Mining Patterns for Web-based Emergency Management Systems

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ABSTRACT

Design patterns describe problems that occur recurrently, and specify the core of the solution in such a way that we can (re)use it in different contexts and applications. Although, web-based Emergency Management Systems domain is still in its nascent stages, there are design principles, real systems and design patterns from other related areas that can be a valuable source of knowledge to mine design patterns. From these sources we have created a patterns catalogue to assist novice designers on discovering what issues should be addressed to develop useful and successful systems. In this paper, we present the mining process and some patterns as example.

Keywords

Emergency management, crisis response, design patterns, design principles.

INTRODUCTION

In recent years, governments have increased resources for the development of web-based Emergency Response Systems (WEMSs) and literature studies have shown the great complexities surrounding the design of this kind of systems (Kyng, Nielsen and Kristensen, 2006). However, the rush to develop this kind of applications can lead to spend resources looking for a solution that has been already implemented and proved in other environments, or making wrong design decisions. Unfortunately, although there are some general designs principles available (Turoff, Chumer, Van de Walle and Yao, 2004) that designers can consider when starting a new project it is difficult and costly to apply them since they are too general and there is no obvious way to translate them into concrete solutions. Besides, not knowing how others previously solved a problem or why they did things in a certain way makes it complex to reuse design knowledge. Design patterns are a mechanism for capturing and sharing design knowledge. Designers can use them to identify and propose solutions to recurring problems (Gamma, Johnson and Vlissides, 1995).

We focus particularly on those design issues and principles that developers should consider when dealing with WEMSs. We record and gather those recurrent problems and their solutions systematically in the form of patterns. With all these patterns we are elaborating a catalogue that gathers the best practices on the development of WEMSs.

Next, we introduce the concept of pattern and describe the process used for mining design patterns in our domain.

THE PATTERNS MINING PROCESS

Design patterns describe problems that occur recurrently, and specify the core of the solution in such a way that we can (re)use it in different contexts and applications. Knowing about patterns in a domain, like WEMSs, helps us facing non-trivial problem as expert designers. New patterns are a matter of discovery and experience, not invention (Gamma et al., 1995). Therefore, we have followed the next steps:

- The study of design principles and guides available for WEMS.
- Experience acquired in the development of this kind of systems.
- Evaluation of existing patterns that belongs to design areas that should be considered like Usability (Van Duyne, Landay, and Hong, 1995), Ubiquity (Landay and Borriello, 2003), Security (Kienzle and Elder, 2002).

Following this approach we mine two kinds of patterns:

- New specific patterns for WEMSs combining the knowledge gathered by the design principles available on this domain with the solutions provided by real web applications.
- Patterns adapted from other domains to make them easier to apply by novice designers.

Next sections describe these two processes:

New specific patterns

Although, this domain is still in its nascent stages, there are many designs and developments that can provide a valuable source of knowledge. In (Turoff et al., 2004) a set of generalized design principles to improve the design of WEMS are described. Those principles, that crystallize years of experience in the design and implementation of the EMISARY system used for fifteen years in the federal government to handle national emergencies, can be summarized as follows:

- **DP1-System Directory:** The system directory should provide a hierarchical structure for all the data and information currently in the system and provide a complete text search to all or selected subsets of the material.
- **DP2-Information Source and Timeliness:** In an emergency it is critical that every bit of quantitative or qualitative data brought into the system dealing with the ongoing emergency be identified by its human or database source, by its time of occurrence, and by its status. Also, where appropriate, by its location and by links to whatever it is referring to that already exists within the system.
- **DP3-Open Multi - Directional Communication:** A system such as this must be viewed as an open and flat communication process among all those involved in reacting to the disaster.
- **DP4-Content as Address:** The content provides a comprehensive searchable space for people to find what they need and to create their own filters and links accordingly.
- **DP5-Up-to-date Information and Data:** Data that reach a user and/or his/her interface device must be updated whenever it is viewed on the screen or presented verbally to the user.
- **DP6-Link Relevant Information and Data:** An item of data and its semantic links to other data are treated as one unit of information that is simultaneously created or updated.
- **DP7-Authority, Responsibility, and Accountability:** Authority in an emergency flows down to where the actions are taking place.
- **DP8- Psychological and sociological factors:** Encourage and support the psychological and social needs of the crisis response team.

While design principles provide with high-level and sometimes abstract suggestions, patterns offer concrete solutions to specific problems. They are not intended to replace design principles but rather to complement them. In order to acquire knowledge of how these design principles have been implemented in specific systems, we have analyzed those we have developed in collaboration with the Spain Department of Civil Defense and Protection that include:

- ESA6[1]: Web-based System for analyzing historical information about fire extinction statistics in Spain.
- SIGAME (Montells, Montero, Diaz, Aedo and De Castro, 2006): Web-based System for Resources Management on Emergencies)
- ARCE (Aedo, Díaz, Fernández and de Castro, 2002): Web-based system envisaged to cope with the lack of synchronism among assistance requests and responses in a multinational environment.

