Balancing Complex Page Modeling and Usability for Rich Internet Applications

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Abstract The growth of Rich Internet Applications (RIAs) calls for new conceptual tools that enable designers and web engineers to model and keep under control the design complexity unleashed by innovative interaction (with increasing communication potential) and carefully consider the impact of the design decisions on the optimal flow of the user experience. Based on the theory of Situational Awareness, in this paper we illustrate how 5 major "interface demons" are particularly relevant for RIA engineering and undermine an effective dialogue between users and RIA interfaces. From this analysis, we propose a set of conceptual design primitives (Rich-IDM) to enable designers and web engineers to characterize the complex components of RIA models and take design decisions which meet both usability and communication requirements.

1 Introduction

Rich Internet Applications (RIAs) are an increasingly common family of interactive systems that is pervasive in many web domains, from e-commerce to branding sites, to social networking, and other Web 2.0 services. With respect to traditional web

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applications, low-latency interactivity, widget-rich pages, and desktop-like navigation among screens are some of the most apparent features of RIAs that are affecting not only our way to use, but also our paradigms to conceive, design and engineer the future generations of web applications. It is possible to identify at least two broad categories of meta-requirements or high-level driving forces behind the evolution and articulation of RIAs: *communication effectiveness* and *usability* [16]. On the one hand, by communication effectiveness we mean the set of requirements concerned with the key messages that the application wants to convey to its target audience. In this perspective, it can be argued that the highly-engaging, interaction-rich, and dynamic user experience afforded by modern RIAs is a potentially great enabling factor to meet these requirements, by it unleashes designs aimed at inducing pleasure, fun and even surprise. On the other hand, usability is traditionally concerned with the degree to which the application can be used efficiently and effectively by the intended target audience to achieve the expected tasks in specific contexts of use (ISO 9241).

Ensuring that users can make sense of the application features, understand what they can do and easily identify, locate and manipulate the means to do it are fundamental concerns for a successful user experience [7]. Highly effective applications from the communication perspective can be catastrophic from a usability standpoint; and highly usable sites can be so dry, crude and minimal that miss to make a positive, long-lasting impression on the target audience. Looking at this tension through the theoretical lens of Situation Awareness [2], in this paper we will analyze phenomena of poor usability of RIAs, and we will indicate how these issues can be addressed by adopting a fine-grained systematic modeling of the user experience design. We advocate that the notion of *user interface plasticity*, originally introduced by [6] as "the capacity of user interfaces to adapt, or to be adapted, to the context of use while preserving usability", and proposed by other authors [17] as a criterion to evaluate "design decisions... in terms of their influence on UI ergonomic quality, using Ergonomic Criteria", must be effectively extended to the interaction flow between the user and the application. In RIAs, this calls for new or updated methods to engineer the system's *information architecture*, correctly balancing technical concerns (rich interface widgets), and communication concerns (related to UX requirements). To argument our ideas, case studies will be shown in order to practically explain five well-known SA demons [2]: Attention Tunneling, Misplaced Saliency, Errant Mental Model, Requisite Memory Trap, and Data Overload. These case studies will correspond to five existing RIA applications, spanning form e-commerce domain to social software. To address these issues, we propose a suite of simple conceptual design primitives that can enable designers to avoid these pitfalls on RIA pages and yet to engineer complex interactions leveraging RIA technologies. The remainder of the paper is organized as follows: Sect. 2 is a systematic introduction to the poor RIA design problems using the Situational Awareness theory; Sect. 3 reports on key related work in the area of RIA engineering approaches and User eXperience (UX) requirements design; Sect. 4 gives a brief introduction to our methodological approach in order to address these issues; in Sect. 5 the conclusions summarize our key messages.

2 Interface Deamons for RIA Design

The new features of RIAs tend to exhibit potential "demons" that can negatively affect the usability of the interaction, and that can be vividly characterized by following Endsley's general principles of "poor" Situational Awareness (SA) [2]. In the following, we present each demon providing an example derived by the analysis of real RIA websites.

