots are the best way to see, really. Who knows one day we can see videos, but... it’s not something I searched for.” (*lines 119-121*)

“The images in the case help you see how the systems were implemented and its notes can guide you to the important parts of the solution.” (P4.3)

P4 showed concern about the quality of the case evaluations by suggesting that they should also have some sort of meta-evaluation.

“Now, maybe, on the future, it might need a... an evaluation of the evaluation, I don’t know. But, I trust that the evaluation is done by someone who is good at it [evaluating].” (*lines 96-98*)

P4 did not read the problem section of the case, because, since he already knew the domain, the case title was enough for him to understand the problem it deals with.

“[When answering why he didn’t read the problem section] because I already the title, you know? TAM’s or Azul’s buy tickets. Indeed, I didn’t read the problem part, but... (...) On a domain I know, it is [the case title is enough]. Buying tickets is something trivial.” (*lines 108-110*)

“If you do not know the domain the case deals with, you can read the problem section to have a better understanding.” (P4.4)

Both the case title and the thumbnail helped him grasp the idea of a case before looking at the details.

“The title and this page [the case list]... these small screens [thumbnails] really helped me [finding an interesting case].” (*line 181*)

“The case title and the thumbnail can help find an interesting case more quickly.” (P4.5)

P4 used the tags during the warm up session, but not during the activity. He justified it saying that he did not need to filter the cases, because the tool had only 30 cases and all of them were displayed on the main page, which made it easier for him to know what could be interesting just by browsing the list. He prefers a case list with thumbnails, like the ones in CHIDeK, to a chunk of text.

“it’s hard to say, because there are only 30 and it’s all on the first page, but like, thinking on 300 or something... (...) Yeah, 30 [cases], you can look without needing it [the tags or search box] and stuff.” (lines 173-177)

“The small pictures [thumbnails] also helped me, I liked them. Much better than just text, text, text.” (lines 185-186)

P4 complained that there was no explicit relation between the tags and the case content. For example, when he was exploring the tool during the warm up session, he selected a case with a to-the-top-link tag, but the case description did not mention a to-the-top-link.

“when I was exploring [during the warm up session], I clicked on this ‘to-the-top link’ [tag] and, like, it wasn’t... they are screens that have a to-the-top link, but I didn’t see any balloon [note] coming out. Maybe that can be reviewed.” (lines 170-172)

### 5.5.5. P5

#### 5.5.5.1. Activity

P5 made two proposals. The first one was discarded after he concluded that it was too messy to be shown to a client. The second proposal was made with some adaptations to the first one.

Also, P5 only looked at the first part of the cases. He never scrolled down and saw only up to the first image of the case solution.

P5 was the participant who used the action type tags most often. He associated the action type tags with the tasks the bike user system had to do. For instance, the user had to *choose* a reservation type, the user had to *inform* the station he wanted to reserve the bike at and the user had to *distinguish* from among the reservation types.

Figure 20 shows part of P5’s table regarding the reservation type item. It shows the steps for the first proposal (up to step 25) and for the second proposal (steps 46, 47, 48, and 49).



At step 5, while looking at Google Maps case, P5 said that it would be good to use a map to show the bike stations and the number of bikes available on each of them. At step 20, P5 added that solution to his first proposal. On the second proposal, P5 adapted his solution considering the case with more than one bike with the same distance from the user.

“Yeah, I thought the... part of the information cool... when I inform my location, it’s good to see it on a map and have the stations shown on Google Maps and then I can see.” (lines 60-62)

“I’m doing it a little different, because I thought about something else. For instance, if I have two stations that are within the same distance, when one has a bike and the other has two, the system will obviously want to reserve [the bike] where there are two bikes and not one. But if this one with two bikes is a bit further [than the other station with one bike], what will the system do, which will it offer? I’ll have the offer the closer station... it wants to help the user, doesn’t it?” (lines 155-161)

Figure 22 shows part of P5’s table regarding the delivery time protocol in the second proposal.

Step	78	79	80	81	82	83	84	85	86
Reference	35 76	78	79 72	80				80	85
New									
Add									
Implement									
Recall									
Reflect									
Explore									
Change									

Figure 22: Part of P5's protocol regarding the delivery time item

For his first proposal, P5 conceived a simple textbox solution for the delivery time item. But, while he was working on the second proposal, P5 looked at the “autocomplete” tag in CHIDEK and he had the idea of the system trying to estimate the time the user would deliver his bike.

“Aaah, look at the ‘autocomplete’ [click on the autocomplete tag]. It can even... look, it can inform not only the delivery time, but since the system... he can inform the time he’ll get the bike and he can calculate more or less the delivery time so that he [the user] can accept it or not.” (*lines 216-220*)

P5 added a rule to the delivery time solution that states that the system will consider a 30 minutes window around the time the user said he would deliver the bike.

“then it also warns that this time is not super precise, that he can arrive 15 minutes early or 15 minutes later, after the bike is reserved” (*lines 154-156*)

P5 did not use CHIDeK while dealing with the delivery place or procedure items.

### 5.5.5.2. Post-Activity Interview

Many of the ideas P5 had during the activity or during the interview came from his own experiences. However, he said that just looking at the cases in CHIDeK and seeing that CHIDeK contains cases from certain domains, it triggers his memories about experiences with systems from that domain.

“No, I remembered it. I saw it and then I remembered how I can make a ticket reservation for multiple destinations. (...) But, I think that only laying the eyes [on a case] and seeing... like the ticket purchase website, you can associate something similar to this.” (*lines 29-33*)

“Cases can help you can help you remember about your own experiences with similar systems.” (P5.2)

P5 never looked at the whole case, because there was too much text and he did not realize he could scroll down. He quickly read the problem section and looked at the first image and read its notes. He said that with this, he grasped the general idea of the case.

“Ah, because there was too much text. I was looking only at the images. (...) I looked at the text and grasped the idea only on the first screen.” (*lines 44-46*)

“No, I didn’t see the scroll, actually. But I started seeing that there was too much text, then I started reading the balloons [notes].” (*lines 56-57*)



P5 said that he wanted to use CHIDeK to support the discussion about his proposal with a client. The tool was going to be used to explain the details about his solution.

“actually, there’s a screen missing there [on the first proposal], but I... I thought that I could show [CHIDeK cases]... look, here there will be... the first screen will be similar to this one with the map [on one of CHIDeK cases] and what you’ll show... I would go to the screen and say, look, it’s similar to this, it would be an option similar to this one.” *(lines 63-72)*

“You can use cases to help discussing ideas with other people.” (P5.3)

He used an adapted solution based on the Google Maps case to develop his solution about the reservation place item.

“I changed it, you can see that I didn’t put, I did not do the “how to get here”, which i show it [Google Maps] did there, can’t you? I am showing, on this part of the screen, I put the available stations” *(lines 86-88)*

P5 had trouble understanding the numbers located next to the tags in the CHIDeK main page.

“I didn’t understand the number on the side, actually... I took a while to understand what the system was saying. Because, what I chose the ‘choose’ [tag], other than it filtering here [the case list], it filtered the action types that I could choose” *(lines 114-117)*

P5 gave preference to the action type tags, because he wanted to see how other systems translated those actions into interface solutions. He did not use the widget or UI pattern tags much, because he was confident that his knowledge was enough.

“I wanted to see if there was another action I would need, to consult there, to put on the system. Then, after, only after I looked at the screen that I saw that there was more stuff about... that there weren’t only action types... I had seen this widget part, this I had seem, but I said, ah, I don’t need this, I know what each thing is, I need to consult the actions, how each action is being done, you know? Now, the widgets with those names, I said, ah, I don’t need to know, I don’t need to remember this, this I know by heart. Then, after the patterns [after that there were UI pattern tags], I started looking to see if there were anything that interested me. Then, I thought about the wizard [the proposal], because, actually, this is a wizard, you have one thing at a time, you’ll select one thing after the other... but I didn’t need to consult. (...) Because I had already done it [the wizard].” *(lines 124-138)*

“If you are a novice designer, you can use tags dealing with concrete aspects of interface, such as widget and UI pattern tags. Otherwise, you can use the action type tags and see how other designers created solutions based on the actions users wanted to perform.” (P5.4)

P5 also explained why the “autocomplete” tag made him figure out a solution for the delivery time item. The reason is that he concluded that the action “autocomplete” was what the system was supposed to do help the user inform a time. The system would calculate a time according to the current time when the user is interacting with it.

“because like, to put the date, you have the calendar. So, how am I going to put a time. Then, I was thinking about being easy for the user, because it needs to be precise and such... there are seconds, minutes... what will I let him complete there? Then, I thought that the system would already autocomplete... okay, it’s not autocomplete, but it was... like, I looked at it, it gave me the idea of putting... suggest the time and after he changes it, because he sees the time format he needs to type. (...) Like, here he would be using the internet and it’s 10:00 in the morning. I offered him 10:10, because you have to get [the bike] at 10:10 and there’s an OK button. OK, or something. OK, confirm, something like it.” *(lines 144-154)*

P5 said that what he liked most about the cases is that they helped him “not to think too much”. Since he had a repository of examples, he did not need to try to remember nor to browse the internet looking for similar systems.

“I didn’t need to... I didn’t need to think too much. There are cases there, I don’t need to think on the Internet, like, let me get in here and let me see... it’s already there, it suggests me, you know? While if I were browsing the internet, then I should have to search and remember something similar. I was clicking [on CHIDeK] and I didn’t need to [remember other systems].” *(lines 173-177)*

“CHIDeK’s case library concentrates designs from several systems, which helps you find previous knowledge without spending too much time searching the web.” (P5.5)

P5 complained that there was no way to filter the cases by problem.

“you’re here, you have a problem. Why didn’t we filter by problem or by something more... not by the action type, but by the problem (...) Instead of it [the problem] being as a text [in the case description], this could be like another filter.” *(lines 185-188)*

P5 said that, although he is not used to working with a repository, he thought it was helpful, because it helps him organize his thoughts.

“I’m not used to doing the activity looking at cases. Actually, the way I work is much more about what I know or... (...) I never worked like this, but I thought it was good, I thought it was good to know, to have these cases. Better than... I thought it helps organize our thoughts.” (*lines 243-247*)

He also said that the action type tags made him think about the solution in a more generic way, which is different from what he is used to. This was helpful, because, according to him, thanks to this, he performed the activity quickly.

“Since it has these filters and these action types, it was what I used the most. I stopped to think about action types, you know, that the user would do. Not about screens or... having to abstract his task to turn it into one of those actions. (...) I think exactly on the action that he’ll do and not on a generic action, you know, more high level, like there [on CHIDeK]. It wouldn’t be ‘choose’. It would be to choose between three plans [reservation type] and... and it’s a little different. It’s a little more restricted, you know? (...) I did it [the design activity] much faster, I think... I did the thing in 30 minutes?” (*lines 260-272*)

“The action type tags are generic actions the user can do with a computer system. By being generic, these tags allow you to find interesting cases quickly.” (P5.6)

### 5.5.6. Discussion

Table 4 compares the behavior of the participants of the first stage of the study. We can see the variety of strategies and combination of resources they used to solve the problem. Also, considering the fact that CHIDeK could not fully satisfy some of the participants, we can say that a case library must be diverse enough to support a myriad of strategies to help users to access previous design knowledge.

The first stage of the study showed that CHIDeK was able to fit in the participants’ design activity in different ways. One way was by providing knowledge that can be used during the design activity. For instance, once P1 saw the Unidas case in CHIDeK, he investigated the web system related to it and that gave him ideas that he added to his proposal. P1 was the only one who consulted a web system outside CHIDeK. However, we believe that, if it were not for the study environment, the participants would have visited other systems more often,

especially if links to the websites depicted in the case library were included in the cases themselves.

Table 4: Participants' behavior during the activity of the first stage of the study

	P1	P2	P3	P4	P5
<b>CHIDeK Tags</b>					
Used action type tags		X	X		X
Used widget tags		X			
Used UI pattern tags					X
<b>Other CHIDeK functions</b>					
Used search			X		
Used semantic relations			X		
Browsed the case list (case title + thumbnail)	X			X	
<b>CHIDeK's cases</b>					
Read case problem section					X
Used case title to understand the problem	X			X	
Saw case solution images	X	X	X	X	X
Read balloons	X		X	X	
Read case evaluation section				X	
Mentioned a case	X	X	X	X	X
Compared two cases	X			X	
Compared case with external design solution			X		
Used case knowledge before creating a solution	X	X	X	X	X
Used case knowledge after creating a solution	X		X		X
Used case knowledge directly to solve a problem	X		X		
Adapted case knowledge to solve a problem	X	X	X	X	X
<b>Mentioned an external (previously known) design solution</b>					
Spontaneously		X	X	X	
After having consulted a case			X		
<b>Other</b>					
Recall past experiences after using CHIDeK			X		X
Opportunistic behavior	X				
Difficulty to create specific queries		X	X		
Accessed an external source	X				
Made suggestions about case representation	X	X	X	X	
Made suggestions about a case content		X	X	X	
Made suggestions about tags					X
Made suggestions about tool		X	X		

Another way that the cases supported design was described by P5, who said that even a slight stimulus such as seeing that CHIDeK has a case about a domain can be helpful, because it can trigger the designer's memories about experiences with systems from that domain.

The occurrence of opportunistic behavior during the activity is yet another piece of evidence that CHIDeK fit in the design. For instance, while P1 was looking for cases to solve the reservation place problem, he saw the Google Calendar case and then, he identified a new way to display the user's reservations, solving the reservation history item.

The first stage also hinted that designers are open to experimenting with tools that can help them. For instance, P4 started the design on his own, but after remembering that there was a tool available, he decided to look at it. However the fact that this was a controlled study probably had some weight on this. Still, we cannot say that, if the participants were designing the proposal for real, they would use CHIDeK more or less often.

We have also identified positive and negative results from the use of CHIDeK. For instance, P5 used the action type tags most frequently. He even used the words from the action type tags, such as inform or choose, while doing the think-aloud protocol throughout the activity. In one instance, for the reservation type item, he was looking for a tag called "select", but found "choose" instead, which he thought fitting for the situation. From that moment on, he used the word "choose" for anything related to that item. Although we cannot say that he used that word because of CHIDeK, we can say that the terms used for action type tags were representative of what P5 had in mind.

We observed that CHIDeK's tags were helpful in some situations and not so much in others. As said before, P5 used the action type tags frequently. He would usually look for ways to "inform time" or "choose a reservation type". However, tags were not enough to help some users finding helpful cases. P2 picked the "choose" tag to find interesting cases related to the reservation type item, but the results did not give him the confidence that it would give him an interesting case. P2 said he needed to make a more complex query and did not feel that CHIDeK could help him formulate it. However, he could not explain during the interview what that query was. P3 had the same problem of not knowing what to look for when he had to deal with the optional user input fields described in the scenario. This might mean that, although faceted navigation can be a good tool to explore design options, it may not be enough to help the user in a complex search task. The same can be said about CHIDeK's search mechanism.

The first stage showed that the widget tags are useful in case the designer has a concrete need in mind, adopting a solution-based approach. For instance, P2 at one time wanted to see cases that contained a map, because he already knew that he needed a map to solve the reservation place item. He quickly selected the “map” tag to find them.

The case titles played an important role in helping the designer identify the essence of a case. P1 used the case title to select which of the cases he would see. P4 ignored the problem section of the case, because he felt he understood the case problem just by reading the title, even though the case title contains much less information than the problem description in the case.

We also observed that each participant used cases from different domains. For instance, P1 used a car reservation system (Unidas) and a hotel room reservation system. P2 used an airplane ticket purchase system (TAM). P3 used a DVD rental system. P5 used Google Maps. This indicates that a case library that covers different domains might have a higher chance of being useful to different designers.

When it comes to the case representation used in CHIDeK, the participants’ opinions diverge. For instance, while P1 found the thumbnails on the case list useful, because they gave him an idea of what the case was about, P2 did not. Another example is related to the representation used to describe the case solution. P2 wanted a more abstract representation of the cases, such as a description of the flow of the solution rather than a focus on the interface. On the other hand, P3 seemed more comfortable with a more concrete representation delivered by the images. He even said that the description in CHIDeK should be more specific to each sub-problem and solution. Also, P1, P3 and P5 complained that the cases had too much text. In general, they avoided reading them and tried to capture the gist of the idea by looking at the images and the balloons in the solution.

The evidences described above show that case representation we used is not very helpful if the designer shows a less exploratory behavior, such as P2, who wanted the case descriptions to focus on what he wanted to see. He complained about the fact that, once he selected a case he found after selecting some tags on the case list, he wanted the case description to focus on the tags he chose and not to describe the whole case in detail.

In addition, we realized that the case representation we chose lacks support for dynamic representations, which are important to describe interaction. This was evident while observing P1 who, in order to understand some aspects of the solution described in a CHIDeK case, had to resort to visiting the web system itself. However, this can also mean that case description in CHIDeK does not need to be very detailed, especially when it comes to behavior. If the designer wants a deeper understanding of the solution, he can always visit the system in question, if it is available.

During the analysis, we realized that a case describing HCI design can be seen as the system designer's message about his view of the system to other designers or to himself in another moment. This idea has some similarity to the metacommunication message, which is the designer's message about his view of the system to the user.

We also noticed the presence of static signs (such as the case images), dynamic signs (ways to describe interaction effectively, such as videos) and metalinguistic signs (such as the text in the case, the notes on the images or an evaluation for each case) in the cases. We can say that the case description is a way for the system designer to communicate to other designers about the system's metacommunication and, to do so, he should make use of those signs to effectively convey his message.

This suggests that it is possible that Semiotic Engineering theory can be used to investigate better ways to describe HCI design knowledge in the form of cases. However, it should be noted that a case represents a different context of the system it describes. Not only is it not restricted to the same signification system of the system, but the receiver of the case's message (another designer) is different from the receiver of the metacommunication message (the system user). Still, it may be possible for Semiotic Engineering to help create better cases. However, instead of learning that vision to use the system, the receiver learns it in order to build his own vision about the system he is creating.