Table 1 shows design principles considered by each application. For example, SIGAME and ESA6 present specific solutions related with the design principle DP5**.** We have combined these solutions with the foundation of the design principle to show novel designers why it is important to consider this issue and how to materialize it using real examples. Next we describe the resulting pattern:

[1] http://www.esa6.es

	SIGAME	ARCE	ESA6
DP1	X	X	X
DP2	X	X	X
DP3	X	X	
DP4		X	X
DP5	X		X
DP6	X	X	X
DP7	X		
DP8	X	X	

Table 1. Design principles covertures over evaluated systems

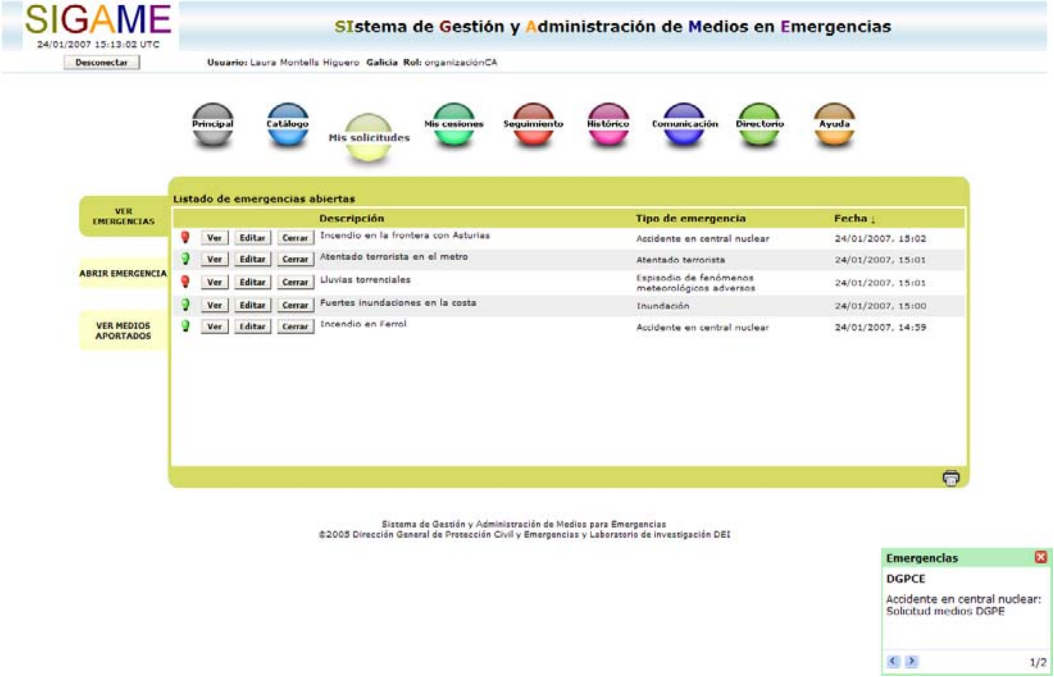
Pattern name: Up-to-date

Related design principle/pattern: DP5

Context: In a crisis, responders need to access essential information and be sure that such information is reliable and updated.

Problem:

The user does not have time to search for an event of concern and a change of status in an event of concern that should just be delivered and presented.



SIGAME
24/01/2007 15:13:02 UTC

SIstema de Gestión y Administración de Medios en Emergencias

Usuario: Laura Montells Higuero Galicia Rol: organizaciónCA

Listado de emergencias abiertas

		Descripción	Tipo de emergencia	Fecha ↓
🔴	Ver Editar Cerrar	Incendio en la frontera con Asturias	Accidente en central nuclear	24/01/2007, 15:02
🟢	Ver Editar Cerrar	Atentado terrorista en el metro	Atentado terrorista	24/01/2007, 15:01
🔴	Ver Editar Cerrar	Lluvias torrenciales	Espisodio de fenómenos meteorológicos adversos	24/01/2007, 15:01
🟢	Ver Editar Cerrar	Fuertes inundaciones en la costa	Inundación	24/01/2007, 15:00
🟢	Ver Editar Cerrar	Incendio en Ferrol	Accidente en central nuclear	24/01/2007, 14:59

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Emergencias

DGPCE

Accidente en central nuclear: Solicitud medios DGPE

1/2

Figure 2. SIGAME notifications system

Solution:

Users must know that the information they are seeing at every moment is updated.

Metaphors are very useful to represent changes on the status of the system. For example different colors can represent different states as traffic lights do.

Users must receive notifications when relevant events take place on the system

There are many ways to notify a user that something has happened on the system. For example windows or sounds alerts used standalone or combined are a valid method. If there could happen many different kinds of events it is important to clarify the nature of the success on the alert message. For this particular situation using only sound alerts is not enough.