Attentional Tunneling. At the micro-interaction level, design features that mix static content (such as text and image), multimedia (such as animation, etc.), and new, dynamic and reactive interface widgets can divert the user's attention from the intended, unifying message of the page.

This unexpected effect that is increasingly common in RIA interfaces, is well known as a fundamental problem of *Attentional Tunneling* in the theory of SA [2]. It is mainly caused by the expanding number of interaction rules that highlight specific interface elements over others at any given time. A clear example is visible in the design of Hogan site (Fig. 1), a well-known Italian shoe brand (www.hoganworld.com). The whole site content revolves around the variety of shoe products manufactured by Hogan. The site design is based on a real world metaphor: *the street*. This metaphor is used as the *main information channel* to provide access to the entire site's content. The main site section is a panoramic, interactive 360-degree photo of a street. On this photo, there are some hot-spots (represented by specific objects) that allow the user accessing specific features of the site. This type of *exploratory interface* is quite common in RIAs. By definition, an exploratory interface is not necessarily self-explanatory and immediately intuitive. Users need to explore the panoramic photo to "discover" hot-spots (they are not explicit from the outset), and to memorize their location: link labels suddenly appear as users accidentally mouse over the various parts of the map, and disappear as the users move away. This interaction also implies that users encounter many redundant links (many parts of the map lead to the same place), and overall it is very difficult to get a clear sense of how much is available and what are all the navigation options for the users. Attentional Tunneling comes into play as this page design emphasizes so much this exploratory interface that users risk to be *exclusively* drawn to it, thus neglecting the other parts of the page, which provide primary navigation options. The main navigation, in fact, is the "Navigon" link (reported on the left of Fig. 1) that is presented as a minor, hidden, and deemphasized option, which is communicated as equivalent in importance as secondary, "service" links, such as Contacts. Finally, once drawn to explore the map, there is no way for users to be contextually alerted of complementary (more traditional and comprehensive) navigation options, enabling them to move out of the exploratory channel. How to address this design issue to avoid usability problems and still leverage the communication potential of attractive interface components?

Misplaced Saliency. Moving from the level of the access structures (how to navigate to locate and reach contents) to the actual content base of the application, recurring Attentional Tunneling can easily bring users to misplace (or mis-locate) the "saliency" of the overall message of the page content. This problem can be

Fig. 1 www.hoganworld.com, homepage (Oct. 2010)

summarized by the implicit question of the user: What is the designer showing me now? What is the main intent of this page? A clear example of *Misplaced Saliency* is visible on the site of Gilette (www.gilette.com). The main goal of the Gilette site is to illustrate information about the shaving products. In detail, the example is focused on the page that shows the features of the razor "Gilette Fusion Power" (Fig. 2). In the middle of the page, the picture of the razor has several hot-spots that highlight each one a specific feature. It is clear that the designer needs to address the user attention on the razor (present in the third section) in order to encourage the user to click the hot spot. Instead, the second section, which provides the animated shape of the razor testimonial (3D avatar), results doubtless more salient for the user. Although, the animation through its movements tries to spur the user to access the razor, it remains overly prominent over the content itself. This dynamics is also compounded by the fact that the avatar suggests that he is going to do something, and this calls the user for waiting upon his actions. What is the relationship between this animated avatar and the content?

Errant Mental Model. At the general design level, users may have difficulty in capturing the underlying conceptual model of the designers—which should ideally match the user's mental model—thus giving birth to so called *Errant Mental Model* [2]. An example of this demon is visible in the homepage of the site Scrapblog (www.scrapblog.com). The homepage has the goal of providing a complete vision of the site offers and the access structures to them. The homepage (showed in Fig. 3) is dominated by the Sect. 2, which is composed by a set of pictures that alternate to the user (carousel), and that highlight the site features. When the page is showed, the user can act on two buttons placed in the second and third section, and labeled in the same way "start creating". The interface makes immediately clear the semantic relation between the two buttons because: (i) they have the same label; (ii) they have a similar look&feel aspect; and (iii) the button of the third section does not have its

Fig. 2 www.gilette.com. Showcasing the features of the fusion power razor (Oct. 2010)

own description, but it use the explanation of the button of the second section. This relation defines a mental model that connects the two buttons through their goals, their look&feel aspects and their positions. In a first moment, the homepage seems well structured and does not present usability problems but, after few seconds, the carousel updates the central part of the page, showing a new picture (Fig. 4) that contains a new button in Sect. 2.