### 5.5.7. Metacommunication message discussion

Table 5 summarizes all the metacommunication message fragments we assumed the participants received during the design activity with CHIDeK, as reflected by their verbal statements or by their behavior.

Table 5: Metacommunication message fragments assumed from the participants' design activities

Participant	Message
P1	<p><b>P1.1)</b> You can use the cases to help you reflect about the issue you are dealing at the moment or other issues you need to solve to complete your design.</p> <p><b>P1.2)</b> You can use parts of the cases' solutions in your design.</p> <p><b>P1.3)</b> Cases can also help you be sure whether a solution you have in mind is appropriate to solve the problem.</p> <p><b>P1.4)</b> CHIDeK has many cases, which help you analyze tradeoffs or create new solutions by combining previous ones.</p> <p><b>P1.5)</b> The description of the cases is not meant to help you understand the interaction of the systems described in the solution.</p> <p><b>P1.6)</b> Cases provide a small summary of the solution to give you a general idea of how the system's designer decided to address the user's needs. You should use this information to decide whether the solution can be useful to solve your problem or not.</p> <p><b>P1.7)</b> To find cases, you can use the tags on the left side. However, you can also browse the case list on the right side. To help you identify interesting cases, we titled them with names that gave a general idea of the problem they deal with. Furthermore, the case list shows a thumbnail picturing an example of what you will find in the case.</p> <p><b>P1.8)</b> The solution section of the cases make heavy use of images to help you quickly grasp the idea of the solution implemented by the system designer.</p>



**P2.1)** Tags are domain independent. Therefore, to effectively use of them, you must consider more generic aspects of the problem or solution you want to explore.

**P2.2)** If you already have a solution in mind, you can try using the widget tags to find cases.

**P2.3)** You can use cases to find new solutions and reflect whether they are suitable for your problem.

**P2.4)** If you are adopting a solution-based approach and has a concrete need in mind, the widget and pattern tags can be especially helpful.

**P2.5)** CHIDeK offers many cases from which you can extract a solution and adapt it to solve your problem.

**P2.6)** The cases can help you visualize how a solution you came up with was implemented in other systems.

**P2.7)** CHIDeK's description of the solution focuses on interface issues and does not mention interaction aspects in detail.

**P3.1)** Cases can offer solutions that help you remember your own experiences with similar systems or help you remember about how different systems implement similar solutions.

**P3.2)** You can reuse the solutions described in the case in your design.

**P3.3)** Cases can help you explore different solutions for the same problem.

**P3.4)** Cases can also help you remember how systems you know solve a problem.

**P3.5)** You can only search for cases using make broad queries.

**P4.1)** You can use multiple cases, compare their solutions and identify a pattern of how different systems solved the same problem.

**P4.2)** Cases help you remember interface details more quickly.

**P4.3)** The images in the case help you see how the systems were

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implemented and its notes can guide you to the important parts of the solution.

**P4.4)** If you do not know the domain the case deals with, you can read the problem section to have a better understanding.

**P4.5)** The case title and the thumbnail can help find an interesting case more quickly.

**P5.1)** Images can help you identify solutions that you might want to use in your design.

**P5.2)** Cases can help you can help you remember about your own experiences with similar systems.

**P5.3)** You can use cases to help discussing ideas with other people.

**P5.4)** If you are a novice designer, you can use tags dealing with concrete aspects of interface, such as widget and UI pattern tags.

P5 Otherwise, you can use the action type tags and see how other designers created solutions based on the actions users wanted to perform.

**P5.5)** CHIDeK's case library concentrates designs from several systems, which helps you find previous knowledge without spending too much time searching the web.

**P5.6)** The action type tags are generic actions the user can do with a computer system. By being generic, these tags allow you to find interesting cases quickly.

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We contrasted the fragments we obtained from the study with the metacommunication message we created to help develop CHIDeK (see page 27). With this, we show that, despite having used study participants with different profiles than the interviews participants, there is consistency between how we emitted our message, based on the expert designers' opinions, and how HCI students received it using CHIDeK. Therefore, the results of our research remain valid.

First, we observed that HCI students had some views in common with professional designers about using past design knowledge. We saw during the interviews that designers use previous knowledge as a source of reflection, to reuse solutions or to help communication. Here is part of what we envisioned as their need:

“(...) you turn to examples to find out what competitors are doing, to reuse previous solutions, or to talk about design ideas with other stakeholders.”

This is in line with the messages that the HCI students received using CHIDeK. They used its cases to help reflection (see fragments P1.1, P1.3, P1.4, P2.3, P3.3, and P4.1), to reuse past solutions (see fragments P1.2, P2.5, P3.2, and P5.1) and expressed a wish to use the cases to help communicate with other people (see fragment P5.3).

We have also identified consistency between how we envisioned an appropriate case representation and how the students seemed to understand our choice for that representation.

“(...) you prefer to work with images rather than text.”

In the message students received from us, CHIDeK designers, images were selected to represent solutions because they are easier to understand and quicker to communicate ideas (see fragments P1.7, P1.8, P4.3, P4.5, and P5.1). They seemed to understand that images were used to speed up the identification of interesting cases and the understanding of the idea behind a case. This is in line with our vision that the designer does not have much time to spare using the tool.

“You don’t have much time to spare, so the tool must speed up your progress. Therefore, you don’t want to spend a long time in order to grasp the idea behind a case. In the same way, you don’t want to spend a long time looking for an interesting case.”

The students also received messages from us that made them identify other ways to speed up the design. P1 stated that the small summary at the beginning of the solution section was supposed to help designers decide quickly if the solution is useful or not (fragment P1.6). P4 understood that, by looking at cases, he could remember details from interfaces more quickly (fragment P4.5), while P5 understood that, by providing the action type tags, which, according to him, have a more general nature, we wanted CHIDeK users to find cases quickly.

The students understood our vision regarding the variety of design strategies. Our metacommunication message said:

“Depending on the situation, you can adopt either a problem-based or a solution-based strategy (...) There are tags focusing on the problem you need to solve, such as the action tags, and focusing on the solution you might already have in mind, such as widgets and UI patterns tags.”

P2 realized that, in our vision, widget and UI pattern tags might be more suitable for a solution-based strategy (fragment P2.4), while P5 noted that the action type tags might be more suitable for a problem-based strategy (fragment P5.4).

Fragment P2.7 shows P2’s interpretation of a limitation in the case representation we chose for this study. While, at first, this might seem like a disparity between our metacommunication message and how P2 seemed to receive the message, it actually shows that our initial vision of how the designer works matches what P2 wanted to do (to view cases at a more abstract level). More specifically, in our metacommunication message, we said:

“You are an HCI designer who works with a variety of artifacts, such as wireframes, prototypes and documents, and deals with multiple domains and restrictions. (...) it [a rich text field] gives you freedom to describe your case (...) You can also attach any kind of file to your case”

This shows that we anticipated that the designer might want to see a variety of representations in the cases. However, due to the short time we had to finish our study, we could not work on multiple representations for each case, such as task models or interaction models.

We have also observed an unexpected interpretation of our message. The message received by P1 and P2 stated that they could use cases as a way to attest the quality of solution they had in mind (fragments P1.3, and P2.6). Although this was not expected when we developed our metacommunication message, it does not represent a disagreement; instead, it adds to the original message. This unexpected interpretation introduces a discussion about how a CBR tool can aid novice designers and expert designers. While none of the expert designers mentioned the need for a verification of the applicability of their solution (and, therefore, this was not implied in our initial metacommunication message), two HCI students interpreted that they could use the solution described in cases as a way to test their solution implemented in real systems. A possible reason for this is that seeing the solution they have in mind implemented in an existing system

gave the HCI students confidence that their solution might be appropriate. P1 reinforces this finding during the interview when he said that it was “scary” to see a solution deemed appropriate by him to have a bad evaluation in the case.

These results suggest that a CBR tool might help HCI students (novice HCI designers) learn about HCI design. In fragment P5.4, the participant mentions this point when he said that widget and UI pattern tags might be more appropriate for novice designers, since they might not have much confidence in their knowledge.

## 5.6 Second Stage: the Design Activity without CHIDeK

In this section, we describe the second stage of the study, the design activity without CHIDeK. We wanted to find out how designers accessed and used design knowledge without the presence of a CBR tool.

### 5.6.1. P6

#### 5.6.1.1. Activity

P6 made a reference to the system he works with as a developer when solving the reservation type item. His solution involved choosing the reservation type using radio buttons and there would be an interrogation mark icon with a tooltip next to each reservation types explaining it.

“Make your reservation... there will be 3 radio buttons. Quick reservation, reservation for one trip and reservation for one day [draw the radio buttons with the options]. But, it’s still a little confusing to know this. So, on the side of these sentences, there will be a small interrogation mark, just like the \*\*\*\*\* [system the participant works with as a developer]. Okay, I’ll put an explanation here for the interrogation mark. When the user passes the mouse over it (...), it will show the explanation about how the reservation works [takes note about what he just said].” (*lines 47-54*)

Figure 23 shows a small part of P6’s table regarding the reservation place item. The solution consisted of two alternatives: a map and a drop-down list listing the stations.

Step	39	40	41	42
Reference	2	2	40	40
New				
Implement				
Add				
Recall				
Reflect				
Discard				

Figure 23: Part of P6's table regarding the reservation place item

At step 39, P6 put himself in the user's shoes when thinking about the possibility of him making frequent reservations on the same station. Then, at step 40, P6 came up with the idea of offering the user an option to reuse the previous reservation station to speed up the process. At step 41, P6 put himself in the user's shoes again and thought that he would also frequently use different stations to make a reservation. He also thought about the possibility of the station having no bikes. So, considering that choosing a station in his proposal is not difficult and reusing the previous station would make the process more complicated, P6 ended up abandoning the idea.

"Then, he chose the station, the reservation type... this design doesn't depend on the user have or not a pre-established reservation. For example, I live at \*\*\*\*\*. If I get the bike every day, there's a great chance that I'll get the bike on the \*\*\*\*\* station, because I live on the corner. Would it be cool for to have a system and that, when I logged on, it would already know which station that I always get the bike? And already used it as a default, allowing me to change the station if I wanted, but as a default, it would choose the station \*\*\*\*\*. Let me think. A default could be complicated, because in the morning it would have to choose \*\*\*\*\*, and in the afternoon, it would choose \*\*\*\*\* [another station]. It is possible, but I think the complexity that.... it's not worth it, considering that he [the user] only needs to press one button to get the station. And what if I am at \*\*\*\*\* [place where the participant works], but I don't want to get it at \*\*\*\*\* [a station], but I want to get it at \*\*\*\*\* [another station]? Like, there's no bikes at \*\*\*\*\*, I will have to go to the previous screen, so that I can get the bike at \*\*\*\*\*. So, leave this as it is, he only needs to press one button to choose the station, it's not so bothersome." (lines 64-78)

P6 solved both delivery place and delivery time items quickly. For the delivery time, he used the same solution as the one for reservation place. And for the delivery time, he created a textbox where the user must inform the time.

### 5.6.1.2. Post-Activity Interview

P6 said that the ideas he had to create his proposal came either from his experiences as a developer or from visualizing himself as a user of the system he was designing.

“Yeah, I think it’s that thing, a little of my own experience as a developer and also as a possible user of the system. Since I think that we have to avoid the number failures, communication breakdown, as we usually to say. So, I guess it’s a merge of all we know about the system, that we don’t want happening to the user. Be it ticket purchase, be it online stores...” *(lines 87-92)*

P6 explained that he used a map to solve the reservation place item, because he viewed it as a default way either as input or output related to location. He also said that he had already visited Bike Rio’s website and saw that they use a map to display the bike stations.

“Because I guess that, nowadays, almost everything we see has a map, doesn’t it? Even Google maps. I think people locate themselves more easily with images than with a list of stations. (...) On the website [Bike Rio’s], it has the map. (...) It even has all the stations, there’s the... I don’t know its name... a panel like with a list of all stations, the number of each station and the location they are at.” *(lines 15-26)*

P6 also talked about the option for the user to reuse a previous reservation station to make a new reservation. When explaining where the idea came from, once again he used himself as an example, talking about where he lived and did not mention other systems during the explanation. He used his real life experiences to not only conceive the idea, but to discard it later.

“I was thinking, if I live at \*\*\*\*\* and come every day by bike to \*\*\*\*\* , then, theoretically, my default station would be \*\*\*\*\* and the destination would be here from \*\*\*\*\* . But on the other hand, what if not? It would be more troublesome on the day that it is not the default, I would have to log in and I would be on the same station, I would have to leave the station [on the system, not the real station] to choose another one. And what if I go to my station and there are no available bikes? So, there’s an error margin that I decided to remove. It’s confusing for the user, oh where am I? At my station? I don’t want my station. What if... I prefer to pick the station that is only one click, and I go to the map if there are bikes available or not, than having to go to the station and having no bikes or if it wasn’t the one I wanted?” *(lines 36-46)*

P6 associated the scenario used in the activity to a movie rental system, although he had never used one.

“When I read reservation, I thought about film rental, but since I never had the contact, I only thought that... I don’t know, reservation led me to rental.” (*lines 70-71*)

P6 said that, if he had to look for ideas to build a system like the one described in the scenario, he would look for reservation-related systems, like car reservation or movie reservation.

“Maybe rental websites. Cars... I don’t know if there are still movies, but... what else can we reserve? Maybe there’s a... hmmm... I think there is a system here at \*\*\*\*\* [the place where he Works at], that does \*\*\*\*\* reservation.” (*lines 124-126*)

## 5.6.2. P7

### 5.6.2.1. Activity

P7 solved the reservation type item using radio buttons with a small text next to the reservation types explaining them. He did not mention any previously seen examples when talking about this item.

“Then, here will be choose... select the reservation type [writing]. Then, there are three types, right? Then here there’ll be something pretty and big like this. Quick reservation [adds a radio button] and here will have an explanation of that does quick reservation mean” (*lines 81-84*)

P7 solved the reservation place item using a map and a drop-down list as an alternative, like P6. He spent some time trying to figure out how to display the additional info about the stations, such as the address and number of bikes available. After some attempts, he decided to display only the station icons on the map and the additional information would be on the right side of the map. To make it quick for the user to see which stations had bikes or not, P7 decided to give the icons colors that were similar to Bike Rio’s colors. An orange icon meant a station with bikes and a grey icon meant a station without bikes.

“It’ll be like this: when he clicks on the spot [bike station mark on the map] or selects an element on the list, it’ll show a thing here on the side. (...) Then, there’ll be: station X [writing on the right side of the map], then there’ll be Marquês de São Vicente street, number XYZ. Then there’ll be three bikes available, right?” (*lines 51-55*)



“When there are no bikes, it won’t list, or then it will list disabled [writes ‘gray’ above the spot]. Here, the bike will be gray [writes orange above the spot on the other map], because it’s the color of the brand [Bike Rio’s website].” (*lines 59-65*)

He solved the delivery time item using a drop-down list where the user would have to pick the time he would deliver the bike. He also added a rule in his proposal stating that the system should have a 30 minute tolerance window.

“This time, you’ll inform it as a time, like half an hour from now, or you inform the exact time? Because I pretty much could put it like this: delivery time. And here, there’s a small box [a drop-down list] with the time options. And here there are the time options [draws a drop-down list]. And here, there’s a detail that I don’t know if I can add it as a requirement. It must have a tolerance, I don’t know, 15 minutes forwards or backwards, right?” (*lines 94-100*)

P7 solved the delivery place item using the same solution as the reservation item. We could not identify any relevant aspect of the design activity while he solved this or the procedure item.

### **5.6.2.2. Post-Activity Interview**

P7 said he had already used a bike reservation system. It was a previous version of Bike Rio, while it was still called “Samba”.

“I already used it at the beginning, when it wasn’t even Bike Rio, it was just Sampa, when there were fewer stations and stuff. I know that now it’s much cooler, that you can make [the reservation] via cell phone and all that.” (*lines 70-72*)

While explaining the reason of the tolerance rule he added to his solution to the delivery time item, P7 said that it was a matter of courtesy and also it is very hard to be punctual when it comes to transportation. He mentioned Rio’s traffic, more specifically. Later, he said that that the tolerance should be applied only after the specified time, because people tend to be late instead of early.

“I was thinking like, dude, it’s traffic, it’s Rio de Janeiro, I don’t know... it would be stupid to the system to establish a fixed time, because there’s no way to guarantee that you’ll be there at that exact time. Then, the tolerance is more like, first, a courtesy, any person... and also, because of the domain, you’re talking about transportation. Then, let’s suppose 15 minutes forwards and 15 minutes backwards. Actually, it would be better 30 minutes forwards, because people, in general, are more often late than

early. Or maybe, if the tolerance was like... yeah, the tolerance helped in a delay.”  
(lines 116-125)

P7 did not feel the need to consult other systems, because his knowledge was enough to create a proposal that solved the items described in the scenario. He said that he could have done it to improve the proposal, but he was satisfied with what he had created. He also said that the scenario was descriptive enough to guide him during the design without having to resort to examples.

“I guess that when the... I really stuck to the scenario, you know? Like, all the names that I needed were here and if I had to make a decision, it was more from my head, you know? I only had to... umm, I could have looked, I don't know, tried to see something more about... I don't know, something that was lacking. I don't think that what is here [in the proposal] is incomplete. Probably, if I look at it now, I'll see some things that could be improved. But, for what was requested, I didn't see any need.”  
(lines 3-8)

“But it's not to criticize the scenario. I think it... I think that the scenario was done well enough for me to not to search this. Because, for example, if you hadn't put the [reservation] types... I dunno, maybe I would try to think which types there would be, right, that people make and I would think about... Consulting some place, how do people reserve bikes, what are the difficulties...” (lines 60-65)

P7 said that he would not browse the web for systems other than Bike Rio. He wanted to keep a consistency between the current system and his proposal.

