An Interactive Behavior-Based Hierarchical Design Method for Form Hints

Cao Huai and Zhou Qi(✉)

School of Mechanical Science and Engineering,
Huazhong University of Science and Technology, Wuhan,
People's Republic of China
caohuai@hust.edu.cn, 384415003@qq.com

Abstract. A form prompt message refers to the prompt message generated when a user accesses to a form. At present, the research on the approach to design the form prompt message is not perfect. Therefore, this paper provides a method to design the form prompt message based on behavior path. The first part of the paper combs through the existing interactive behaviors and the basic theories of prompt message design, then analyzes the interaction among behavior and path, hint and memory load, and plans a hierarchical model of interactive behavior combined with the existing GOMS model. Moreover, this paper discusses the influence of the importance, frequency and circumstance property on evaluating the priority of prompt message, and sorts out a hierarchy diagram of form prompt message based on interactive behavior. Finally, experiments are carried out with this approach to verify the validity of the hierarchy design approach presented in this paper.

Keywords: Prompt message · Hierarchy design · Interactive behavior · Path

1 Introduction

Jared• M• Spoor, the founder of User Interface Engineering (UIE), once said: "Identifying the subtle points of form design may bring dramatic influence to online experience (and baseline) and the whole. Once you learn to control these subtle points, you may become a top master-hand" [1]. A form prompt message is generated during the user access, which is the subtle point mentioned by Jared• M• Spoor. When users meet some difficulties in visiting forms, the prompt message will provide users with some necessary hints and guidance. But in the meanwhile, in case of a large form experience load, the prompt message may degrade the user experience with the form.

In recent years, the theory of prompt message design is improved gradually; and the ideological level of design is also enhanced gradually. But meanwhile, enterprises and design researchers have not reached a consensus on the definition of form prompt message. In a book named Web Form Design: Filling in the Blanks, Luque • Wroblewski, a famous user experience designer of Google, interpreted the prompt message as: help text as well as error and success messages. Help text refers to the words helping users fill in the form successfully; error message is to inform users of their failure to continue filling in the form and of other solutions; and success message

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is to inform users of their success in completing the form. In a book named About Face 3: The Essentials of Interaction Design, Cooper et al. [3] interpreted the prompt message as: dialog box—a dialog box for error, warning and confirmation. Xiong [4] described the prompt message as a supplement function helping users complete interactive behaviors in the access process, and the prompt message is generally a feedback of interactive behaviors. They think that the prompt message is a feedback of user behavior; and the form of feedback is diversified, i.e., help texts also can be error messages and dialog boxes, etc.

In the existing literatures, the research on the approach to design form becomes increasingly richer; however, there is deficient in research on prompt message design approach. And at present, the research mainly focuses on the fields such as cognitive psychology, behavioral psychology and ergonomics. Rasmussen [5] summarized three modes of interactive behaviors in information design, among which, Rules Based Behavior (RBB) mode means dividing all behaviors into several steps, which will be executed step by step. This mode provides guidance for this paper to analyze interactive behavior path. Raskin [6] put forward Goals, Operators, Methods and Selectors (GOMS) keystroke mode. Figure 1 shows a simple calculation method to quantify interface efficiency, which helps this paper quickly quantify the user's behavior path. Wei [7] thinks that combing through information hierarchy and establishing a suitable information architecture are extremely important to applications. Furthermore, Cao Ruping et al. also discussed the approach to design information hierarchy with visual elements. All these theories are beneficial to the development of researches in this field (Table 1).

Table 1. GOMS keystroke mode

Name (tag)	(Keying) K	(Pointing) P	(Homeing) H	(Mentally preparing) M	(Responding) R
Average time (S)	0.2 s	1.1 s	0.4 s	1.35 s	
Implication	The time required to tap a key on the keyboard or mouse	The time that the user (with the mouse) points to a position on the display	The time it takes a user to move his hand from the keyboard to the graphical input device (mouse), or from the graphical input device to the keyboard	The user to enter the next step required for mental preparation time	The time the user waits for the computer to respond to the input

This paper solves two difficulties: the first one is to extract the path of user's interactive behavior and put forward a hierarchy mode of interactive behavior based on the existing GOMS Keystroke mode; and the second one is to divide the priority of information and present a hierarchy diagram of form prompt message. And then the designer obtains a result by quantitative grading.