The change of the pictures is not compliant with the mental schema defined before by the user. The new couple of buttons, compared with the previous one, has the same graphical aspect, the same position, and label with similar meaning ("Start Creating" and "Get Started Now"). But the goals of the two buttons are different: "Get Started Now" allows accessing the specific site features for the kids, while "Start Creating" allows creating a generic product (as in the first version). This mismatch between the first and second versions of the page is an example of *Errant Mental Model* demon. The carousel makes a modification of the functionalities of the page elements, without a correct change of the context, such as a change of the position or of the look&feel. What is the perceived relationship between the several elements of the page? How can these relationships be modeled in order to delivery a correct message to the site visitor?

Requisite Memory Trap. The massive use of animations (such as sliding windows), that trigger continuous changes of the interface, greatly stresses user working memory by forcing users to recall their specific position in the local and global information architecture, the affordance of specific controls, and where they are located. This effect is traditionally called *Requisite Memory Trap* demon [2]. An example of this demon can be found in the homepage of the site of communication carrier Verizon. The homepage that we do not report for lack of space, shows the features of the offered services. The page content is not so dense, but the page is long and requires the use of the mouse scroll to be completely viewed. The page presents various mechanisms that allow users to change (hide/unhide) completely the provided information without page reloads: there are 6 areas but 17 several contents that can

Fig. 3 www.scrapbook.com. The view of the homepage when the user accesses the site (Oct. 2010)

Fig. 4 www.scrapblog.com. The second image of the carousel of the homepage of Scrapblog (Oct. 2010)

contain other dynamically showed elements. The information showed *one-shot* to the user is few if compared to the global quantity of information contained in the page. But, to have a complete schema of the information, the user could access all the hidden elements, which are mutually exclusive. This situation is directly related to the Required Memory Trap demon. What is the role of mutual interactions between the page elements in the information delivery? How can the designer check the user required cognitive workload to understand the showed information?

Data Overload. As related effect, the current trend to use RIA enhanced interface to compress the information in a single page view is prone to cause information overload in the dialogue with the users. This is known as *Data Overload* demon [2].

In the analysis of this demon, it is necessary to take in care that the concept of Data Overload in a web environment is related not only to the number of line of data presented to the user at the same time. This concept must be seen as the capability of the user to create a schema of the information compliant with his/her background. In a standard application (focused on specific information contents) the quantity of information puts this capability in difficulty while in a web application the user becomes in crisis because he/she has to manage many little pieces of heterogeneous information. In both cases, even if for different reasons, it is possible to recognize the Data Overload demon. An example of this demon is present in the homepage of the site of the stylists Dolce and Gabbana (www.Dolce&Gabbana.com). The site homepage contains a set of big pictures that present in a single view all the images about collections, restaurants, events, and shows that are not semantically connected. The effect for the user is an overload of heterogeneous and not focused contents. How can the designer manage heterogeneous information delivered to the user?

In this analysis of potential problems of RIA user experiences the emerging fundamental issue is that the chances that users get lost in this complex, interactive dialogue are very high.

3 Related Work

The research on RIA conceptual modeling has followed two main tracks: the first one is related to the modeling of data and business logic on the client-side, the second one is related to the modeling of enhanced user interface elements [12]. Many design methodologies that are helpful in the modeling of the traditional web application have been extended in order to model the new features of the RIA. OOHDM design framework proposes a design process in which the interface and its behavior are explicitly analyzed and examined [18]. The Rich Internet application User eXperience model [15] (RUX-model) is a significant methodological advance in RIA interface model. RUX-model through its abstract interface level describes the aspects of the interface common to all the RIA technologies. WebML [4] adopts all the RUX-Model level related to the interface aspects while UWE (UML-based Web Engineering [11]) extends its connection rules between the used presentation model and the RUX abstract interface meta-model. The approach offered by OOH4RIA [13] is based on a model-driven process that specifies the artifacts to model a complete RIA for a Google Web Toolkit (GWT) [9].

