Using Metaphors for Visualizing Enterprise Architectures

ABSTRACT
In this paper, we describe a possible solution to a common problem with the arrival and settlement of Enterprise Architectures and their appliance to business and IT. Enterprise Architectures are blueprints of the enterprise in its various forms, like a blueprint of a house. The problem is that complexity and dimensionality of that kind of data complicates its retrieval and further communication and sharing. Our proposal is the separation of EA visualization from EA modeling. Furthermore, we propose a visualization system that utilizes visual metaphors to represent EA models, thus making use of the highly patterned manner brain uses to learn. Visual metaphors had proven success in user interface design, and have an established support from theory. We give an example of that effectiveness with the city metaphor.

Categories and Subject Descriptors
H.5.m [Information Interfaces and Presentation]: Miscellaneous

General Terms
Algorithms, Management, Design.

Keywords
Visualization, enterprise architectures, visual metaphor, city metaphor, representation, stakeholder, information retrieval.

1. INTRODUCTION
Enterprise Architecture (EA) is increasingly seen as the best way to maximize existing IT investment while planning for future growth. Only by establishing a blueprint with which to operate can companies comply with corporate and government mandates requiring closer alignment of business processes with IT investment. Further, since change is a constant in IT, the blueprint must be dynamic enough to anticipate and adapt to evolving business models and economic trends [12]. Over the time, EA’s have become more important, and turned into a field of study, resulting in standards, frameworks, methods, tools, etc.

On the other hand, visual representations are fundamental when talking about EA’s. Visualization has accompanied us since we exist as an intelligent life form. Rock paintings are made since the Upper Paleolithic, 40 000 years ago. Nevertheless, the basis objective remains the same: to transform some information or knowledge into some kind of visual representation which is friendly to another human being (Figure 1). The need of communication and the recent advances in visualization technologies provide the capability to begin to use human visual/spatial abilities to solve the abstract problems found in business [13].

Figure 1 – Visualization
In general, visualization is the process of representing data as a visual image. Visualization relies on different methods to accomplish useful representations. One of those is visual metaphors, which are representations of a new system by means of visual attributes corresponding to a different system, familiar to the user, which behaves in a similar way [6].

We can learn a lot about the utilization of metaphors in interface design. In fact, a good interface is always supported by a well-known metaphor. For example, a PC movie player conserves the old VCR buttons (Play, Pause, Stop, etc.). Dieberger reinforces that the use of appropriate navigation metaphors can help to make the structure of modern information systems easier to understand, and therefore, easier to use [5].

2. RELATED WORK
Usually, EA models are graphically modeled and later stored in several diagrams with different levels of detail. A typical business process is translated into a graphical representation. In Figure 2 a typical business process is translated into a graphical representation. Figure 3 shows a graphical map that crosses two arbitrary dimensions.
A visual metaphor is also a method for translating EA models into graphics, like the city. A practical example of the city metaphor is the one proposed in [4]. The authors wanted to organize the corpus or a subset along multiple dimensions, or perspectives, adding relevant background material, significantly expanding and accelerating the viewer’s comprehension and integration of knowledge about broadcasts, etc. (Figure 4).

Another example of visual metaphors is the Chernoff faces [3], which display multivariate data in the shape of a human face. The individual parts, such as eyes, ears, mouth, and nose represent values of the variables by their shape, size, placement, and orientation (Figure 5). The idea behind using faces is that humans easily recognize faces and notice small changes without difficulty.

WWW has achieved global connectivity stimulating the transition of computers from knowledge processors to knowledge sources. This project consists of two related designs with which to evolve the Web and its clients. The first is the WebBook, a 3D interactive book of HTML pages. The second is the Web Forager, an application that embeds the WebBook and other objects in a hierarchical 3D workspace [2].

Another work based on metaphors is the solar system for representing software metrics. One way of potentially increasing empirical analysis activity on this realm is to contemplate visualization as a means to readily analyze either static or evolving code to perceive in real-time, suspected areas of risk within the codebase. This project represents a first attempt at 3D visualization of software metrics by using a familiar metaphor to present empirical concepts [7].

Finally, we present a project based on another complex system: the periodic table of elements. This work compiles existing visualization methods in order to develop a systematic overview based on the logic, look, and use of the periodic table of elements [10].

3. PROBLEM

We should formally define the problem before trying to solve it. The EA visualization process is not concerned only on the prettiest representations, but with the creation, analysis, proper delivering, and usage of views (and viewpoints). One must see only what he is supposed to see and with the exact level of detail.