“No, what I would go after is Bike Rio's website, which I know that exists. I wouldn't, like, research about reservations, maps. I wouldn't look for anything like it. What I would is... if I was going to do, I would go straight to... to the service's website and to see how is it there, like, because... maybe because to keep the consistency of the website, maybe. I guess that if I was really going to do it [the proposal], I would have the obligation to do it, right? Knowing the client, see how the login is, see how is the...” (lines 16-22)

But, when asked by the researcher what he would do if the Bike Rio system did not exist, P7 said he would browse the web in search for bike rental systems.

“I would search on Google something about bike reservation. Or maybe in English, rent a bike, I don't know, and see if there's already a website that has this service and check it out, more to know about what already exists, you know? Yeah, I could have done that indeed. I guess I went more like... I don't know, I went by the scenario. But, on the real world, I guess I would look at, like... I'm not sure what would I see, try to see, if not the... some service similar to bike rental.” (lines 45-51)

P7 thinks that Google Maps is a default solution for a location-related item.

“So like, all this is... it’s that thing, all we do that involves location has a map. So... I already know that this Google Map interface exists, that you can put it on your website and blah blah blah, but the icon you want, right? So all this came to my mind, you know?” *(lines 72-76)*

Before creating his proposal, P7 made a few scribbles, which he called a model, to allow him to view the whole problem without having to consult the scenario text every time. Those scribbles listed the tasks he had to address in his proposal and the order in which they had to be performed.

“It’s funny because, I don’t know if it’s because I’m doing some modeling to a [academic] discipline, but what I wanted to do was making the MoLIC. The MoLIC or something like a task model. But like, since it was a quick thing, I started sketching. But if you think about it, I have the conversations, the possible tasks, the path, like, I tried to... it’s a summary of the scenario. So that I don’t have to keep going back to the scenario... I even forgot part of it, right?” *(lines 84-89)*

P7 said he would have liked to use a prototyping tool during the activity to improve the quality of his proposal. He said that it would have made it easier to implement what he had in mind.

“I missed using something like Balsamiq, I confess. Even if like, I guess that I managed to... I managed to do this nicely, but it feels like going there and modeling, go there and incorporate what you’re doing, you know? Because, for example, this dynamic thing [dynamics sign], which I spoke about, umm, when I click here, it’s going to happen... it’s hard to put this on paper. My representation is very precarious.” *(lines 130-135)*

### 5.6.3. P8

#### 5.6.3.1. Activity

Unlike the other participants, whose solutions were the same regardless of the reservation type, P8 viewed them separately. For each function he added to his proposal, he would check if it was compatible with each reservation type. In the end, he proposed different screens depending on the reservation type. Like most of the participants, he used radio buttons for the user to pick the reservation type. Figure 24 shows part of P8’s table regarding the reservation place item.

At step 6, P8 visited Bike Rio's system and decided to use its solution, which uses Google Maps, to solve the reservation place item.

"What I thought, for example, the matter of finding the stations, he already gives me it [clicks on the option to find stations from Bike Rio]. I won't do anything different from what he's offering me." (lines 26-29)

Step	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	34	35	36	37	38	39	40	41
Reference			6			6	6			8	15	8	17	17	19	15 17	6		17	36	17	17	39	39
New	■																							
Reflect			■			■	■											■			■			
Recall																								
Alternative											■													
Implement												■	■	■	■	■					■		■	
Add																								

Figure 24: Part of P8's table regarding the reservation place item

As said before, he was creating a different proposal for each reservation type. At step 15, he decided to add a map and a drop-down list as an alternative for the first reservation type.

"For the quick reservation, I will have to show the take out station. Then, I'll have two options or something. By district [makes a drop-down] and I'll have the option of Google Maps" (lines 63-65)

But, at step 34, he decided that, since the user would have to inform the bike station to get the bike regardless of the reservation type, both the bike station and the reservation type would have to be informed on the same screen.

"The station and the reservation could be on the same screen. I could already indicate it here, on this first [screen]. It's because it's a common aspect of all of them [reservation types]. No, although the quick reservation I only have to indicate the station I'll take out the bike." (lines 94-97)

P8 did not spend much time solving the delivery place item. He reused the same map solution as the reservation place. He was also quick to solve the delivery time item, creating a text field to inform the time. P8 did not seem to stop to think much about the procedure item either. He also dealt with the payment item even

though it was not mentioned in the scenario. However, this did not seem to pose an obstacle for him. He created a screen with some fields with payment details. P8 did not mention other systems when dealing with these items.

### 5.6.3.2. Post-Activity Interview

Just like P7, P8 tried to make it so that its proposal was consistent with Bike Rio, because he saw his proposal as an extension of the current system.

“Because the idea, from what I understood, was to make an extension of the website which already exists, right? So, even seeing which types of patterns it already used, like... ask the location. Station location, it already finds the closest one, but... I think I didn't even see here if it gives me other criteria. I put in my proposal to do it by districts, like... ahh, I don't want to see the location on the map of where I am, or something, I want to do it by district. I gave another option for him [the user] to be able to find [stations]. But I thought I had to start from something... the pattern it [the existing system] was already following here.” *(lines 4-11)*

Since one of P8's concerns was keeping his proposal consistent with Bike Rio, he said that he would not have visited other websites. However, he considered visiting web UI pattern libraries, but he did not.

“Other websites, I don't know if I would go to other websites. I guess that given... the website I would keep its integrity would be Bike Rio itself, but I guess I'd go to these... these pattern libraries.” *(lines 79-81)*

P8 did not explore Bike Rio's system in detail. He only opened the main page and the bike stations page and, once he saw that the system used a map to list the stations, he was satisfied, because he knew he could use a map in his proposal to help the users select bike stations for reservation.

“I went straight to see how it dealt with the location issue... saying where the stations are. So, that's why I stopped here [showing the first page on the system], I said cool, it uses a map [on the first page, it's possible to see a map with all stations], ok then, another map is an alternative I'll consider... But I didn't even look if it had another... but I thought that by district would be interesting to put [in the proposal].” *(lines 18-22)*

P8 justified this approach to the task saying that, since he wanted to keep his proposal consistent with the current system, he needed to see which UI patterns

Bike Rio used. He said that, if the system did not have anything he could use in his proposal, then he would have looked for something new.

“I started with the assumption that the data that I was showing was an extension of what already exists, that was my stance: looking at how it is being done today. If it isn’t something like, oh, I’ll redo it, start from the beginning, redo it, maybe I wouldn’t have looked at it [Bike Rio system]. But since it is an extension of what already exists, I started... my thought was to look at the patterns it followed, the ways it did stuff so that I could follow, keep the same patterns and if it didn’t use a pattern or a component or something, then I’d propose something new, but keeping the pattern it already follows.” *(lines 49-55)*

P8 said that if he had to look for something new, he would have looked for it in UI pattern libraries. He would have had in mind the problem he needed to solve and looked for UI patterns that solved that problem.

“Oh, there’s a pattern website that I know, interface patterns, and it would depend a lot on the designer’s needs. But there’s... I won’t remember now, there’s UI Patterns, I guess... let me remember... so, the patterns... they are sort of categorized for certain situations, the patterns that are used or recommended.” *(lines 66-69)*

“I’d already have in mind, maybe, the options that I could have. I would see if there’s already something more recent or if it’s more ideal for the situation that I’m searching or something like it. But I’d already, like, okay, I need something that deals with this situation. So, what is there that deals with visualization, visualization, lots of data... it [the library] sort of gives me a categorization, so maybe it would already give me something more focused on that situation that I have, so that I... choose what I’d use as an interface component.” *(lines 71-76)*

Like P7, P8 also missed a prototyping tool during the activity.

“Oh, I thought it was really horrible doing it on paper. I think I’ve never done this, it’s funny. Yeah... I Always did it with a computer support. So, like, I missed something, I guess... I guess if it were something for real, I would do it with some... knowing that the tools already have the components and stuff.” *(lines 84-87)*

#### **5.6.4. P9**

##### **5.6.4.1. Activity**

Like P7, P9 spent the first minutes of the activity making some notes of what he needed to address in his proposal according to the scenario.

P9 solved the reservation type item quickly. Like the previous participants of the second stage, he decided to use radio buttons. He did not make any mention to other systems or examples from where he took the solution.

“And some kind of option like a radio button or something like it, so that he can say the reservation type he wants to do. There could be a ‘find out more’ here next to it so that if he doesn’t know what is each of these things, at first.” (*lines 11-12*)

Figure 25 shows part of P9’s table regarding the reservation place item. This was the only item which made him refer to another system.

Step	1	2	3	4	5	6	7	8	9	10	20	21	22	23	24	25	26	27	28	29	30	31	32	48	49	50	51	52	53		
Reference				3	3			5	5	5		3	5	8	23	23	5	26	26	28	28	28	31		5	8	3	3	3	3	
New			■		■																										
Alternative								■			...														...						
Reflect									■	■			■	■		■						■					■	■	■	■	
Recall												■														■	■			■	
Implement													■	■	■			■		■			■								
Add																	■						■								
Change																				■											

Figure 25: Part of P9's table regarding the reservation place item

At step 5, P9 decided to give the user an option to choose the bike station using a drop-down list. Then, at step 8, he considered an option to make the system find the closest stations to the user. At this time, he referred to the Apontador system (a system to find places such as restaurants and hotels).

“For example, from a drop-down list here, he will choose which station he wants to reserve.” (*lines 9-10*)

“So, there’s another option here... there’s another here, in this station here, it might have to do some kind of... it’s not only a matter of choosing the station, it must have some kind of search, like... search stations, I don’t know, so it... in there [in the option] there will be something like a pointer, just like Apontador, so that he [the user] can search where is the station closest to him.” (*lines 17-22*)

At step 23, P9 reflected about the solution he thought at step 8. He decided to add another option to the drop-down list, called “Find” that, if selected, would open a

new window where the system would show the stations that are closer to the user. However, he did not give any detail about how would the interaction be.

“he can be in a different place, in a place he doesn’t know, and he doesn’t know what the stations are. Then I have a doubt if there’ll be an option here that... in these station-related options, which will be an option like search, locate... it’ll be in here and if he chooses it [the option], he’ll go to another screen... some other thing that maybe can be another screen... like Apontador, like I said before, so he can find himself.” (*lines 80-86*)

At step 49, P9 said he did not know how to add that option to his proposal. At this time, he said that other reservation systems come to his mind. Then, he went to the Ingresso.com system, but he was not satisfied with the option it offered to the user to choose an event location.

“this thing from Apontador, like I told you, I have a doubt... here, what’s missing here is this, in terms of representation [how to represent in the interface the “Apontador thing”]. I know what I want to do. (...) when I say something like Apontador, I mean that thing of it saying where he [the user] is, look at a map and in the map, look which are the stations, I mean, show a map showing the stations from where they are. (...) What comes to mind is that thing, like, ticket [for event] purchase, because, in a way, you’re making a reservation of something [goes to Ingresso.com website] (...) I don’t remember having seen this option. It doesn’t have the search thing here. At least, I don’t remember. (...) So, I think this doesn’t solve the problem.” (*lines 143-163*)

Then, at step 53, he went to the Apontador system. He saw the label “close to you” on a button, which seemed to be a good representation of the solution he talked about on step 8. But, once again, he did not think about the details of how the system would show the closest stations and how the user would select one.

“Let me see another option here, a Apontador [opens Apontador system], which I have a doubt about. Yeah, it could have something like this, a thing like this “close to you” [a label on a button] (...) it would be like, umm, station X, but there’s an option like this “close to you”. Just like I put this “locate” here in the middle, and whet the person chose “close to you”, it would... later, I have to see how this works, right? But, on an ideal world, this “close to you” would ask me where I am and show the stations closer to me.” (*lines 173-181*)

We could not identify any relevant design iteration while P9 was dealing with the delivery time and delivery place items.



P9 solved the procedure item in the same way P1 did. He decided to divide the reservation process in three steps and show everything on the same screen.

“Yeah, everything will be solved more or less... [writes a title to the window] on the same screen, more or less like this. I don’t know if there’ll be a lot of transitions from one dialog to another.” *(lines 51-53)*

“So, I’ll put something sort of like this, indicating him that it has, from what I understood [from the scenario], it has basically three steps. Since it’s just a few steps, then I’ll put like this, on the same window.” *(lines 66-68)*

#### 5.6.4.2. Post-Activity Interview

P9 referred to the Apontador system, which he almost never uses, because its name expressed how he wanted to solve the reservation place item in his proposal.

“I mentioned Apontador, but I remembered more than a... I remembered the Apontador, I remembered those websites like, like Google Maps, for example, websites that you normally search... when you want to have a vision kinda like GPS, what is the path I use to get to the place or when you have the address and see what you have. I visit a lot Google Maps. The Apontador [website], I almost never use. Because of it that I had a lot of difficulty looking at the... I wasn’t used to looking at the website [Apontador’s website]. I use more Google Maps.” *(lines 4-11)*

“I used the term ‘Apontador’ [pointer, in Portuguese], because it gave me an idea that it will point, that idea of intuition, that will point me where I want.” *(lines 15-16)*

P9 came up with the same solution for the procedure item as P1, but unlike P1, who was inspired by a case, P9 said that this solution came from the idea of minimizing the amount of clicks and not from any other specific system.

“it’s that really basic HCI concept that when you make a reservation of whatever, you pay a bill and say: here, you see, it’s just a few steps. So, you look at it and it shows only one thing, but while you are clicking, that thing becomes a monster and it seems that you are in a form that never ends. Since here, if I understood well, there were just a few things that the person had to inform, actually it’ll only have more interaction if the person doesn’t know a lot [about the reservation data, such as the stations]... but if he had done it once and it’s a thing that he does frequently, with 3 clicks he’ll practically solve his problem.” *(lines 50-59)*

Since P9 does not create new interface proposals often, he considered, during the interview, visiting a web UI pattern library to see whether there were UI patterns of which he could make use.

“From the moment I chose to start sketching the screen, since I don’t have a lot of... it’s not a matter of experience only, but that thing of doing this every day, looking at interface patterns and stuff... so I knew that I would lack, eventually, an idea of something more up to date that I had seen about web patterns. So, I thought, umm... I didn’t think this at the time, but I could, when in doubt, look not only at similar systems, but look at that website of... that has web patterns.” *(lines 78-85)*

Like P7, P9 made some notes regarding the requirements described in the scenario before creating his proposal. He said that he needed to extract the tasks he had to address to in his proposal from the scenario.

“So, I have like, when I’m reading something, like a specification and stuff, I have the need to... this [the study scenario] is a quick specification and small, but it has... I even underlined here the ‘make a reservation’, ‘inform the user’, so like... (...) for how long he [the user] intends to use the bike... it has like, a few tasks embedded in it, so it was a need more like to extract which would be these steps that he would need to conclude the task.”

*(lines 96-102)*

P9 tried to create a first version of the proposal by himself, before consulting any other system, so that he would not lose his focus on what he needed to do. He said that he did not think it was hard to do so, since he thought the scenario was not very complex and did not need to create something more elaborate, like an interaction model.

“actually, like, I didn’t make an effort to, like, I won’t go [visit a website], I won’t do it. I guess it’s a personal attempt to like... let me do how I think it would be without looking straight away [at websites], because, maybe, if I looked straight away, it would make me, I would end up losing the initial focus. Since I didn’t find very hard to quickly imagine something, even knowing that this... [if I considered] making an interaction model, maybe I change it [his proposal] a little... so, like a v0, it’s not even a v1, a v0 I didn’t find very hard to do. Maybe, if you gave me a task that I had no idea of where to start, maybe I would have resorted to it [visiting to websites], even to have this base that I would be lacking. I guess it was basically it, the non-difficulty of thinking on a v0. If I had no idea, I would have certainly looked [at a website].” *(lines 107-119)*

When asked about which other domains could have been helpful to look at to help in his proposal, P9 mentioned car rental, DVD rental, book rental, and event ticket purchase (because the user must make a reservation of his seat).

“Umm, I could have thought a little about car rental, that I used in something mine, that had something related to reservations and it only shows... (...) In [event] tickets, it seemed adequate (...) there’s that thing about reserving seats for you in a cinema. So, it was the analogy I did.” *(lines 128-138)*

“what comes to my mind now is that think of DVD rental” *(line 176)*

“Or book [rental], maybe. A library. It comes to mind other stuff that you rent” *(line 185)*

Later, P9 said that he would have given priority to the domain, looking for other bike rental systems first. While he was looking for systems with similar domain, he would have also looked into web UI patterns in order to explore solutions more specifically, such as maps. If he could not find anything related to bikes, he would have looked for similar systems, such as car or DVD rental.

“search a car rental website... not car, bikes. So [typing ‘bike rental’ on the computer], online bike rental. See, there’s even in other places [bike rental in other countries], right? So, maybe, I would do that. I would try, I would see the thing of bike rental, right? The domain, I would see the domain first...” *(lines 192-196)*

“I guess what I would do would be to try to search in the domain, what more or less... because, like, I think that there’s the matter of the web pattern, that was that thing I spoke about, that I did a search here, so I think I would search for web patterns and within web patterns, I would try to think what would I search, if I would look this thing about... something related to maps, that sometimes these patterns have (...) but since I think it’s a too specific domain, renting something, maybe if I went to related websites, I would have found more interesting things (...)” *(lines 199-209)*

P9 said that if he thought about car rental systems while he was creating his proposal, he probably would have created a different solution for the reservation place item.