This paper creatively puts forward an approach to guide designers to design form prompt message.

2 Problem Definition

Form has various types. In the time dimension, users take several seconds or hours to complete a form; in the information dimension, users usually fill in information on several items to several papers. The current design methods mainly aim at simple forms requiring less time and information. However, the methods are not properly applied in complex forms. Complex forms have a large amount of information with a number of prompt messages, which increase the cognitive difficulty for users. The version of form upgrades rapidly. Influenced by design cost, etc., enterprises usually make minor modifications, making it difficult to form the design specification of form prompt message. As shown in Fig. 1, Facebook Advertisement Management Form, we mark all prompt messages in grey including icons, links, help texts, etc. All these prompt messages are stiffly presented on forms, which not only distract user's attention but also reduce the availability of form.

Fig. 1. Facebook advertisement management form

3 Interaction Behavior

Interactive design focuses on not only behavior design, but also the way how behaviors relate to content and form [9]. The decision logic of interactive design mainly adopts behavior logic [10]. Good behaviors shall be designed as considerate as a person, so do prompt messages. Consideration has been given a series of features which will be analyzed in the following aspects:

3.1 Behavior Path

A considerate prompt message is timely. We always hear some users complain like "why not tell me earlier" when they are filling in forms. In practice, we find out that many prompt messages are not designed correspondingly for a certain behavior, which usually appear earlier or later, disturb user's focus and even arouse user's negative emotion. To make prompt messages timely, users' behaviors have to be made clear.

Form is usually composed of elements such as label, input box, text, drop-down menu, check box and radio box, etc. Based on GOMS keystroke mode theory, the interactive behaviors of these elements are broken down into single actions whose integration is user's behavior path. Label and text message mainly involve user's eye movement and reading behavior, which are not mentioned in this paper. From Table 2: Behavior Path of Each Element in Form, we can clearly see the behavior path of each element. Only when the prompt message is arranged after a correct subaction based on the path can the prompt message be timely.

Table 2. Behavior path of each element in form

Element	Sample	Path
Label	昵称	
Input box		M+H+P+nK
Text	修改原因： 请在此填写修改原因	M+H+P+nK
Drop-down menu	公历 公历 农历	M+H+P+K+P+K
Radio box	详细信息 籍贯 性别 生日 身份证 学历 电话	n(M+H+P+K)
Check box	男 女	M+H+P+K

3.2 Hint

On one hand, the usability of a product is reflected in whether the product adequately guides and hints user's behavior; on the other hand, it is reflected in whether the path for setting product functions is direct and short enough. When users judge that task completion needs a relatively short operation path, the task will have a better guidance [11].

The research shows that the majority of users hate filling out forms. The limitation of existing technology leads to a result that users are usually forced to complete forms. Therefore, it is really necessary to relieve the strained relation between users and forms. In emotional design, Norman [12] mentioned that users like to communicate with people rather than machine. Interactive design adopts enlightening information related to target user's behavior and habit [13]. Once this kind of enlightening information is associated with behavior, it not only enables the experience more humanized but also reduces the perceived gap among users and makes the design closer to user's habit.

In addition to this, this design can also establish and convey the relationship among elements; and location also hints the ordinal relation between elements. In the course of interactive design, the more important the function is, the briefer the operation path shall be adopted preferentially [11]. Briefer operation path is to hint users: we think this function is more useful compared with other ones. Replacing functions with prompt messages means that the core information has higher priority and shorter operation path. In man-machine interface design, we always use similar philosophies, because the delivery of information is in rhythm. Rhythm not only helps users to memorize but also hints them the priority of information.