It might well necessitate notifications levels to allow the user to control the amount of delivered material by indicating what events should result in interruptions to the user rather than just being queued.

If the system generates many alerts at the same time, users can feel overload. In this kind of situation it is important to provide them with a mechanism to decide which alerts are more important or implement an algorithm to automatically prioritize alerts.

Examples: SIGAME uses icon metaphors to notify users that what they are seeing is up-to-date (see figure 2). It refreshes the notification area on the screen every 10 seconds. Besides it shows a window alert on the bottom of the screen that collects the last important events ordered by priority.

Adapted patterns

Using design patterns is not a new trend in the field of software production. There are many proposals of patterns catalogues or languages documenting recurrent problems in different areas as we mentioned before.

In a previous work (Montells et al., 2006) we applied several Usability patterns as the ones described in (Van et al., 1995) to design usable interfaces for WEMSs. However, this was not a simple task. First we had to check if it was applicable, and then we had to adapt the solution proposed to our specific domain. From this experience we have adapted several usability patterns adding examples from the WEMS domain to make them more comprehensible to novice designers. Next, we provide as example a pattern adapted from the [B3 Hierarchical Organization design pattern] documented on (Van Duyne et al., 2003).

Pattern name: WEMS Directory

Related design principle/pattern: DP1 / [B3 Hierarchical Organization design pattern] (Van Duyne et al., 2003).

Context: WEMSs can provide different services and have different features depending on the application scope (local, state, national or international), the intervention stages (pre-crisis, in-crisis or post-crisis) and motivation. The services offered can be: communication (news, e-mail, forums, etc.); management (human and material resources, etc.); interoperability (communication platforms, data interchange, etc.); coordination (human resources, responses, etc.); location (area, GIS, GPS, etc.); report/notification (action plans, missing people, contact points, etc.); alerts (meteorology, road conditions, etc.); analysis (historical data for preventive purposes, etc.); etc. Due to the huge amount of information that has to be managed it is crucial to organize it according to a well defined and hierarchical categorization.

Problem:

Organizing information in a hierarchy of categories can help users find things. Building an effective hierarchy is not easy.

Hierarchies are a common way of breaking long lists into smaller chunks. But users think in different ways and may not put the same chunks together in the same cluster. To achieve a good organization depends on the target audience, the language that audience uses to describe the subjects that will categorize, and the amount of information presented at a given time.

Solution:

Organize hierarchy to match the way users think.

This task can be quite a challenge because users do not all think alike. The selected organization should be the result of studying the different processes that users are used to. It is very important to know user's principles and techniques to organize the content on the site. There are different techniques to collect this knowledge from target users. For example, interviews, surveys, scenarios or card sorting can be used with this purpose (Van Duyne et al., 2003). The resulting categories can be related by creating links between them. It is also useful to provide a few redundant links to the same information, especially if different users consistently give different names for the same thing.

Use descriptive and distinctive category names.

Users may choose unexpected names for categories. It is not that users will not understand the names that a designer chooses, but words that a designer thinks best describe a category may not be the same as those that most users choose.

Category labels need to be descriptive of what that category stands for. Some kind of labels has to be avoided. For example, labels such as miscellaneous and other names that are so ambiguous that users will not know what they mean. Category labels also need to be distinctive from one another.

It is a good practice to test the categories and category labels. Card sorting technique can be used with one group of potential users to configure categories and category labels.

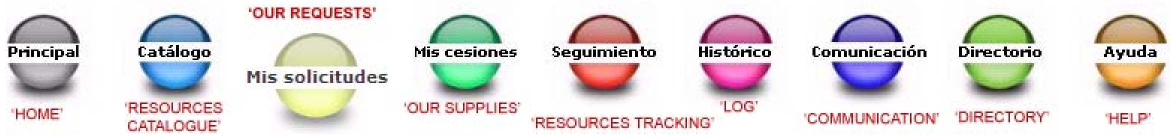

Figure 1. SIGAME main sections ('Our requests' is currently selected).

Examples: SIGAME, a fully structured application, follows the next categories schema:

- Users
- Emergency management
  - Emergency evolution
  - Resource requests
  - Resource offers
  - Resource tracking
- Communication
  - Mail
  - News
- Historic data
  - Logs
- Help

SIGAME uses eight main section labels to give access to each category. For example 'Own requests' is the section name where users representing an autonomous community (this is similar to a state in USA) can register a new emergency. Emergency details can be updated when necessary creating new entries on the system with a specific date (Emergency evolution). Besides, in this section, users can request resources associated with an emergency and receive offers from other communities (Resource requests and resource tracking).

CONCLUSIONS

We are creating a catalogue that gathers the best practices on the development of WEMSs in such a way that the knowledge is organized to help designers finding good solutions and avoiding errors, such as inadequate notification mechanisms or ambiguity on information representation. Besides, we are evaluating their usage on other WEMS, such as, SAHANA[2] in order to test their utility and complete them with additional examples.

[2] www.sahana.lk

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