“if, at the time, I had thought about cars, maybe I would have preferred putting like, where will you get [the bike], having in mind the delivery matter, where will you get it and return it? I could put something like car rental does. You already say where you’ll get and return the car.” *(lines 170-173)*

Once P9 saw the label “close to you” on a button in the Apontador system, he used it as a name for the option which makes the system find the closest stations to the user. He said that the label expressed what he intended to do as a solution for the reservation place item.

“So, I was satisfied quickly, because when I saw this “close to you”, this more or less solved that problem of like... since I’m talking here about stations and I’ll tell the user that he has an option of finding stations close to him. So, I thought it was interesting and I don’t even know what this is for in here [what the button does on the website].”  
(lines 225-228)

“I put here first “locate”. But this “locate” wasn’t expressing very well. But this “close to you”, oh ok, it’s a station close to where I am. Then, he would go from there to somewhere else.” (lines 247-249)

## 5.6.5. P10

### 5.6.5.1. Activity

P10 said he was a frequent user of the Bike Rio system. He said he knew both the web and the mobile systems and, therefore, would not need to look for examples at first.

“to do something like this, generally I would research, look at other systems... but, I probably won’t do that now, because I really always use it [Bike Rio’s system], so I have it fresh in my memory how Bike Rio’s system is, both online and mobile.” (lines 1-4)

Even though the scenario mentioned that the proposal had to be a web system, P10 said he would make his proposal based on a mobile system, but it still was a web system.

“I will sketch it sort of like mobile, but it’s still web, even if it’s HTML5, there’s no problem.” (lines 30-32)

For the reservation type item, he made a screen with three buttons for the reservation types and an explanation next to them, similar to a mobile screen.

“I would have the reservation types. There would be a simple screen with three buttons, reservation types [sketching a small screen]. And here, quick, for a trip, for a day [writing on the buttons]. And he would see some information about the difference between them. I don’t know if it’d be better to show it on the side, writing, sort of like text, button, text, button [scribbles some lines near the buttons].” (lines 44-45)

To solve the reservation place item, P10 used a map. He copied the icons from Bike Rio's system. He even visited Bike Rio's website to make sure his proposal would have the same icons.

"And then, soon after, it would show the map, on the same page with the options... with the available stations [sketching a map on the screen]. And, following again the same pattern that it uses... well, I remember Bike Rio's pattern, it uses a balloon, a... it uses a gray balloon [draws a balloon at the top of the paper]... I mean... it has a white balloon when there are no bikes. It has a blue balloon, which here I'll represent as black, when the station is full [drawing another balloon]. And it has the other that I think it's only orange, normal (...) I can look on the internet, just to make sure [goes to Bike Rio's website]." (lines 53-62)

"Stations [clicking on the stations link on Bike Rio's website]. Oh ok, the gray is when it's in activation [draws a balloon on the proposal] that is, if I'm not mistaken, related to orange, but with an X, that is saying that it has a problem, it's not activated [puts an X on the orange balloon]. It must have another... which is the normal situation [writes "normal" below the first balloon]." (lines 70-74)

P10 also made a reference to Bike Rio's website when describing how his proposal would present the information about a station. He said he would use the same way the website does to display the station information in his proposal.

"And then, when he clicked on these two types that don't have a problem, it would show just like it shows here [making a reference to Bike Rio's website], it shows this balloon showing the information [draws a balloon next to the map]. It, in this same balloon that it shows, it would also have the information about how many bikes are... there would to have a difference, there would have to be the available bikes..." (lines 82-88)

After finishing the whole reservation process, P10 decided to remake the first page of his proposal. He decided to do it based on Bike Rio, using the idea of tabs on the first page: one to show the reservation information and the other to make another reservation.

"let's rethink about this matter about which would be here in the first page [erases the first page in the proposal]. I would have a tab or another way to distinguish, where it shows, like it shows the reservation cards from Bike Rio [sketches another screen with tabs], it shows my reservation card, what is the reservation type that I have, and if it's a reservation like this 30 minutes one... I mean, if it's the 30 minutes one or if's the for a day one and reservation for one trip, it shows how long this... the expiration. Shows the expiration [writing on the screen]. So, there are still... you still have 3 hours, if it's for one day, or 10 minutes if it's for half an hour... ok. And on the other

tab, it will go to this matter of the... another tab to make the reservation [draws arrows showing the flow between the drawn screens].” (lines 153-162)

### 5.6.5.2. Post-Activity Interview

P10 said that his proposal is based on mobile systems, divided in steps. He also said that, since he has so much experience with Bike Rio’s system, he managed to organize the reservation process described in the scenario in a similar way Bike Rio does.

“This is because it didn’t seem to me a problem different from what you do when you buy... I mean... when you take the bike. So, I thought it was like that. On mobile, you have that sequence, you have the... the steps, after you choose that you want to do a... you pick the station, here [on Bike Rio’s system] there wouldn’t be this step of choosing the reservation type. Then, you pick the station, after the bike station, [you pick] the bike, after the bike, you confirm [the reservation]. (...) Then, since I have a lot of experience with Bike Rio and I use it every day (...), I thought it would be more interesting to keep the interaction and the appearance it already uses.” (lines 15-27)

When asked about what he would do if he did not know Bike Rio website, P10 said that, if he had to do an extension of the current system, like he thought the scenario asked, he would first explore the current system to try to keep a consistency between it and his proposal, or suggest some changes. Then, he would look for similar systems to have new ideas, like e-commerce systems. However, if the problem is peculiar and that he has seen a possible solution elsewhere, he would look for interface elements.

“I would look for the systems that... for example, this one [a system like his proposal], which is an expansion or a modification of a system that already exists, I would look first how is the system, in case I didn’t know it (...) to keep this matter of identity, even making some change suggestions (...) And, then, given the problem that I have, I would look for a system... a similar system or many similar [systems] to have ideas.” (lines 8-15)

“[talking about similar systems] an e-commerce system, in general (...) It has some patterns, after all it’s an e-commerce system. It’s there to sell, so you’ll have a way to filter the kinds of shoes, you’ll see the price... so, many similar problems. But, depending on the level of the problem, the kind of the problem, there may be some parts that are... that are peculiar and that I had already seen or believe that could have a solution in different system. And this is this second part that I said about looking for interface elements specifically.” (lines 38-46)

P10 said that his idea to organize the reservation in a wizard was based on mobile systems. The idea of adding the reservation expiration time was based on Bike Rio's system.

“The wizard, it was because how it works on the cell phone. Because, it's step-by-step [process], when you take the bike.” (lines 68-69)

“This, [the idea of adding the expiration of the reservation] is also something that I get the... that I see in Bike Rio's application. It shows how long... it doesn't show... yeah, it shows for how long you have the bike that you already got.” (lines 96-98)

P10 said that his proposal was similar to the Bike Rio system. He made some changes to accommodate the requirements listed in the scenario, but there was no big difference between both.

“I think it's pretty similar, I think... I think I could... that's why I was asking if it [his proposal] was something new or to integrate... here or on the cell phone, I think that it would fit and would be able to keep the identity easily.” (lines 117-120)

“it has a mix of different parts of the system that fit better here, but... there wasn't a big change” (lines 147-149)

### 5.6.6. Discussion

Table 6 shows a comparison between the activities from the participants with and without CHIDeK.

Table 6: A comparison between the participants from the two stages

	P1	P2	P3	P4	P5		P6	P7	P8	P9	P10
<b>Mentioned an external (previously known) design solution</b>											
As a user							X				
As a developer							X				
Spontaneously		X	X	X			X	X	X	X	X
<b>Other</b>											
Knew Bike Rio website			X				X	X	X		X
Accessed Bike Rio website									X		X
Accessed another website	X									X	
Proposal consistent with Bike Rio								X	X		X
Used non-Bike Rio solutions	X	X	X	X	X		X			X	
Considered cultural aspects							X	X			
Radio button to solve reservation type problem	X	X			X		X	X	X	X	

From the participants in the second stage of the study, P6 and P7 did not consult web systems during the design. P8 and P9 only visited Bike Rio in order to keep their proposals consistent with the current system. P9 was the only participant who visited different systems, like Apontador, to try to solve the reservation place item. We came up with two hypotheses to explain this: either the scenario was too simple, allowing the participants to propose solutions with their own knowledge only; or, since the participants only had to make a draft to help in a first discussion with a client, they did not feel it was necessary to look into details. This is illustrated by P9, when he was thinking about how the system could recommend stations closest to the user. Although he put in his proposal that the system would do so, he did not detail how the system would do it.

Only the participants at this stage seemed to be concerned about making their proposal consistent with the current Bike Rio system. This can be seen as design fixation (Jansson & Smith, 1991), since the participants did not seem to reflect on the quality of the current solution and used them as is. Silva (2011) discussed this aspect of design, stating that designers tend to innovate only when they have a strong reason not to use the current solution, in fear of the user rejecting the new solution or not being able to use the new solution at all. Silva concludes that designers should have existing design cases at hand to help identify bad solutions, lowering the fixation on those.

Participants with CHIDeK did not seem to bother about keeping their proposal and the current Bike Rio system consistent. Most of the time, they would either adapt the solution found in a case for their problem or use it directly after pondering whether it would be useful or not. We came up with two hypotheses for this difference: the first is due to the random division of the participants between the stages. The first stage only had one participant who knew Bike Rio (P3) and the second study had four participants (P6, P7, P8 and P10). The second hypothesis is that having a library with cases describing different systems in different domains available motivates the designer to look for new alternatives. For example, although P3 knew Bike Rio system, he used the library to view cases from other systems Google Calendar, Blockbuster and Apontador. However, we need to conduct more studies before we can reach a conclusion.

We observed an interesting behavior from one of the designers in the second stage when he put himself in the user's shoes. P6 viewed himself as a user of the



system he was designing when considering an option to reuse the station from a previous reservation to make a new one. In his reflection, he considered the place where he lives and his routine to come up with a solution. He used the same kind of reflection to discard the solution later. A similar fact occurred when P7 was justifying the need of a tolerance for the delivery time using the traffic of the city he lives in, Rio de Janeiro, and the fact that people are not punctual. These occurrences called our attention to the fact that the designer can, sometimes, consider his own lifestyle or the culture he is immersed in during the design process. Since this enriches the design activity by making the designer discover new requirements or create new solutions, like we saw during the activity, case libraries should also take culture into consideration. This is something the case content we used for the study sessions with CHIDeK lacked.

Both of the stages showed that some kinds of problems tend to have a default solution in most of the participants' minds. This was clear with the reservation place item, a location-related problem, which most participants made a reference to Google Maps while solving. The only one who did not mention Google Maps was P4, on the first study.

We also noticed that all participants in the second stage used the same solution for the reservation type item. All of them used radio buttons for the user to select the reservation type. There were variations to this concerning the explanation of each reservation type, but we could not identify any significant difference on the overall solution. The only exception was P10, who, instead of making a proposal based on a web system, he made a proposal based on a mobile system. His solution had buttons with the reservation type options. On the other hand, in first stage, we identified two kinds of solution: the regular radio button list with the reservation types, and a table analog to the one used by Blockbuster to show its DVD rental plans. This solution was used by P3 and P4. P3 said that the solution was inspired by the rental plans table he saw in the Blockbuster case and by his experience with other DVD rental websites. P4 did not mention Blockbuster or any other system when making his table. However, while he was drawing the table, he had the Blockbuster case open on the computer monitor. Still, we can say that a case can motivate different solutions even for simple problems, such as the reservation type.

PASSO 2: Escolha TIPO DA RESERVA

RESERVA RÁPIDA saiba mais

RESERVA POR UMA VIAGEM saiba mais

RESERVA POR UM DIA saiba mais

Figure 26: P9's solution for the reservation type item, using radio buttons

① TIPO DE RESERVA > ② ESCOLHER ESTAÇÃO DE RETIRADA > ③ L/C INCL

TEMPO DE RESERVA	30 MIN	24 HORAS	24 HORAS
NÚMERO DE VIAGENS	1	1	ILIMITADA DURANTE O DIA
PREÇO	R\$10,00	R\$25,00	R\$40,00
	ESCOLHER	ESCOLHER	ESCOLHER

Figure 27: P3's solution for the reservation type item, using a table similar to Blockbuster's

## 6 Conclusion

In this chapter, we discuss the contributions of this work, the threats to its validity and new questions that can guide further research.

### 6.1 Contributions

In this work, we discussed the importance of previous design knowledge in the design activity. Usually, designers use them to further understand the problem they are working on or to develop solutions for it.

The first step of this research was to interview professional designers to find out how they access and reuse previous design knowledge, and their motivations and expectations regarding the use design knowledge aided by a CBR tool. The first contribution of this work was to show the positive attitude users had towards using a CBR tool to support HCI design, and the ways they related CBR to how they work.

With this interview, we also elicited unanticipated requirements and constraints for the tool under development. The second contribution of this work was then to identify requirements for a CBR tool to support HCI design (see Table 1 on page 26).

Based on the elicited requirements and on Semiotic Engineering concepts, we have designed and developed CHIDeK, a human-machine CBR system, the third contribution of this work. CHIDeK is a case library containing HCI cases. It uses faceted navigation, semantic relationships and simple search to help users find suitable cases for the problem they need to solve. Although CHIDeK, by default, provides all the facets listed on Table 3 (page 44), we did not use all of them in our study, because there was not enough time to create as many cases as necessary to use all the facets.

After we developed the tool, we conducted a study with students to observe the HCI design activity with and without CHIDeK. We wanted to observe

how access and reuse of previous HCI design knowledge with a CBR tool took place when compared with access and reuse of design knowledge without such a tool. Although CHIDeK allows the designer to add new cases, this functionality was not addressed in this study, because it was not the focus of this research. In this study, the participants had to create a proposal for a bike reservation web system.

From the studies, we observed that CHIDeK supported the design activity by providing solutions that the designers used to solve the problem described in the scenario. CHIDeK also stimulated the participants to remember their own experiences with systems similar to the ones described in the cases. These study results reinforce CHIDeK as a contribution of this work. We observed, however, that CHIDeK could not equally help all designers find relevant cases. While some of them managed to find cases by using the facets or simply by looking at the case list, others could not find cases when they had a more specific need in mind, such as “optional (input) fields”. This shows that, in certain situations, the quality of the user experience with CHIDeK strongly depends on the case content and organization, to ensure that the set of facets and the direct search would help find the relevant cases.

We have also contrasted the metacommunication message we created originally, based on the interview with expert designers and the message we assumed the HCI students (novice designers) who used CHIDeK received. We discovered that, despite our metacommunication message being targeted to expert designers, the HCI students managed to understand most of it. The analysis also showed that research on how a CBR tool can impact the design from novice and expert designers is due.

On the sessions without CHIDeK, we observed that participants did not access external design knowledge very often. Some participants did not look for anything at all, creating their proposals entirely from their own knowledge. Three participants consulted external design knowledge. Two of them, however decided to consult only Bike Rio’s system, because they saw their proposal as an extension of Bike Rio’s current system and wanted to keep both interfaces consistent. On the other hand, the participants who used CHIDeK consulted many cases from a variety of domains, such as online maps, airplane ticket purchase, car rental and DVD rental systems.

## 6.2 Future Work

Based on the analysis of the data collected, we have formulated some questions that can guide further work on CBR tools for HCI design.

First, three participants of the study without CHIDeK claimed to know Bike Rio system, while only one of the participants with CHIDeK knew about it. This had a major impact on the proposals of the participants without CHIDeK, resulting in evidences of design fixation. However, our study did not establish a clear relation between the presence or absence of the CBR tool, the participant's knowledge of the domain and how he designed his proposal. So, a few questions that come to mind are: How does the activity with the CBR tool compare with the activity without the tool when the scenario is more complex and unfamiliar to the designer? How do the activities in both conditions differ when the participants are knowledgeable of the domain?

The latter question is related to Table 4 (page 92), which shows that participants on the study with CHIDeK used a variety of methods to solve the task we gave them. It also shows that participants used different means to find cases in the library. Some used the facets, others the search function and some simply browsed the case list. However, despite this, not all participants were fully satisfied with the results they obtained, as they did not seem to be helpful. These participants also did not know how to make a query on CHIDeK that would yield helpful results either. Additionally, browsing the case list would not be practical if the library had hundreds of cases. So, additional questions raised in this work are: How can we improve the access to cases? How can the case library help the designer formulate his query ranging from those who have a more generic need (such as a way to “choose a bike station”) to a more specific need (such as a way to “combine a way to choose a station to reserve a bike with an optional station for deliver the bike”)? One way to tackle this problem can be drawn on de Souza (2005), who states that the communicative potential of UI patterns can be used to organize a knowledge base. Therefore, it can be interesting for a case library to organize its cases according to their communicative or cultural aspects.

We also raised a few questions regarding the case representation. In the study, we observed that, although most of the participants liked the use of images, the case representation we used had a few problems. One of them was shown by

P2, who wanted to see the solution at the level of the interaction and not interface. Likewise, P1, who liked the case representation we used, also had difficulties in understanding one of the cases, because the images did not show the behavior of the web system it described. So, a question that arises is how can the case representations satisfy multiple preferences, ranging from designers who prefer dealing more concrete solutions to those who prefer abstract solutions? Considering the interviews, when the designers said that they did not want to spend a long time using the tool and that the library must be concise, how can we make informative cases while trying to keep the complexity of the library and the case description as low as possible?

Also concerning the case representation, we observed during the study that the Semiotic Engineering's metacommunication message is analog to the message described in a case (see section 5.5.6). Therefore, some questions that come to mind are: How can Semiotic Engineering further contribute to improve the quality of the case description? How can cases help the designer learn about the metacommunication message of other systems and contribute to his reflection of the metacommunication message of the system he is working on? We can use this knowledge to develop guidelines to help designers think about the structure and content of the cases they want to create.