3.3 Memory Load

In form interaction, users may face a situation that a pop-up window appears in another pop-up window, and a new page jumps to another page successively. This may make users lost in the process of interaction, which is the result of the continuous growth of memory load [15]. Through the analysis of Sects. 3.1 and 3.2, the relation between information and behavior path becomes clearer. We think that behavior path is the basis for division of prompt message hierarchy. Information with higher priority shall be arranged before the path. Hierarchy will be produced according to the number of subaction in the path. Therefore, the prompt message shall be arranged more logically. However, many daily behaviors are "habitual behaviors" cultivated by practicing and learning repeatedly, and also "automatic behaviors" without concentration [16], which are the function of subconscious memory and can dramatically reduce the memory load in interactive design. We deem that user's memory space is limited; the more the hierarchies are, the larger memory space is occupied; the heavier the user's memory load is, the higher the error rate of automatic behavior will be. To ensure the stability of form interaction, we put forward that the number of hierarchies must be balanced with the memory load produced. Hierarchy is not infinite; and we consider that 3 to 5 levels are the best.

Summary: This chapter extracts the path of form interactive behavior, puts forward the concept of hierarchy division based on path, discusses that enlightening elements can make hierarchy division more reasonably and rigorously comes up an idea that the number of hierarchy shall be limited. We make Fig. 2 to help you understand the hierarchy more intuitively. Taking the input box of the form for example, the space between every two subactions is for the prompt message. In a path, the earlier a subaction appears, the higher the hierarchy the prompt message has.

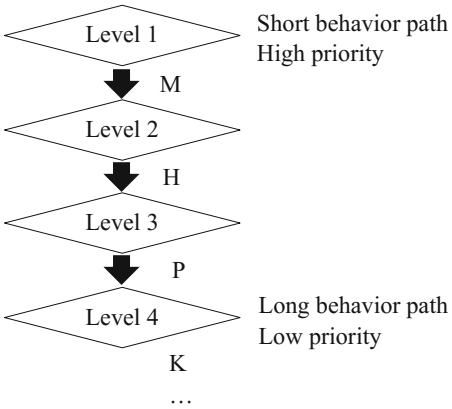

Fig. 2. Hierarchy of behavior path of input box. Level 1 is the highest hierarchy

4 Prompt Message Hierarchy

From the perspective of function, the form prompt message mainly falls into reminder message, guiding message, interpreting message and feedback message. As for the rule based on behavior, prompt messages for content and interface are consistent and have one-to-one mapping [17]. Since the designer must consciously analyze the priority of information sources [8], we put forward the following three criteria for analysis.

- Importance

Generally, the more important the information is, the more quickly the user shall be informed. When users advertise on Tencent social advertisement platform, the prompt message they first notice is the balance of account, because in case of insufficient money logically set for the product, the user will fail to do the advertisement. This prompt message can effectively avoid the user's invalid operation. Unlike Tencent, Google advertisement platform does not have this prompt message. Google users always find that the form cannot be completed during the creation, and then they have to give up filling out the form for topping up. Obviously, in doing an advertisement, the balance of account directly determines whether the task can be completed successfully. This prompt message, which has a great influence on the result of behavior, is fairly significant. We consider that the importance of a prompt message shall be measured in accordance with the result of user's behavior. The more probably the prompt message helps the user to complete the task, the more important the prompt message is; and vice versa.

- Frequency of use

Every user has a distinct cognition of information; and information also has memorability and learnability. When filling out a form, we may have access to interpreting prompt messages. Generally, the cost of cognizing these prompt messages is quite low, which means that users can easily understand and memorize them after

reading once or several times. And afterwards, these messages will become a "useless decoration" to disturb users. Almost all forms have the problems above; therefore, the designer shall reasonably judge the use frequency of each prompt message so as to determine their priorities.

- Circumstances

If we do not understand the circumstance, many behaviors in our life will be difficult to understand [18]. Forms shall be designed so that users are provided with the appropriate help information based on the practical circumstance [9]. When filling out forms, we may also encounter a situation where a feedback prompt message may appear if we input an unqualified character. This feedback prompt message must appear in the current circumstance, which is a fixed logic hierarchy. We define the situation above as the prompt with strong circumstance. The stronger the circumstance the prompt message has, the more specific the problem is. We can judge the circumstance of a prompt message by its impact scope and accurately arrange the hierarchy of the prompt message, so as not to affect the user experience.