Besides these approaches, there is a research area that is focused on the specific user interface features. Model Driven Engineering (MDE) approach is been pushed [6] to the limit in order to reconcile high-level modeling techniques with low-level programming to model the advanced features of modern application. Moreover, many studies are exploring new issues: (i) the needs to have a systematic approach for characterizing UI tuning in terms of quality in use along context of use variations [17]; (ii) how human-computer interaction can be based on discourse modeling, even without employing speech or natural language [10]. The system AUGUR [8] provides

context-aware interaction support for navigating and entering data in arbitrary form-based web applications. Formal methods are widely used to analyze human-computer interaction in order to prevent the gap between the interface and the user mental model [5]. Furthermore, the formal models of user interface designs are used as the basis for designing software evaluation studies [3].

According to the need of evaluating the interface in the early phase of the design and to support the designer to project correctly the communication aspects, we start our approach analyzing the interface of RIA through a set of demons of Situation Awareness [2]. Whereas all these approaches provide support for bridging the gap between the interface features of RIAs and methodologies for conceptual and technological development, they lack in characterizing the fluid, smooth and organic nature of the user interaction and navigation in RIA. To meet the challenge to model all the RIA aspects, we propose to extend this perspective to examine the connection between RIAs interface modeling (well connected to an underlying conceptual structure) and the requirements for the user experience.

4 The Rich-IDM Primitives

The new features of the RIA have changed radically the user experience. Thus, many design methodologies have requested specific extensions to manage correctly the new RIA features: webML [4] and UWE [11] are been extended through RUX [15]. These approaches formalize the technological aspects of RIA but they do not consider enough (in our opinion) the evaluation of changes in the user experience and how it evolves.

The importance of the user experience analysis has been already described through the *interface demons* caused by the incorrect use of the augmented RIA interface. Thus, it is clear that it is really important to have suitable methodological tools in which the single primitive has a well defined communicative semantics and allows to design the fluid, smooth and organic nature of interaction and navigation paradigms of RIA. On the basis of these needs, in the following, we present a methodological approach called Rich-IDM [14] based on Interactive Dialogue Model [1]. Interactive Dialogue Model is a dialogue-based design technique for model the communicative structure of information-intensive interactive applications. At first, we present briefly all the primitives of Rich-IDM considering their notation, semantics and user experience aspects (see Table 1). Then, for each primitive we describe its semantic and its specific features. In this analysis, we presume that the reader knows the basic concepts of IDM (available at [1]).

The RIA Page Element. In Rich-IDM, the minimum piece of information is called RIA-Page Element and it is managed as a unique block. In detail, the RIA-Page Element is defined as coherent atomic fragment of RIA page which displays a specific content, mapped to a dialogue act belonging to the IDM logical design. It could be specialized in: (i) Introductory RIA-page Element that has the main goal to introduce the specific content and, often, is related to an introductory dialogue act;

Table 1 Rich-IDM modeling primitives at a glance

Name	Notation	Design semantics	User experience concern
Content RIA-Page Element		A coherent, atomic fragment of RIA page which displays a content unit, as directly mapped from IDM content dialogue acts	Perceive the "rheme" (novel message) of the interactive communication flow
Introductory RIA-Page Element		A fragment of a RIA page which displays mechanisms to enable access to multiple instances of a topic, as directly mapped to a introductory dialogue act of the L-IDM design	Grasp the coherence of a group of topics and be able to start exploring them
Transition RIA-Page Element		The reification of an IDM transition dialogue act on the RIA page. It allows users to follow the semantic relation of two topics	Explore analog topic through associative, lateral paths
User experience core		A connected composition of page elements, which communicates the semantic nucleus of what is offered to the user at a given moment	Focus the attention on the primary, central message of the page
RIA-Handle		An interaction affordance, which enables users moving within two or more page elements of the same user experience core	Activate micro-interactivity on content elements without leaving the context of the core of the page
Context view		A set of user experience cores that maintains navigational context, orientation, organic, and fluid transition between the cores	Keep peripheral attention on the secondary, framing elements of the page
Default element		Indicate the default RIA-Page Elements	–