Another opportunity for further research stems from the metacommunication message discussion in section 5.5.7, where we talked about the use of a CBR tool in HCI design by novice or expert designers. What kind of role can a CBR tool have in both of these situations? The case representation we used in the study was based on interviews with expert designers, but we found out that there is still opportunity for improvement. So, how can we make case representations more useful for expert designers? And what is the appropriate case representation to be used by novice designers? How do both of these kinds of designers look for previous HCI knowledge? We have also discussed that it may be possible to use a CBR tool to help novice designers learn about design, by helping them understand and incorporate signs and rationale used by expert designers in their own design activities.

CHIDeK also presents several opportunities for improvement, such as: better support for search, better mechanisms for managing tags, a way to hide balloons on the case images, and sophisticated support for dynamic signs.

CHIDeK could also present a solution ranking, like mentioned by P3, to quickly let its user know to what degree of effectiveness the solution solved the problem (e.g., grade 5 for completely solved the problem and grade 1 for not having solved it at all). Another possible improvement is to give the semantic relations more visibility. An idea is to show the relations in a graph, like a visual thesaurus. Finally, considering one of the requirements elicited in the interviews, integration with other tools, CHIDeK could read files from other HCI tools, such as mockups created by prototyping tools and display their contents on the case.

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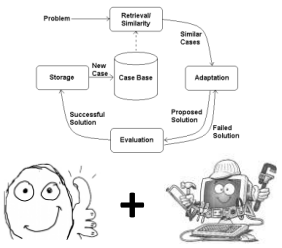
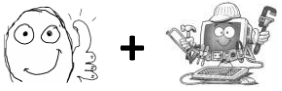
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## Appendix A: Interview Material

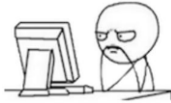
This section displays the material used on the first step, the interview with professional designers: the CBR presentation slides and the questions which guided the interview.

### A.1 CBR Presentation Slides

<p>Design com uma ferramenta de CBR</p>	<p><b>Problemas de design</b></p> <p>Juquinha irá servir um almoço para vários amigos...</p> <ul style="list-style-type: none"> <li>• Alguns não comem carne bovina ou de frango</li> <li>• Alguns só comem carne</li> <li>• Um é alérgico a leite</li> <li>• Um é fresco</li> <li>• É verão</li> <li>• É época de tomates</li> </ul> 
<p>Ferramenta de CBR em Design</p>  	<p><b>Introdução</b></p> <ul style="list-style-type: none"> <li>• Luisinho é um designer de interfaces que foi contratado para remodelar o sistema de compra de ingressos e foi contratado para remodelar o sistema CinemaOnline.com, que é um sistema de compra de ingressos de cinema online via smartphone.</li> <li>• Luisinho dispõe de uma biblioteca de casos que ajuda o designer no processo de CBR e decide utilizá-la para esta tarefa.</li> </ul>
<p><b>O problema (cenário)</b></p> <ul style="list-style-type: none"> <li>• Paula gosta de ver filmes alternativos. Um amigo a recomendou um filme interessante que assistiu outro dia. Paula resolveu ouvir a recomendação do amigo e entrou no site de venda de ingressos CinemaOnline.com pelo smartphone. Quando faz isso, ela vê que o sistema a reconheceu automaticamente. Como o filme é alternativo, não deve estar disponível em muitos cinemas, então ela decide fazer uma busca pelo nome do filme no sistema.</li> </ul>	<p><b>O problema (cenário)</b></p> <ul style="list-style-type: none"> <li>• Paula verifica as sessões encontradas e decide comprar o ingresso de uma vez. Ela escolhe a sessão no cinema mais próximo de sua casa, informa o número de ingressos e a forma de entrega. Depois, ela confere o pedido, indica a forma de pagamento e confirma a compra. Por fim, recebe uma mensagem de confirmação da compra dos ingressos.</li> </ul>

### CBR – Busca

- Para começar, Luisinho consulta a ferramenta em busca de casos que possam ajudá-lo.
- A ferramenta exibe algumas palavras-chave para que casos possam ser encontrados.
- Luisinho escolhe a palavra "Buscar".
- O sistema, então, lista alguns casos que falem sobre buscas em smartphones.



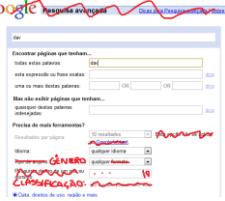
### CBR – Busca

- Um caso que pareceu interessante é a busca avançada do Google.



### CBR – Adaptação

- Porém, por se tratar de um problema diferente, Luisinho precisa adaptar o caso



### CBR – Avaliação

- Depois de fazer as adaptações, Luisinho avalia a solução. Para isso, ele pensa em como o usuário irá lidar com a interface...



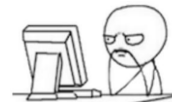
### CBR – Avaliação

- E conclui que não é uma solução muito boa, pois a interface é muito complicada para ser usada por smartphones
- Sendo assim, ele decide procurar outro caso que interesse



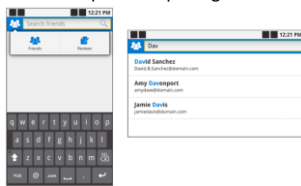
### CBR – Busca

- Luisinho volta à ferramenta e decide refinar sua busca. Além da palavra "Buscar" já selecionada, ele também seleciona a palavra "Dispositivo móvel"



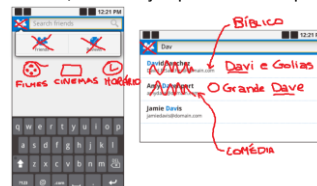
### CBR - Busca

- Outro caso que pareceu interessante é a de busca de um aplicativo que organiza contatos.



### CBR - Adaptação

- Porém, por se tratar de um problema diferente, esta solução precisa ser adaptada



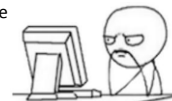
### CBR – Avaliação

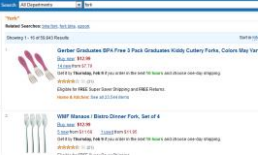
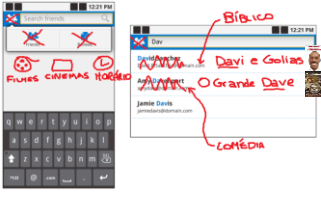

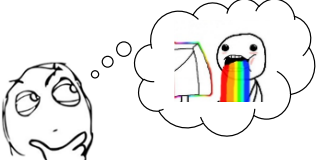
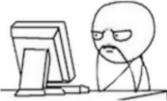

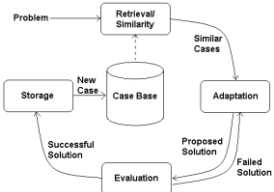

- Luisinho acha que essa solução é melhor que a anterior, mas ele vê que ainda há espaço para mais algumas adaptações



### CBR – Busca

- Luisinho volta à ferramenta e adiciona uma nova palavra-chave a sua busca: "Lista", pois ele quer encontrar algum caso que lide com uma lista de dados (no caso dele, filmes ou cinemas)



<h3 style="text-align: center;">CBR - Busca</h3> <ul style="list-style-type: none"> <li>Ele encontra um caso que exibe uma lista de produtos no qual exibe o nome do produto, detalhes e uma figura</li> </ul> 	<h3 style="text-align: center;">CBR - Adaptação</h3> <ul style="list-style-type: none"> <li>Ele adapta o caso que viu para a sua solução.</li> </ul> 
<h3 style="text-align: center;">CBR – Avaliação</h3> <ul style="list-style-type: none"> <li>Novamente, Luisinho avalia a solução que ele propõe...</li> </ul> 	<h3 style="text-align: center;">CBR – Avaliação</h3> <ul style="list-style-type: none"> <li>Luisinho conclui que essa solução é satisfatória. A busca do sistema lhe parece ser simples de interagir e bem informativo</li> </ul> 
<h3 style="text-align: center;">CBR – Armazenamento</h3> <ul style="list-style-type: none"> <li>Depois que a solução é testada, Luisinho cria um novo caso que será armazenado pela ferramenta de CBR</li> <li>Este caso será utilizado no futuro como insumo para se atingir um outro objetivo</li> </ul> 	<h3 style="text-align: center;">Design de IHC</h3> <ul style="list-style-type: none"> <li>O mesmo processo de busca, adaptação, avaliação e armazenamento do caso é repetido quantas vezes Luisinho achar necessária até concluir o design da interface de todo o sistema</li> </ul> 
<h3 style="text-align: center;">Case-based reasoning</h3> <p style="text-align: center;">O processo de raciocínio baseado em casos</p> 	<h3 style="text-align: center;">Ciclo CBR</h3> <p>Outros casos onde se usa CBR</p> <ul style="list-style-type: none"> <li>Advogados</li> <li>Médicos</li> <li>Call centers</li> </ul> 

## A.2 Interview Questions

The questions for the first step were divided in two groups. One group was asked before the CBR presentation and one was asked after it.

## A.2.1. Pre-presentation Questions

### A.2.1.1. In Portuguese

1. Qual é a sua formação?
2. Qual é a sua experiência na área?
  - a. Há quanto tempo trabalha?
  - b. Quais as atividades que exerce? Quais os tipos de problema com os quais lida?
3. Qual é a sua forma de trabalho?
  - a. Como busca entender o problema?
  - b. Como constrói a solução? Que representações usa (cenários, modelos, *sketches* etc.)?
  - c. Você utiliza exemplos?
    - i. Como (e onde) busca por exemplos?
    - ii. Como você usa os exemplos que encontra?
    - iii. Que tipos de exemplos você normalmente considera úteis? E inúteis? Por quê?
    - iv. Por que usa exemplos?
  - d. [Se não utiliza exemplos] Por que não?
  - e. Quanto de ênfase você dá à análise do problema e ao desenvolvimento da solução? Como você distribui essas atividades?
  - f. Como seria a ferramenta de design de IHC ideal para os seus projetos?

### A.2.1.2 In English

1. What's your academic background?
2. What's your experience in the area?
  - a. How long have you been working?
  - b. What are the activities you do? What kinds of problem do you deal with?
3. How do you work?
  - a. How do you try to understand the problem?



- b. How do you build the solution? Which representations do you use (scenarios, models, sketches etc)?
- c. Do you use examples?
  - i. How (and where) do you search for examples?
  - ii. How do you use the examples you use the examples you find?
  - iii. Which kinds of examples do you generally find useful? Which kinds are useless? Why?
  - iv. Why do you use examples?
- d. [If the participant doesn't use examples] Why not?
- e. How much emphasis do you give to problem analysis and solution development? How do you distribute these activities?
- f. How would the ideal HCI design tool for your projects be?

## **A.2.2. Post-presentation Questions**

### **A.2.2.1. In Portuguese**

- 1) O que acha do CBR?
- 2) Você vê alguma relação com a forma que você trabalha? Quais/Por que não?
- 3) Como uma ferramenta de CBR poderia contribuir com seu trabalho? O que ela deveria ter para ser o mais útil possível?
- 4) Como essa ferramenta poderia atrapalhar? O que ela não deveria ter?
- 5) Qual é a sua opinião sobre a introdução de uma ferramenta de CBR para apoiar o design no seu trabalho? Quanto tempo (em função de números de projetos e meses) você investiria para aprender a utilizá-la?

### **A.2.2.2 In English**

- 1) What do you think of CBR?
- 2) Do you see any relation with how you work? Which ones/Why not?
- 3) How can a CBR tool contribute to your work? What should it have to be as useful as possible?
- 4) How can this tool get in the way? What shouldn't it have?

- 5) What's your opinion about the introduction of a CBR tool to support the design in your work? How long (in terms of number of projects and months) would you invest to learn to use it?

## Appendix B: Study Material

In this section, we display the material we used in the second and third steps, the design activity with and without CHIDeK, respectively. First, we show the scenario used in both studies. Then, we show the questions which guided the interviews for each study.

### B.1 Scenario

#### B.1.1. In Portuguese

O Bike Rio é um projeto de sustentabilidade da Prefeitura do Rio de Janeiro em parceria com o banco Itaú e o sistema de bicicletas SAMBA. As bicicletas do Bike Rio estão disponíveis em estações distribuídas em pontos estratégicos da cidade, sendo uma solução de meio de transporte de pequeno percurso para facilitar o deslocamento das pessoas.

Um dos problemas que os usuários enfrentam é a ocasional falta de bicicletas em algumas estações. Isso é especialmente agravante para as pessoas que passaram a utilizar esse meio de transporte com frequência. Com a popularização do projeto, surgiu a demanda de vários usuários por uma forma de se realizar reservas de bicicletas com antecedência para que, ao se chegar à estação, não haja problemas devido à falta de bicicletas. Você é um designer de interação que foi contratado para desenvolver um sistema WEB o qual o usuário pode acessar e reservar uma bicicleta.

O sistema permitirá três tipos de reserva:

- Reserva rápida: a bicicleta fica reservada para o usuário durante 30 minutos. O preço desta reserva é R\$10.
- Reserva por uma viagem: a bicicleta fica reservada durante um dia inteiro, mas assim que ele retirá-la de uma estação e devolvê-la, a bicicleta estará livre para outra pessoa. O preço desta reserva é de R\$25.

- Reserva por um dia: o usuário reserva uma bicicleta que pode ser usada durante o dia todo. A bicicleta se torna propriedade do usuário durante esse dia, então ele poderá retirá-la e devolvê-la nas estações quantas vezes quiser. O preço desta reserva é de R\$40.

Para realizar a reserva, o sistema precisa que o usuário informe a estação onde ele deseja reservar a bicicleta e o tipo de reserva que ele vai querer. Em geral, o usuário sabe qual é a estação que ele quer, mas pode haver situações em que ele está em um lugar estranho e não saber quais são os locais das estações mais próximas (se houver).

O usuário precisa saber se a estação possui bicicletas disponíveis. Se a estação estiver vazia (sem bicicletas), o usuário deverá ser informado disso e ter a opção de escolher uma bicicleta de outra estação.

O usuário poderá também dizer por quanto tempo pretende utilizar a bicicleta e onde irá devolvê-la. Essas duas informações são opcionais, mas caso o usuário as forneça, o sistema irá reservar um espaço para o usuário devolver a bicicleta na estação desejada e no horário combinado. Isso evita o transtorno que ocorre quando o usuário pretende devolver a bicicleta em uma estação lotada.

### **B.1.2. In English**

Bike Rio is a sustainability project of the Rio de Janeiro's town hall, in partnership with the Itaú bank and the SAMBA bike system. Bike Rio bikes are available in stations distributed throughout the city's strategic spots, being a small-sized solution of means of transportation to ease people's transport.

One of the problems users face is the occasional lack of bikes in some stations. This is especially aggravating for people who started to use this means of transportation frequently. With the popularization of the project, many users started to demand a way to make bike reservations beforehand so that, when they get to the station, there are no problems due to the lack of bikes. You are an interaction designer hired to develop a Web system that the user will access and reserve a bike.

The system will allow three kinds of reservation:

- Quick reservation: the bike is reserved to the user for 30 minutes. The price of this reservation is R\$10.
- Reservation for a trip: the bike is reserved for a whole day, but as soon as he takes the bike from the station and returns it, the bike will be free to someone else. The price of this reservation is R\$25.
- Reservation for a day: the user reserves a bike that can be used throughout the day. The bike becomes the user's property during this day, so that he can take it and return it to the stations as long as he wants. The price of this reservation is R\$40.

To make the reservation, the system needs the user to inform the station where he wants to reserve the bike and the kind of reservation he wants. Generally, the user knows which station he wants, but there can be situations in which he is in a strange place and does not know the location of the closest stations (if any).

The user needs to know whether the chosen station has bikes available. If the station is empty (no bikes), the user must be informed of this and have the option to choose a bike from another station.

The user can also say for how long he intends to use the bike and where he will return it. Both of these data are optional, but if the user provides them, the system will reserve a space for the user to return the bike on the desired station and time. This avoids the nuisance that happens when the user intends to return the bike to a full station.

## **B.2 Post-Design Questions, with CHIDeK**

These were the questions asked after the study with the design activity with CHIDeK:

### **B.2.1. In Portuguese**

- 1) Do que você mais gostou nos casos?
- 2) Do que você menos gostou nos casos?
- 3) O que você achou da estrutura dos casos (problema, solução, avaliação)?
- 4) O que você achou da representação dos casos (texto e imagens)?

- 5) O que você acha que sobrou nos casos?
- 6) O que você acha que faltou nos casos?
- 7) De que forma os casos influenciaram na tarefa?
- 8) De que forma a ferramenta influenciou na tarefa?
- 9) Que tipo de coisa a ferramenta ajudou a encontrar?

### **B.2.2. In English**

- 1) What did you like the most about the cases?
- 2) What did you like the least about the cases?
- 3) What do you think about the cases' structure (problem, solution, evaluation)?
- 4) What do you think about the cases' representation (text and images)?
- 5) What do you think was too much (superfluous) in the cases?
- 6) What do you think was missing from the cases?
- 7) How did the cases influence the task?
- 8) How did the tool influence the task?
- 9) What kind of thing did the tool help you find?

### **B.3 Post-Design Questions, without CHIDeK**

These were the questions asked after the study with the design activity without CHIDeK:

#### **B.3.1. In Portuguese**

- 1) Você já conhece o domínio (ou sistemas similares)? Como?
- 2) De onde você tirou as ideias para montar sua proposta? (quais sistemas?)  
Por que você considerou esses sistemas úteis?
- 3) Se você fosse fazer uma busca para encontrar essas ideias ou outras mais ideias, pelo que procuraria (palavras-chave etc.)?
- 4) [*Caso tenha tirado as ideias de algum sistema*] O que você "olhou" nesses sistemas para ver o que se encaixava ou não no que você precisava?
- 5) Que mudanças você fez em cima dos sistemas para montar sua proposta?

- 6) Você sentiu falta de alguma coisa enquanto realizava a tarefa? O que?