Summary: This chapter explicitly analyzes three criteria of dividing the priority of prompt messages: the more important the prompt message is, the higher the priority the prompt message has; the higher the frequency of use is, the higher the priority the prompt message has; and the stronger the circumstance the prompt message has, the higher the priority the prompt message has; and vice versa. Combined with the result in Sect. 3, we propose to design the model based on the prompt message hierarchy of the behavior path, as shown in Fig. 3. The higher the priority the prompt message has, the shorter the user's behavior path is; and vice versa.

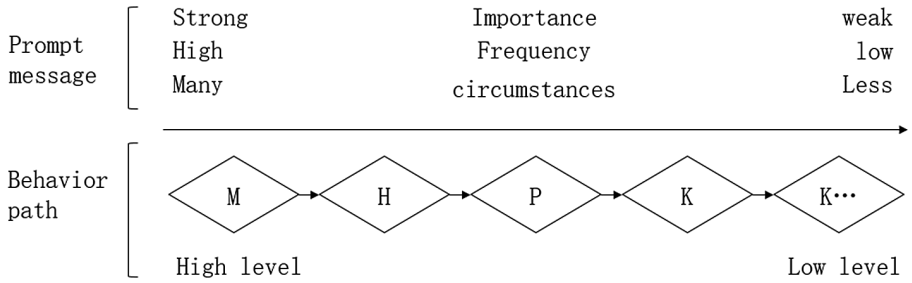

Fig. 3. Hierarchy design method model of prompt message. The higher the priority the prompt message has, the shorter the operation path the user needs.

5 Experiment and Practice

5.1 Experiment 1

To test the validity of the approach to design the prompt message hierarchy based on the behavior path, we design the following experiment.

- Preparation and process of experiment

(1) Testee group

College student, the aborigines of the Internet, not only have a deep understanding of the Internet, but also can clearly and accurately express their thoughts. Therefore, the testee group is determined to be college students aged between 18 and 27.

(2) Testee form design

Since some information frequently appears in a form, the cryptomnesia formed will lead to a result that users easily neglect these information, such as name. Users know how to fill out them without knowing their prompt messages. Therefore, when designing the form, some information that is unfamiliar to college students is selected to raise users' concern, ensuring the feasibility of the experiment.

(3) Test task

This experiment requires testees to complete Form 1 (Fig. 4) and Form 2 (Fig. 5) designed by us. The two forms have the same content. However, all prompt messages in Form 1 are presented directly based on hierarchy while the prompt messages in Form 2 are presented in sequence based on behavior.

Fig. 4. Form 1

- Planning and implementation of experiment

(1) This test involves 30 testees who are divided into group A and B; and each group includes 15 testees. The two forms have the same content, and the first completion

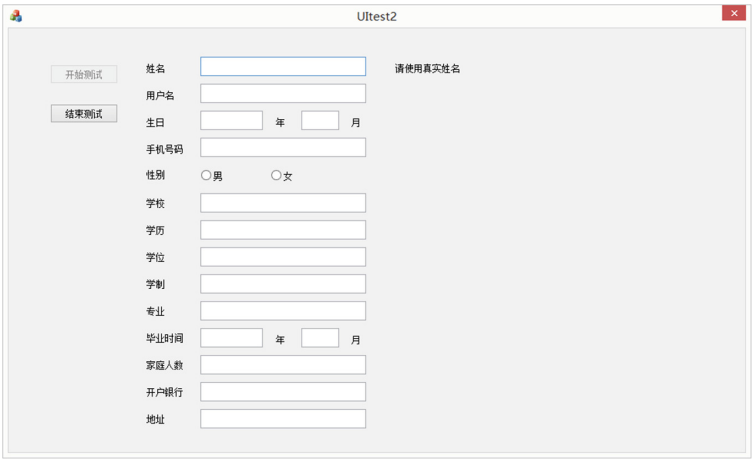

Fig. 5. Form 2

produces memory and affects the test result. Therefore, we asked group A to fill out Form 1 before Form 2 and group B to fill out Form 2 before Form 1. At the meantime, we recorded the time that testees spent on filling out the form.