(ii) the Content RIA-page Element that, mapping (one or more) content dialogue act, displays to the user the payload of the dialogue; and (iii) Transition RIA-page Element that shows the semantic information that links two topics. The relation of these primitives with the model of the information (defined in IDM) allows establishing a direct link with the RIA requirements. Thus, it is possible to evaluate in the early phase of the design the balance between the different types of delivery contents. For example, it is clear that the excess in a single page of Introductory RIA-Page Elements (that are used to access to heterogeneous contents) creates some difficulty for the user that has serious problem to understand the page structure and to establish the correct actions to do. This causes the "Data Overload" demon that could be prevented using Rich-IDM. Relating the primitives to their semantic, Rich-IDM allows balancing the type of the contents and to group semantically the several introductory acts the user can alternatively view.

RIA-Handle. RIAs propose to the user an interaction mechanism that is different from a classical web application. Thus, after the definition of the RIA-Page Elements, that are the interaction objects, it is necessary to define a new primitive that is able to model the mutual relation between the elements of the page. This new concept is the RIA-Handle, which main goal is to model all the dynamic aspects of the UX. The RIA-Handle is a directional relationship between the RIA-Page Elements involved in a user action. Its main focus is not on how the specific technologies manage the events, but on how the user can navigate with the application activating the transition to the target. The RIA-Handle captures the syntactic of RIA interaction, on top of the semantics modeled by the other elements. From the methodological point of view, the RIA-Handle allows designers to represent all the relations contained in information architecture.

A carefully use of the RIA-Handle helps the designer to manage correctly several interface demons. In particular, the number of the RIA-Handle which target is the same User Experience Core (see next paragraph) of the source can express a measure of the interface objects that change and modify the UX (such as in the "Requisite Memory Trap" demon); in fact, each handle acts on an object (the target) and could have effects also on the source (that, for example, could be hidden). Furthermore, the several kinds of the events (such as MouseClick, MouseOver) can measure the number of the possible kind of interactions managed by the interface, and thus it measures the elements of the dialogue. A great number of event types increase the complexity perceived by the user, who has to learn how to compose these events to reach a specific content or goal.

User Experience Core. In a standard web application, the user attention is focused on "a page". On the contrary, in RIAs many information elements (that could not be semantically directly connected) can be collapsed in the same page. Thus, the core of the dialogue is not directly related with the displayed elements. To resolve this need, a completely new concept called User Experience Core is defined. Its main goal is to model clearly the elements of the Rich-IDM design that must be the heart of the dialogue with the users. The designer must manage the elements contained in the User Experience Core carefully because their perception affects strongly the sense and the quality of the message delivered to the user. On this basis, the semantics of

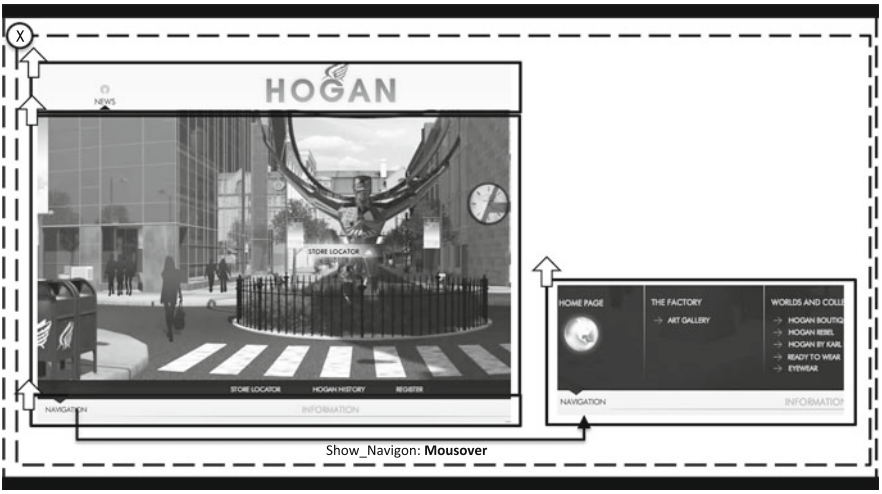

Fig. 5 The Rich-IDM model of the homepage of www.hoganworld.com (Oct. 2010)