### **B.3.2. In English**

- 1) Do you know the domain (or similar systems)? How?
- 2) From where did you take the ideas to build your proposal? (which systems?) Why did you think those systems were useful?
- 3) If you were going to do a search to find these ideas or other ideas, what would you search for (keywords etc.)?
- 4) [*If ideas were taken from a system*] What did you look at those systems to see see what fit or didn't fit in what you needed?
- 5) Which changes did you make on those systems to make your proposal?
- 6) Did you miss anything while you did the task? What?





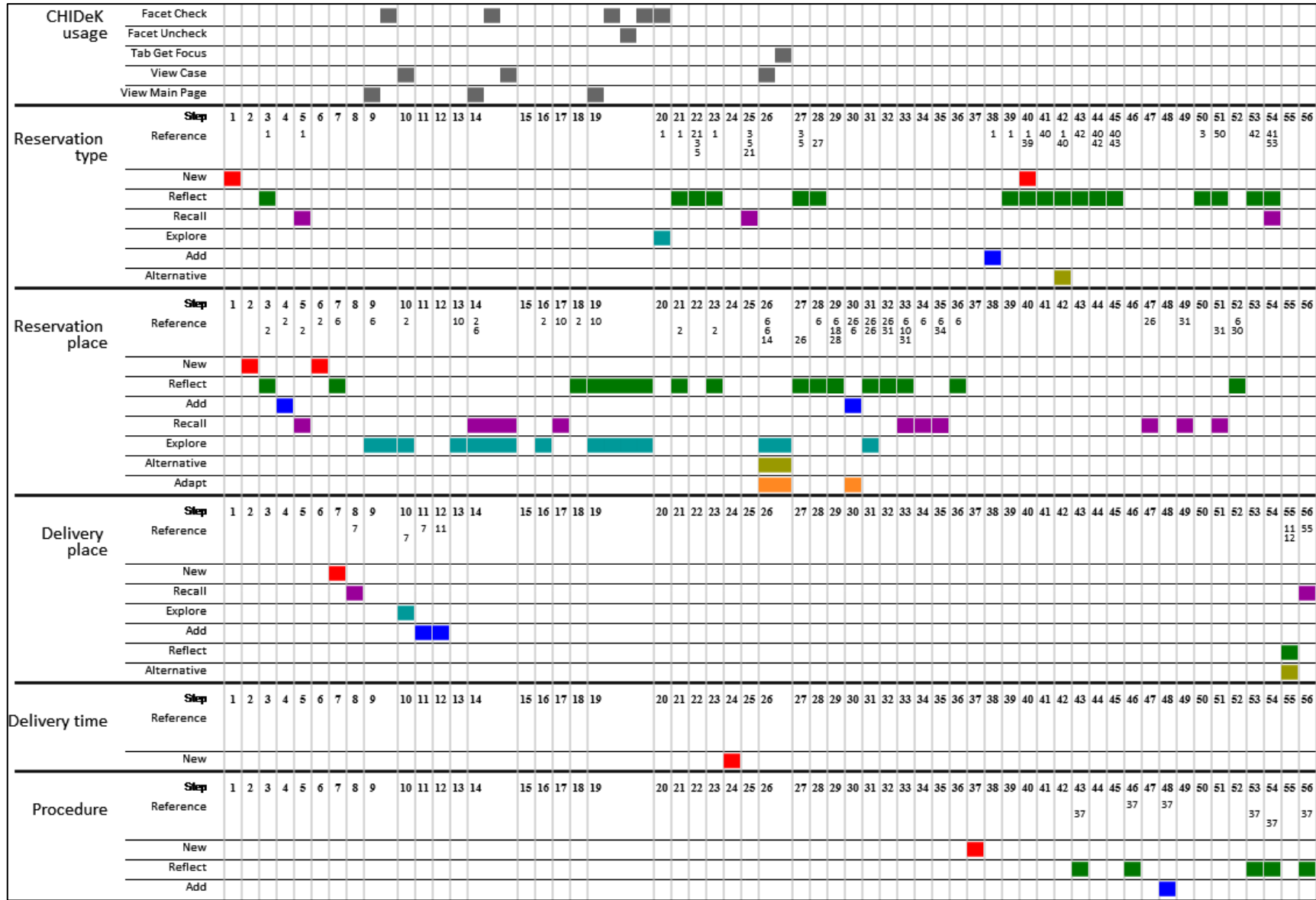


Figure 29: Table with P2's activity

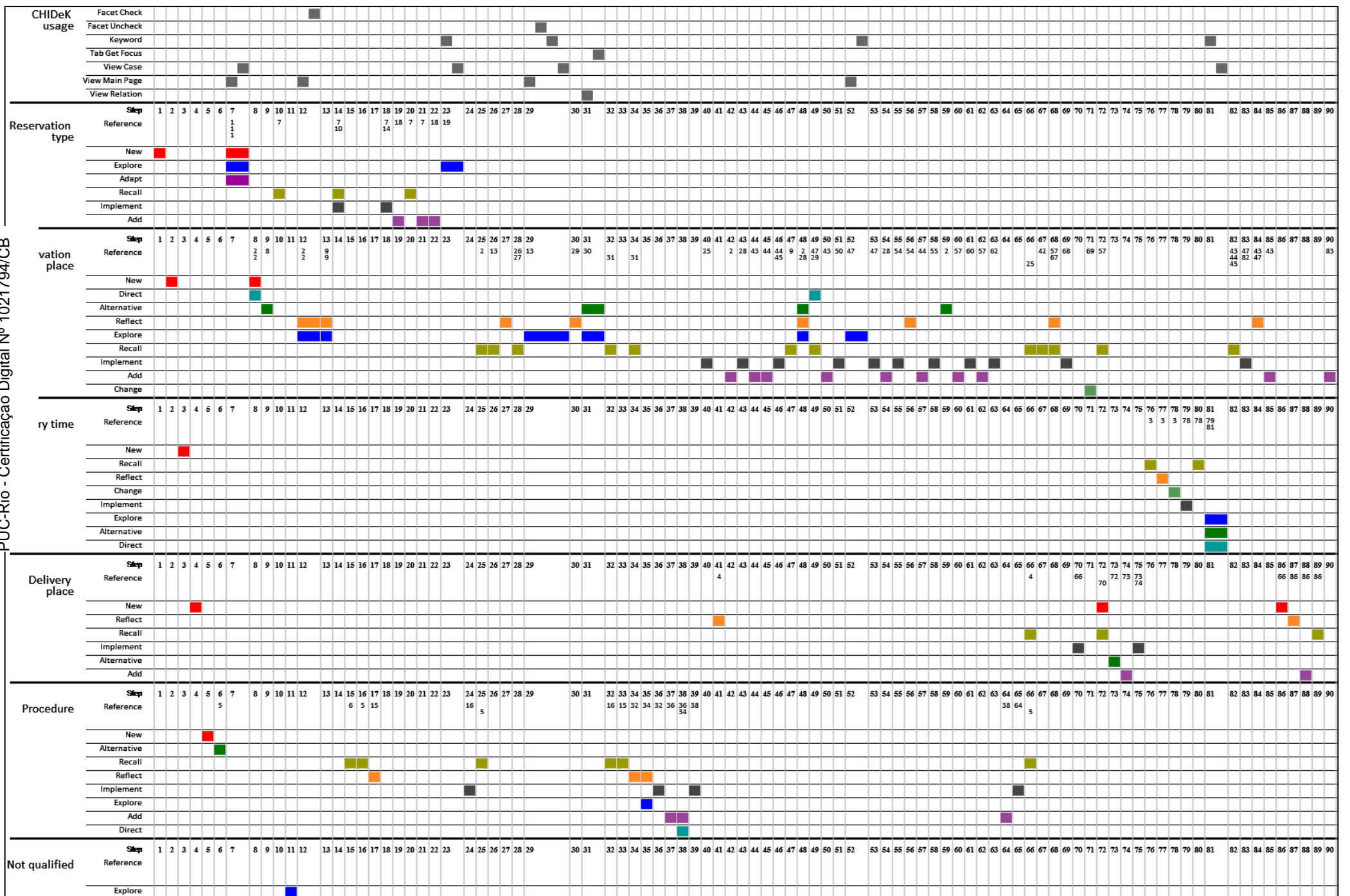


Figure 30: Table with P3's activity

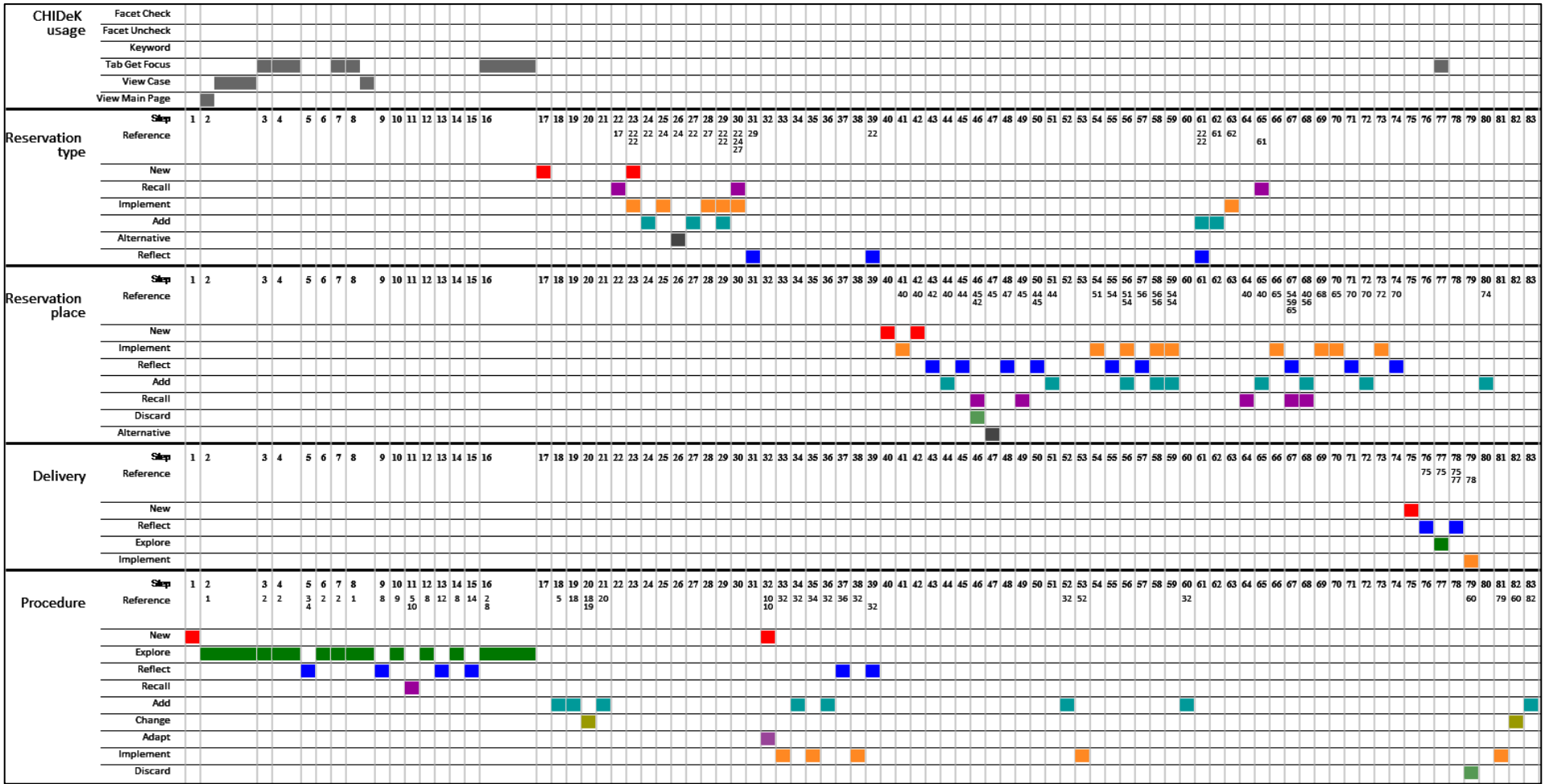


Figure 31: Table with P4's activity