(2) After the testees completed the form, we interviewed them and recorded their experience.

- Analysis of experimental results

As shown in Table 3, the average time to complete the two forms and the subjective satisfaction proportion of the two forms were obtained based on the data statistics of experiment. Based on the experimental result, we found out that Form 1 has a higher completion efficiency than Form 2; moreover, the majority of testees think that the experience of filling out Form 2 is much better than that of Form 1; and they also consider that the design of Form 2 makes them become more focused during the completion, the attention paid on the prompt message in Form 2 is higher and Form 2 also has a lower error rate.

Table 3. Summary of experimental results

Sample	Form 1	Form 2
Average time to complete (s)	102	83
Subjective satisfaction proportion	15.6%	28.1%

In the experiment, there are still some irresistible factors affecting the experimental results; for example, the testees have different cognitions to the same prompt message. Even though the experiment is not absolutely precise, we can also achieve the objective of the experiment.

5.2 Experiment 2

From the experiment above, we draw a conclusion that the hierarchy design can improve the form experience. Next, we will apply the approach, designing the hierarchy of prompt message based on behavior path, proposed in the paper into the practical project for testing.

- Preparation and process of experiment

(1) Project background

With the background of the improvement of Tencent Social Advertisement_Account Registration Form 1.0, we redesigned the form based on the approach proposed and made a comparison between relevant data before and after the improvement. Data is provided by the Tencent social advertisement department (Table 4).

Table 4. Hierarchies of prompt messages in tencent social Advertisement_Account form

Sample	Importance (1–5)	Frequency (1–5)	Properties and circumstances (1–5)	Total	Hierarchy	Behavior path
4	1	1	1	3	**Level 3**	M + H + P + K + R
1	2	1	1	4		
2	2	1	1	4		
8	2	1	1	4		
9	5	1	1	6	**Level 2**	M + H + P
5	4	2	1	7		
6	4	2	1	7		
11	3	2	3	8		
3	5	2	3	10	**Level 3**	M
7	5	2	3	10		
10	3	4	5	11		

(2) Optimal design of Tencent Social Advertisement_Account Registration Form 1.0

We first numbered the prompt messages in the original form, as shown in Fig. 6. Then we graded the prompt messages according to the three criteria for determining the priority of prompt from 1 to 5 points and recorded the data. After sorting out the grades, we divided the hierarchy based on behavior path; the result is given in Fig. 4. Finally, we designed Tencent Social Advertisement_Account Registration Form 2.0, as shown in Fig. 7.

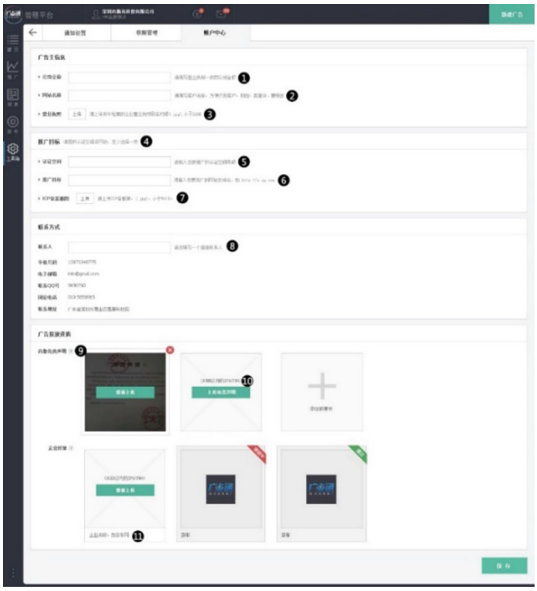

Fig. 6. Serial numbers of prompt messages in tencent social Advertisement_Account form