the User Experience Core is to define the unit of perception of the dialogue. Formally, the User Experience Core is a container of the RIA-page Elements. At the start of the navigation, the default RIA-page Elements showed to the user is marked with the Default Element described in Table 1. The RIA-Handle mechanism is used to model the navigation between the User Experience Cores independently if they are (or not) part of the Context View (see the next paragraph). Many RIA interface demons are mitigate by a correct use of the User Experience Core. In fact, we have to consider that the User Experience Core is strictly focused on a specific subject of the dialogue, thus creating a semantic unit directly connected to the IDM model. From this point of view, the designer and the communication expert could cooperate to include in the User Experience Core all the contents needed to establish the dialogue with the user. For example (Fig. 5) we report the design of the homepage of the site of Hogan (already analyzed above). This model contains three Introductory RIA-Page elements that have the same semantic function to allow the access to the site features. But, the designer, probably to improve the attractive aspects, gives more emphasizes to the central section (where there is the panoramic images), while the other two sections are placed in a reduced space and are unhidden through the RIA-Handle "show_navigon". These graphical differences are in contrast with the semantics of the elements and cause the "Attentional Tunneling" demon that could be evaluated throught Rich-IDM methodology.

Context View. The look&feel of the RIA is more important and often the visualization aspects are used to define specific area of the application and delimitates related arguments. To capture these very important characteristics for the quality of the dialogue flow, designers need to define the User Experience Cores that must be shown in the same way to the user. The Context View allows to the designers to define a specific navigational context allowing harmoniously connecting related User

Experience Cores. Formally, the Context View is a container of the User Experience Core. Its name is due to the idea that the User Experience Cores of the same view context are shown to the user in uniform manner, thus providing a common (and stable) visualization environment to the user.

5 Conclusion

RIAs mark a landmark innovation in the way web engineering can unleash superior user interactions. To balance the trade-off between the potential sophistication of the user interface and the need to ensure proper usability, cognitive workload, and efficiency, we have proposed a set of high-level modeling constructs, which provides a common vocabulary between UX designers (focusing on the user requirements) and web engineers (focusing on translating those requirements into technical solutions). Through a set of case studies and exploiting the Situational Awareness theory in an original way, we have shown the potential of our approach in pointing out one direction to integrate a user interaction and usability perspective in the modeling of RIAs. In particular, our contribution is a new point of view in RIA presentation design, new are some Rich-IDM derived concepts if compared to related works, and novel is the cross-disciplinary application of the SA principles. In detail, we propose new primitives with strong semantics: the User Experience Core describes the communication semantic nucleus (offered to the user in a given moment) connecting the page elements; the Content RIA-Page Elements, Introductory RIA-Page Elements and the Transition RIA-Page Elements inherit their semantic from Interactive Dialog Model and allow the user to access the RIA information; the RIA-Handle enables users moving within two or more page elements allowing to model the dynamic aspects of the RIAs; and the Context View maintains navigational context, orientation, organic, and fluid transition between the User Experience Core. Moreover, through case studies, we demonstrated how these primitives could help designers avoiding poor Situational Awareness effects, as characterized by Endsley's principles. In short, we proposed a simple way to fill the gap between hypermedia design and user experience design for RIA, which is an open issue both from the web engineering point of view and the human computer interaction one.

As future research, we plan to define model metrics in order to provide UX designers and web engineers with means to derive usability measurements directly form Rich-IDM diagrams, so supporting them to discover poor usability situations.