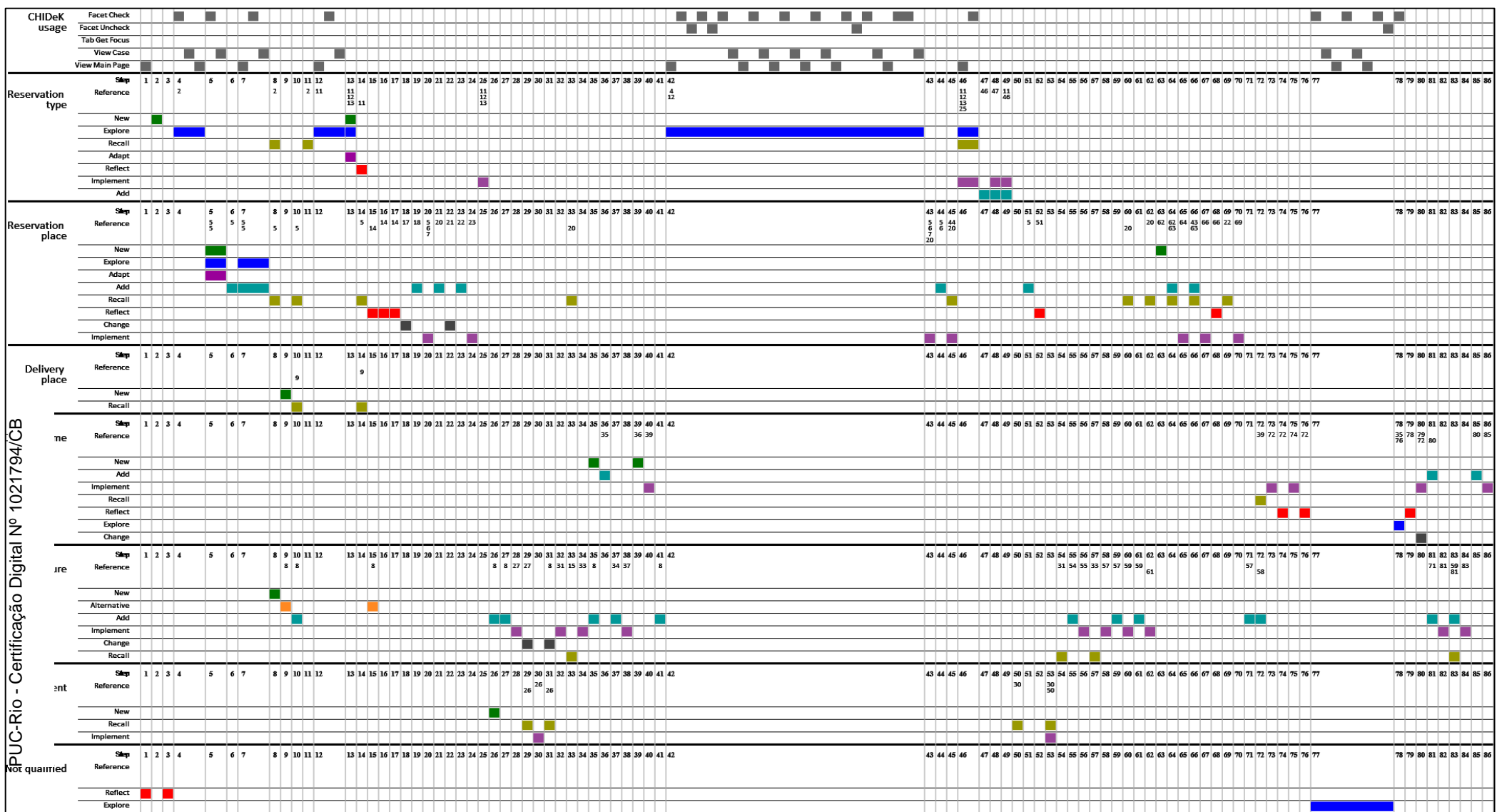


Figure 32: Table with P5's activity

PUC-Rio - Certificação Digital Nº 1021794/CB

Not quarried

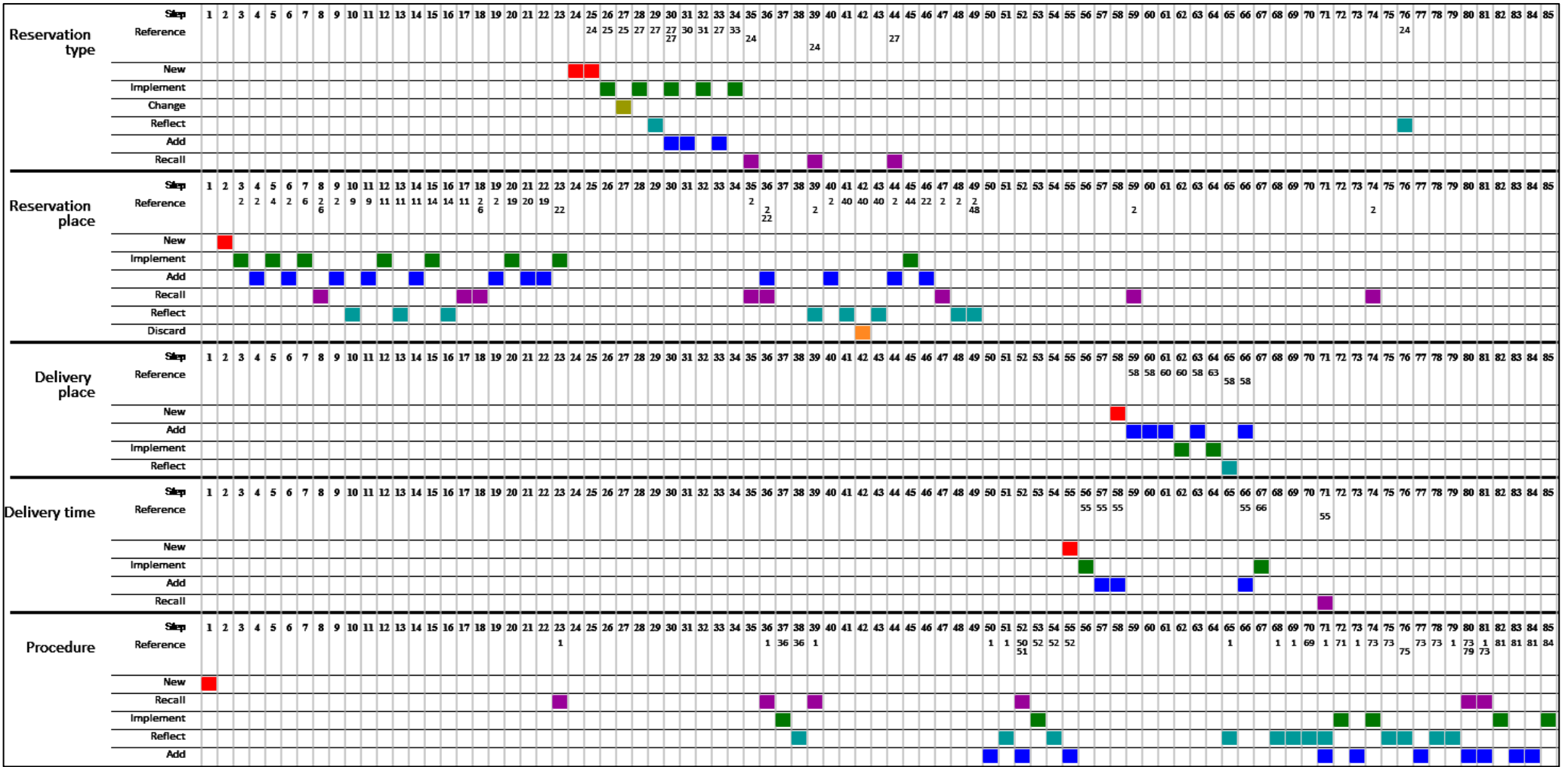


Figure 33: Table with P6's activity

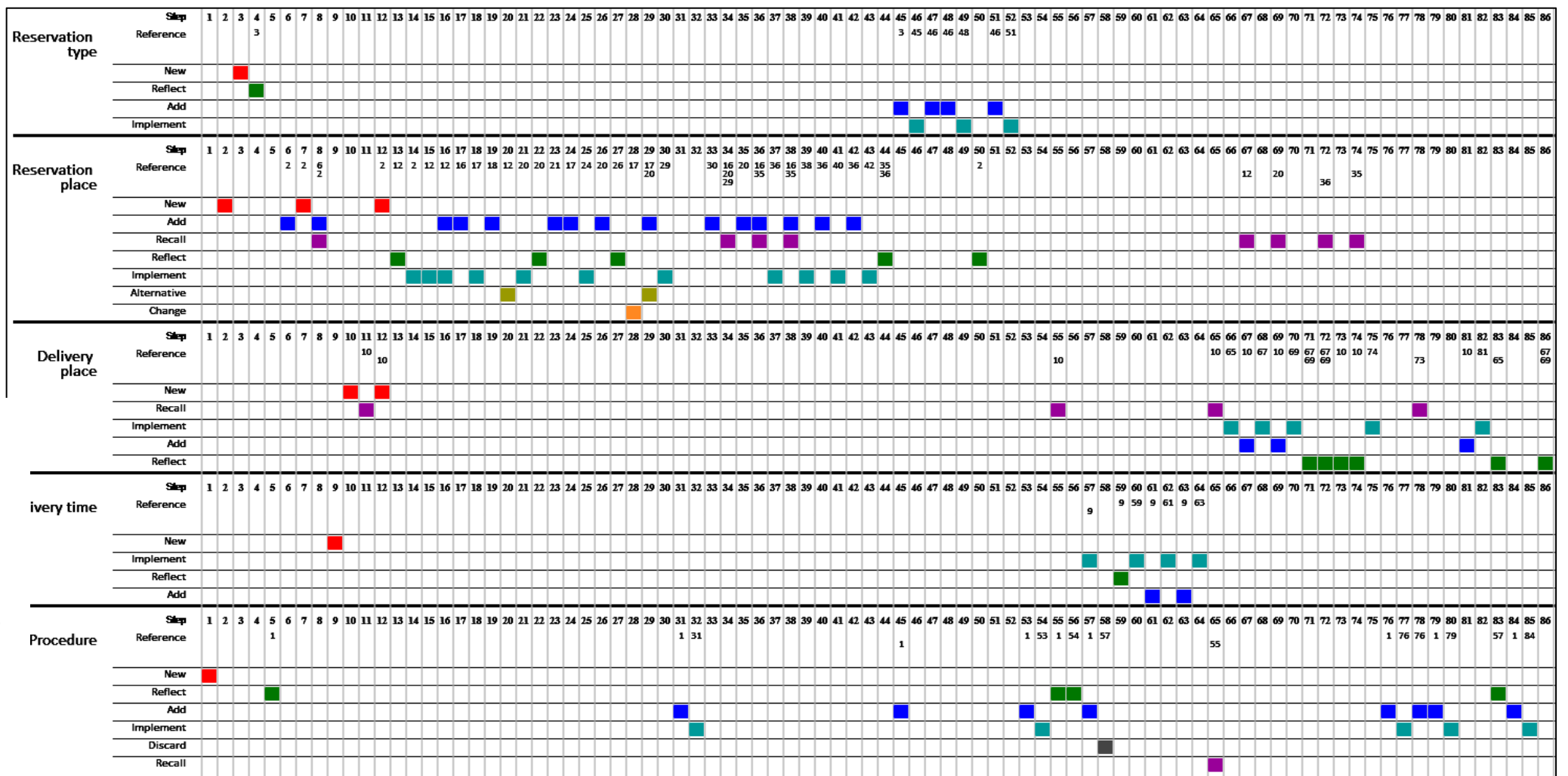


Figure 34: Table with P7's activity

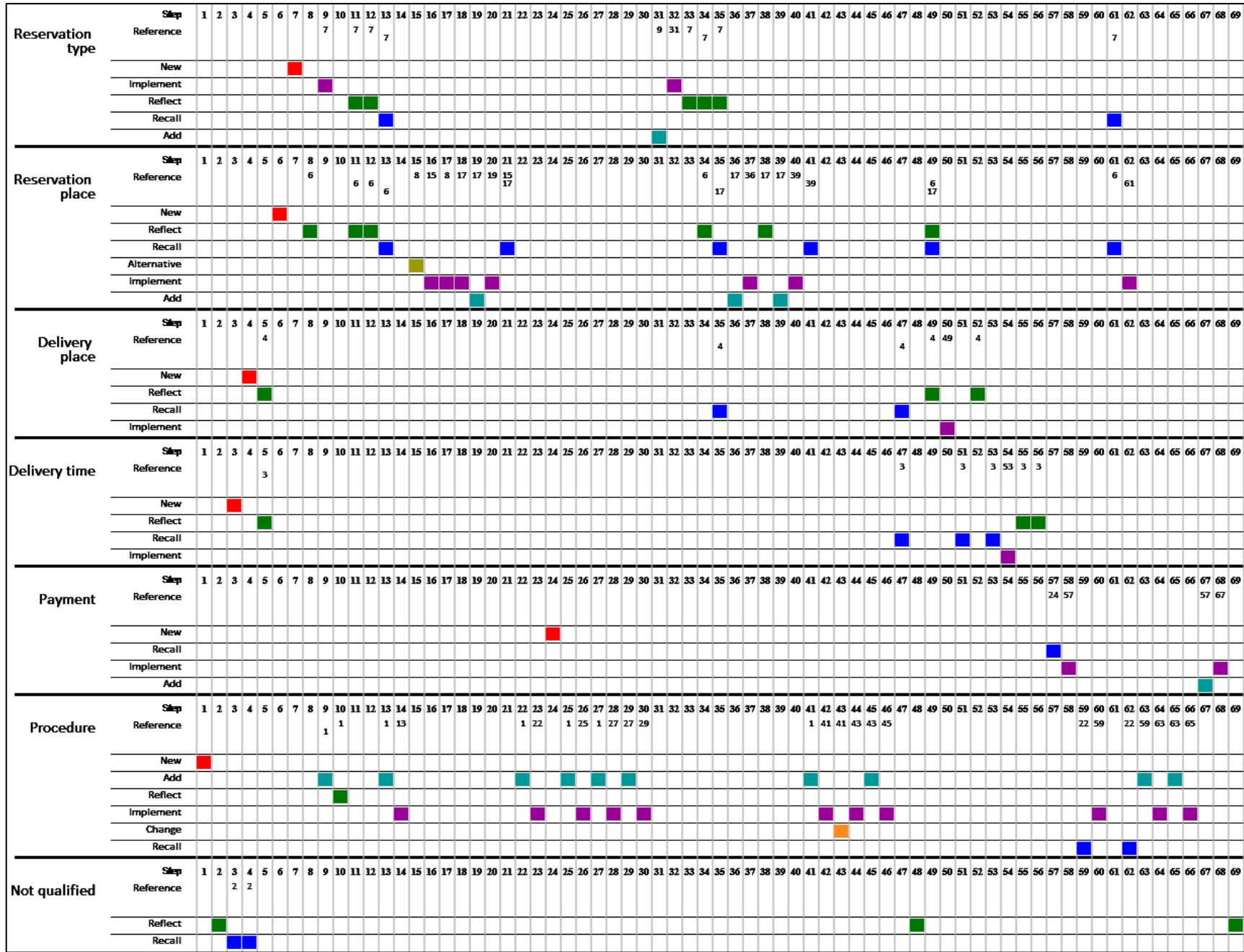


Figure 35: Table with P8's activity

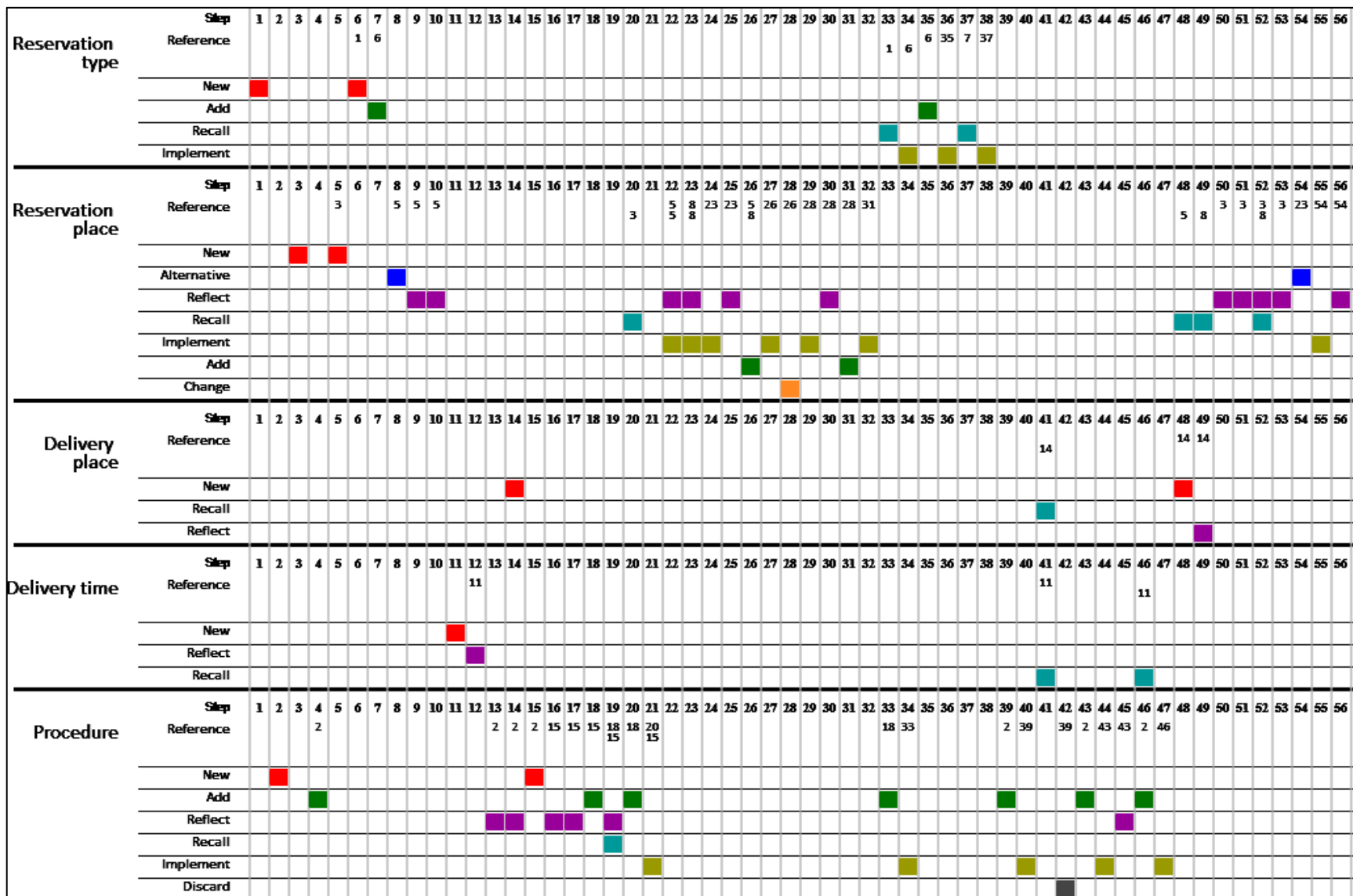


Figure 36: Table with P9's activity

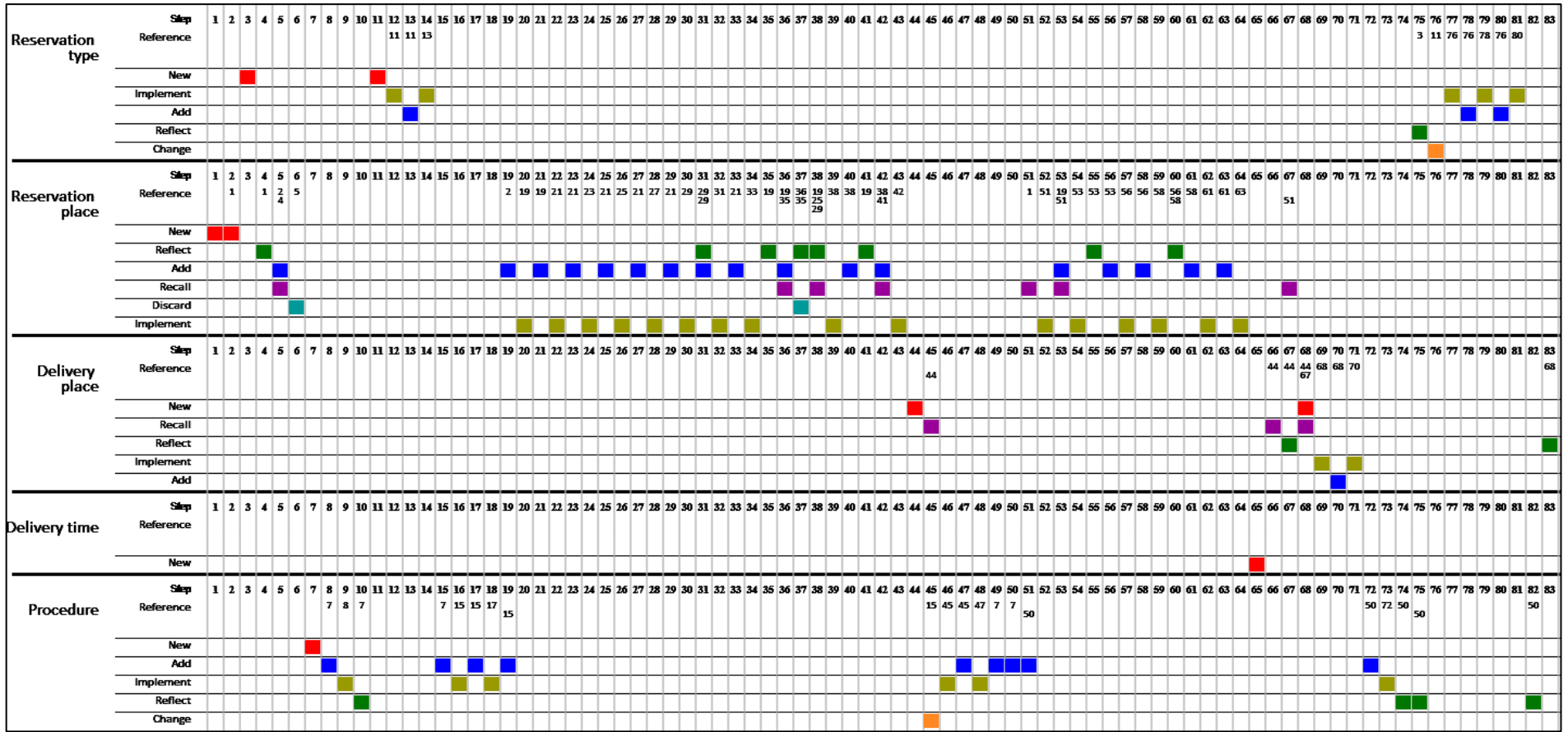


Figure 37: Table with P10's activity

# Appendix D: Study Participants' Sketches

In this section, we present some of the sketches done by the study participants.

## RESERVA BIKE RIO

1º PASSO - LOCAL DA RESERVA

ESTAÇÃO DE RETIRADA (POR BAIRRO)

1	▼
GÁVEA - ESTAÇÃO PUC	
GÁVEA - ESTAÇÃO SHOPPING	
LEBLON ...	