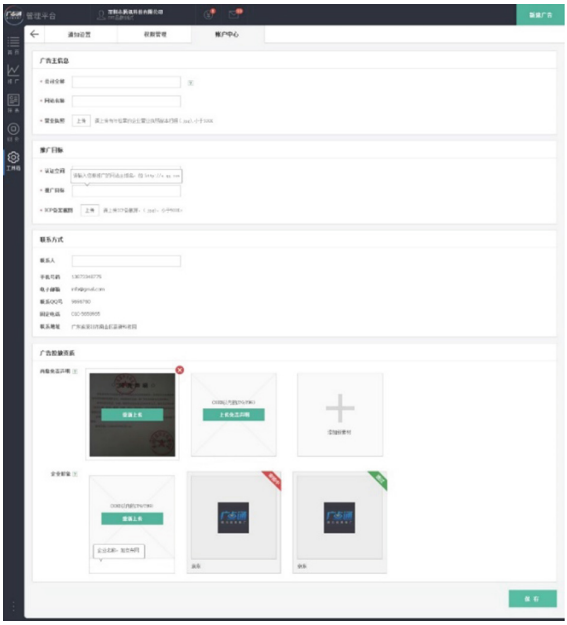

Fig. 7. Tencent social Advertisement_Account registration form 2.0

- Planning and implementation of experiment

The new form has been put into use for 3 months; meanwhile we record the change of relevant data.

- Analysis of experimental results

The experimental result has been demonstrated in Figs. 8 and 9. The rate of submitting form is improved from 16.8% to 21.5% in the process of improvement. At meantime, in the process of scheme review, most designers and experts express that the redesigned Tencent social advertisement form becomes clearer visually; users also feedback that they fill out forms more efficiently, which signifies a better user experience.

时间	进入编辑页面		提交			提交成功			提交失败		
	PV	UV	PV	UV	提交率	PV	UV	成功率	PV	UV	失败率
2015. 12. 25–12. 31	5879	3787	1418	635	16. 8%	1046	607	95. 6%	372	107	16. 9%
2016. 01. 22–01. 28	5056	3231	1080	559	17. 3%	835	532	95. 2%	245	87	15. 6%
2016. 01. 29–02. 04	4817	2474	666	324	13. 1%	463	301	92. 9%	203	72	22. 2%
2016. 02. 19–02. 25	7682	4034	1767	760	18. 8%	1339	732	96. 3%	428	127	16. 7%
2016. 02. 26–03. 03	6980	4475	1544	1044	23. 3%	1402	1019	97. 6%	142	68	6. 5%
2016. 03. 04–03. 10	7588	4930	1531	1059	21. 5%	1400	1022	96. 5%	131	62	5. 9%

Fig. 8.

渠道	统计周期	用户数			占比	
		注册用户	信息补全	有效用户	信息补全率	有效用户率
官网自助	3.4-3.10	6175	664	263	10.75%	4.26%
	2.26-3.3	6008	652	284	10.85%	4.73%
	2.19-2.25	5461	448	219	8.20%	4.01%
	2.18-2.25	6309	522	269	8.27%	4.26%
	1.29-2.4	3515	199	88	5.66%	2.50%
	1.22-1.28	4358	306	151	7.02%	3.46%
	12.25-12.31	5015	342	185	6.82%	3.69%
	12.18-12.24	5393	463	250	8.59%	4.64%

Fig. 9.

6 Conclusions and Extension

This paper proposes an approach to design the form prompt message. As mentioned above, in form interaction, each interactive behavior relates to the next development. The approach to design the hierarchy of form prompt message based on user's behavior path is effective, but this approach is not the only way to design prompt messages. This

approach is only a strategy to improve user experience in design, which can help the interaction designer to design more logic form prompt messages and guide users to complete the form more effectively. This approach can help the designer to set the criteria for interactive design and control the design experience of products more easily.

The discussion on form prompt messages in this paper inevitably has limitations, but the approach and thought of hierarchy design are also of significance to other fields. I hope this paper can enlighten today's designers and a more complete knowledge system is available in the future to help designers.

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