References

1. Bolchini, D., Paolini, P.: Interactive dialogue model: a design technique for multi-channel applications. IEEE Trans. Multimed. **8**(3), 529–541 (2006)
2. Bolstad, C.A., Costello, A.M., Endsley, M.R.: Bad situation awareness designs: what went wrong and why. In: Proceedings of the 16th World Congress of the International Ergonomics Association, Netherlands (2006)

3. Bowen, J., Reeves, S.: Developing usability studies via formal models of UIs. In: Proceedings of the 2nd ACM SIGCHI Symposium on Engineering Interactive Computing Systems EICS'10, pp. 175–180. ACM, New York (2010)
4. Bozzon, A., Comai, S., Fraternali, P., Carughi, G.T.: Capturing RIA concepts in a web modeling language. In: Proceedings of the 15th International Conference on World Wide Web WWW'06, pp. 907–908. ACM, New York (2006)
5. Combefis, S., Pecheur, C.: A bisimulation-based approach to the analysis of human-computer interaction. In: Proceedings of the 1st ACM SIGCHI Symposium on Engineering interactive computing systems EICS'09, pp. 101–110. ACM, New York (2009)
6. Coutaz, J.: User interface plasticity: model driven engineering to the limit!. In: Proceedings of the 2nd ACM SIGCHI Symposium on Engineering Interactive Computing Systems EICS'10, pp. 1–8. ACM, New York (2010)
7. Durrani, S., Durrani, Q.S.: Applying cognitive psychology to user interfaces. In: Proceedings of the 1st International Conference on Intelligent Human Computer Interaction, pp. 156–168. Springer, India (2009)
8. Hartmann, M., Daniel, S., Muhlhauser, M.: AUGUR: providing context-aware inter-action support. In: Proceedings of the 1st ACM SIGCHI symposium on Engineering Interactive computing systems EICS'09, pp. 123–132. ACM, New York (2009)
9. Houben, G.J., Van der Sluijs, K., Barna, P., et al.: Chapter 10. Web Engineering: Modelling and Implementing Web Applications, HCI Series. Springer-Verlag, ISBN: 978-1846289224 (2007)
10. Kaindl, H.: Model a discourse and transform it to your user interface. In: Proceedings of the 2nd ACM SIGCHI Symposium on Engineering Interactive Computing Systems EICS'10, pp. 371–372. ACM, New York (2010)
11. Koch, N., Knapp, A., Zhang, G., et al.: UMLBased Web engineering: an approach based on standards. Web Engineering: Modelling and Implementing Web Applications, HCI Se-ries, vol. 12, No. 7, pp. 157–191. Springer-Verlag (2007)
12. Linaje, M., Sanchez-Figueroa, Preciado: Engineering rich Internet application user interfaces over legacy Web models. IEEE Internet Comput. **11**(6), 1089–7801 (2007)
13. Meliá, S., Gómez, J., Pérez, S., Diaz, O.: A model-driven development for GWT-based rich Internet applications with OOH4RIA. In: Proceeidngs of IEEE ICWE'08, pp. 13–23. New York (2008)
14. Pandurino, A., Bolchini, D., Mainetti, L., Paiano, R.: Rich-IDM: extending IDM to model rich Internet applications. In: Proceedings of 12th ACM International Conference on Information Integration and Web Based Applications and Services iiWAS2010, pp. 145–152 (2010)
15. Preciado, J.C., Linaje, M., Morales-Chaparro, R., et al.: Designing rich Internet applications combining UWE and RUX-method. In: Proceedings of IEEE ICWE'08, New York (2008)
16. Spagnolo, L., Bolchini, D., Paolini, P.: Beyond findability: search-enhanced information architecture for content-intensive RIAs. J. Inf. Archit. **2**(1), 19–36 (2010)
17. Serna, A., Calvary, G., Scapin, D.L.: How assessing plasticity design choices can im-prove UI quality: a case study. In: Proceedings of the 2nd ACM SIGCHI Symposium on Engineering interactive Computing Systems EICS'10, pp. 29–34. ACM, New York (2010)
18. Urbieta, M., Rossi, G., Ginzburg, J., Schwabe, D.: Designing the interface of rich Internet applications. In: Proceedings of the 2007 Latin American Web Conference, IEEE Computer Society, pp. 144–153. Washington, DC (2007)

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