Nº DE BICICLETAS DISPONÍVEIS: 04

ENDEREÇO E MAPA

📍 SAIBA COMO CHEGAR

DEVOLUÇÃO EM OUTRA ESTAÇÃO  SIM  NÃO

ESSE CAMPO É OPCIONAL MAS SE PREENCHIDO, SERÁ RESERVADO UM ESPAÇO PARA A DEVOLUÇÃO

ESTAÇÃO DE DEVOLUÇÃO (POR BAIRRO)

1	▼
GÁVEA - ...	

VAGAS DISPONÍVEIS: 03

HORA DA DEVOLUÇÃO: 19:30:00

📍 SAIBA COMO CHEGAR

[+] FECHAR

2º PASSO - TIPO DE RESERVA

- RESERVA RÁPIDA - 30 MIN - R\$10
- RESERVA POR UMA VIAGEM - 1 DIA - R\$25
- RESERVA PELO DIA - R\$40

3º CPF:

DADOS DE PAGAMENTO

CONFIRMAR

STATUS DA SUA RESERVA

1º PASSO LOCAL DA RESERVA

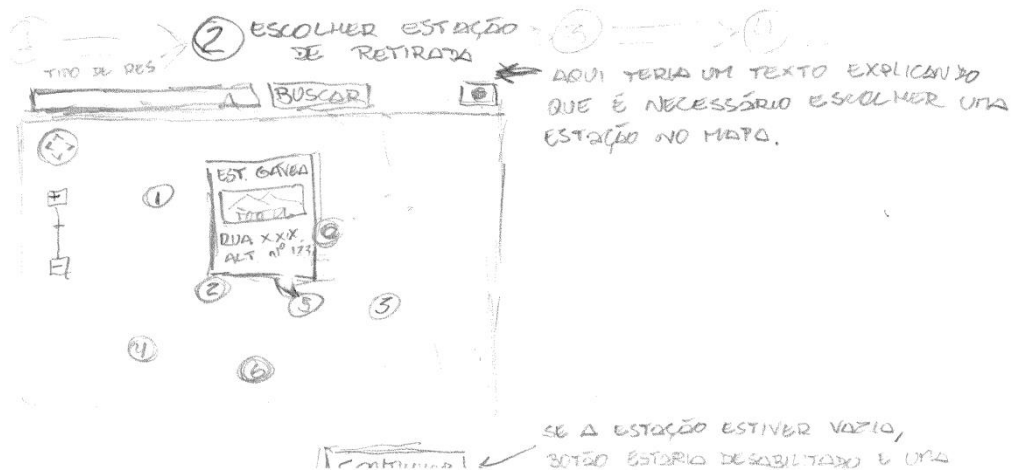
2º PASSO TIPO DE RESERVA

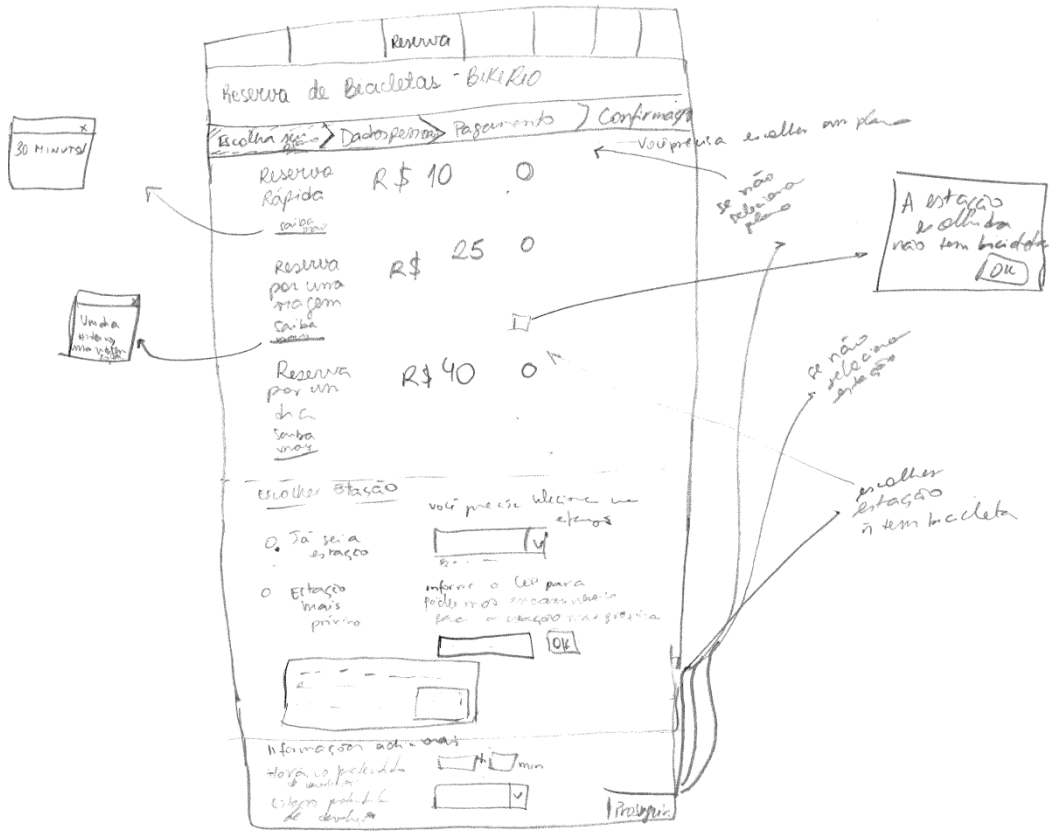
3º PASSO PAGAMENTO



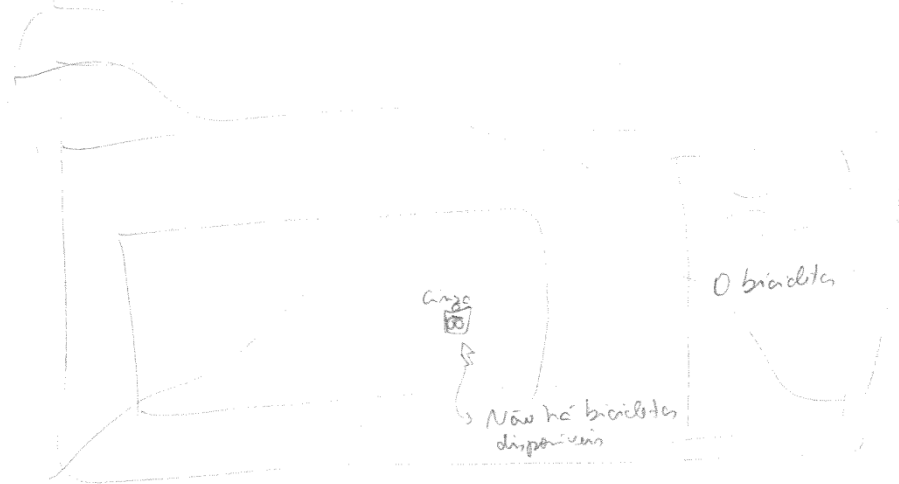
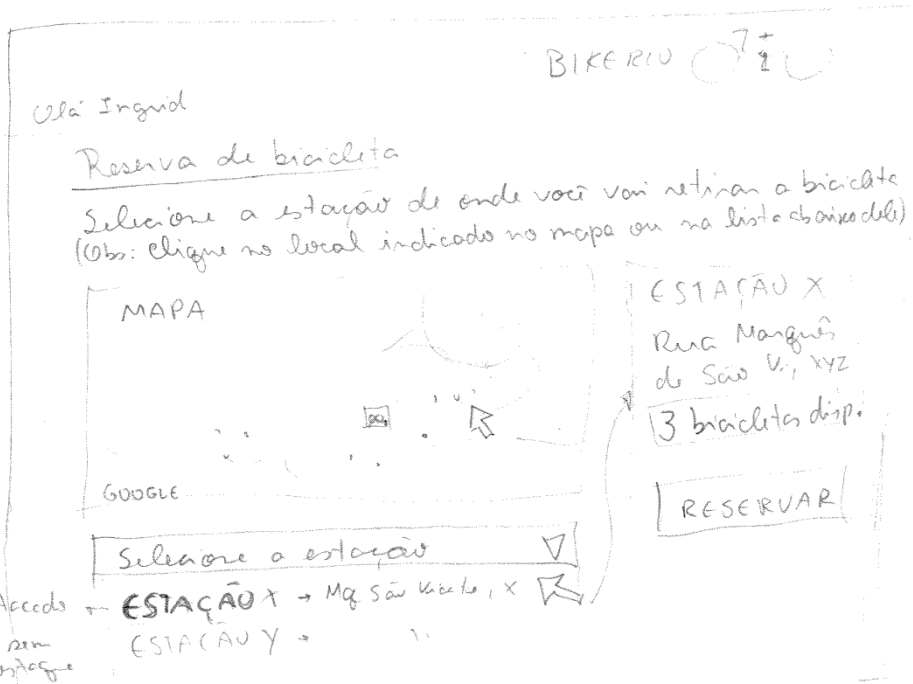
① TIPO DE RESERVA > ② ESCOLHER ESTAÇÃO DE RETIRADA > ③ VALOR EST. > ④ CONTINUA

TEMPO DE RESERVA	30 MIN	24 HORAS	24 HORAS
NÚMERO DE VIAGENS	1	1	ILIMITADA DURANTE O DIA
PREÇO	R\$10,00	R\$25,00	R\$40,00
	ESCOLHER	ESCOLHER	ESCOLHER









(Obs: Usar imagem do site para "Nenhuma bicicleta disponível"  
(imagem branca)

Reserva de bicicletas

Selecione o tipo de reserva.

- ⊙ Reserva Rápida: \_\_\_\_\_ R\$ 10
- ⊙ Reserva por uma viagem: \_\_\_\_\_ R\$ 25
- ⊙ Reserva por um dia: \_\_\_\_\_ R\$ 40

Informações adicionais

Hora da devolução 18h7 ?

Local de devolução  
[Local escolhido]

MAPA

600666

Selecione a estação

→ Telefone

? → explica que haverá  
reserva próximo do local

ESTACÃO

Endereço

→ X vagas

Confirmar

Confirmar  
Reserva

Cancelar

Obs. Usar imagem do site pl "Todas as vagas ocupadas" (imagem azul)

:\http - bikeRio.com.br

## RESERVA DE BIKES

Bom dia, usuário!

Passo 1: Escolha a ESTACA

ESTACAS:

C	
A	plata esp.
B	5"
C	2"

MSG. AVISO!

Perto de você...

Passo 2: Escolha TIPO DA RESERVA

RESERVA RÁPIDA saiba mais

RESERVA POR UMA VIAGEM SABIA MAIS

RESERVA POR UM DIA SABIA MAIS

Passo 3: informe tempo e LOCAL DE ENTREGA

PREVISA TEMPO DE USO:

LOCAL DE ENTREGA:

CONF. RESERVA

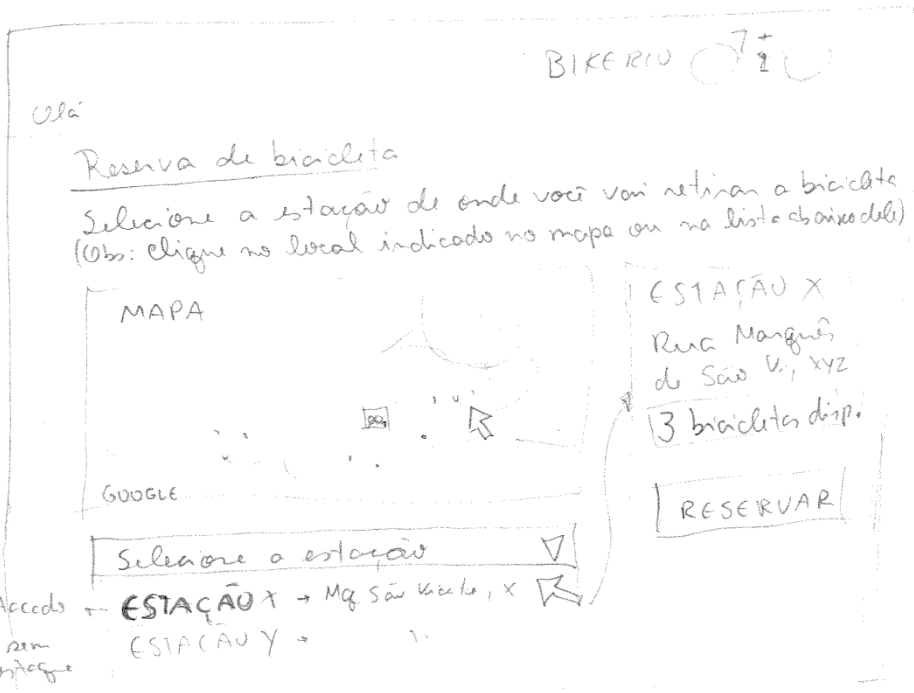
Busca (APONTADOR "like")

↓

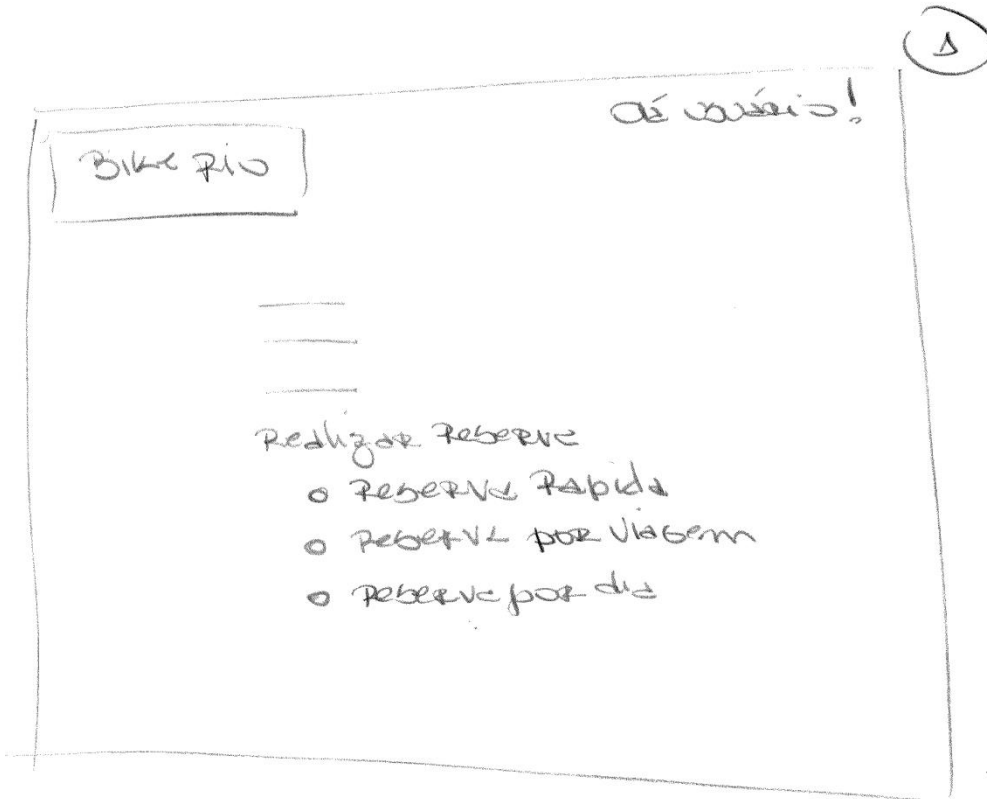
banco

(endereço)

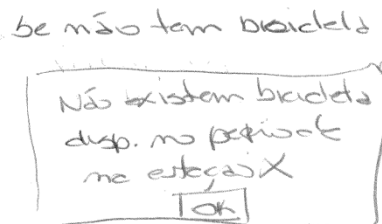
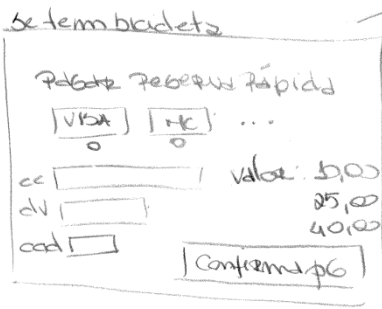
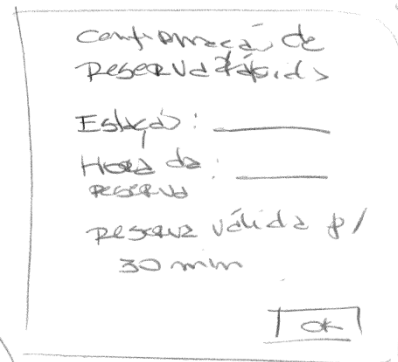
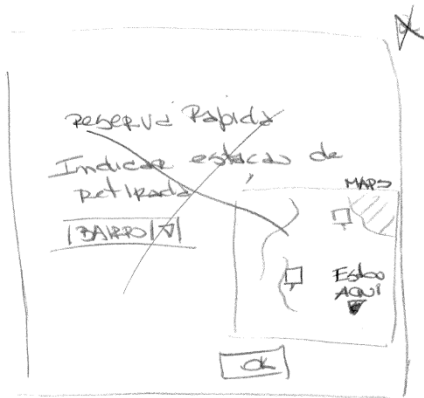
↳ Estações + próximas



Obs: Usar imagem do site para "Nenhuma bicicleta disponível"



Reserva Rápida



2

Tipo Reserva:  Bicielo  Viesem  Plata

Estação Retirada\*

Estação de entrega

Tempo de utilização:

Pagamento 2.1

Variáveis 0  
valor

2.3

Confirmação de Reserva p/ Viesem

Estação R: \_\_\_\_\_

Estação D: \_\_\_\_\_ *se houver*

Duração de reserva:

2.4

Confirmação de Reserva p/ dia

Est. R: \_\_\_\_\_

Est. D: \_\_\_\_\_

Duração:

Nº de bicicletas: \_\_\_\_\_