Current EA tools are essentially oriented for enterprise modeling, leaving behind visualization. People upload and manage a complex amount of multi-dimensional EA models, but have troubles when it comes to retrieving it, thus perturbing decision-making, enterprise consciousness, solving capabilities, etc. EA modeling precedes EA visualization, but EA tools usually address only the first process.

An EA model is a representation of an EA sub-section, which consists of the various structures and processes of an organization. Therefore, EA modeling means the definition of those models. In other words, EA modeling is the process of defining the enterprise subsets, usually through diagrams. EA modeling is the process that precedes EA Visualization and provides its main inputs.

EA visualization appears subsequently and prepares those models for visualization by different stakeholders with different skills, jobs, concerns, etc. (Figure 9).
However, usually, EA models are directly presented to people. At first glance, it is cheaper and faster to deliver unmodified models to people, instead of investing in a separated process of visualization. Additionally, in most bibliography and business, it is common to mix these two subjects since few people see the importance of EA visualization. As a result, usually EA tools are not prepared to deal with EA visualization, and are model or repository oriented, but not visualization oriented.

4. PROPOSAL

Our proposal is an EA visualization system that utilizes visual metaphors to represent EA models, thus making use of the highly patterned and symbolic manner brain uses to think and learn. The visualization system has a back-office for the enterprise architect prepare viewpoints and views to stakeholders, and a dynamic front office that presents views according to the stakeholder.

Even the concept of EA visualization does not explicitly exist, and therefore, it makes part of our proposal. We define EA visualization not only as set of graphics, but as the business process that deliver understandable, relevant, and opportune enterprise representations to stakeholders, based on their permanent concerns but also on present concerns. Permanent concerns are the ones related with his job and enterprise mission, while present concerns are those related with a given task of his daily functions.

A visual metaphor is a representation of a new system by means of visual attributes corresponding to a different system, familiar to the user, which behaves in a similar way [6]. The following facts support the use of visual metaphors in this proposal:

- The way things are represented has a strong impact on the success of problem solving and communication;
- Visual metaphors are critical when representing complex subjects; software interfaces use them long ago with success;
- Input EA models can be abstract (e.g., business processes) or concrete (e.g., TI components). Visual metaphors are recommended when representing abstract data [13];
- Different stakeholders have different needs, concerns, and levels of understanding and metaphors help to speak their language. Quoting William Butler Yeats, «Think like a wise man, but communicate in the language of the people».

5. CONCEPTUALIZATION

A standard establishes a common language, and contains a technical specification or other precise criteria and is designed to be used consistently, as a rule, a guideline, or a definition. In this sense, ISO 1471-2000: IEEE Recommended Practice for Architectural Description of Software-Intensive Systems [8] works as a guiding principle in our proposal. This standard defines concepts like stakeholder, view, viewpoint, architecture, etc. In order to provide a common language we adopted these concepts:

- A stakeholder is an individual, team, or organization (or classes thereof) with interests in, or concerns relative to, a system;
- Concerns are the key interests that are crucially important to the stakeholders in the system, and determine its acceptability;
- A viewpoint is a specification of the conventions for constructing and using a view;
- A view is a representation of a whole system from the perspective of a set of concerns, in terms meaningful to stakeholders.

Each viewpoint shall be specified by: a name; the stakeholders to be addressed by the viewpoint; the concerns to be addressed by the viewpoint; the language, modeling techniques, or analytical methods to be used in constructing a view based upon the viewpoint.

This definition represents the motivation of our first conceptual module: the viewpoint designer (Figure 11). The enterprise architect will use this module to prepare viewpoints.
Please note that the modules are just conceptual, which means that a real implementation could concretize a different structure of modules.

6. VISUAL METAPHORS

Our proposal considers a system that loads an EA model and dynamically translates it to a visual representation based on a preset metaphor. In this sense, we need to make sure this translation is possible.

We relied on Averbukh framework [1], to affirm that a visualization system based on visual metaphors comprises a well-defined language. In this sense, Averbukh affirms that each visualization system contains as its core, the language considering as a unity of the vocabulary, syntax, semantics, and pragmatics. Additionally, visualization languages are built upon some basic idea of similarities between application domain entities with visual objects, i.e., upon a visualization metaphor.

In short, as Figure 12 shows, the use of a formal visual metaphor makes possible the mapping from domain data values do visual parameters. That visual metaphor defines a formal language that a visualization system can automate. This concept is one of the basis pillars of our proposal.

![Input EA Models](image1)

**Figure 12 – Visual metaphor utilization**

The relationship between data values and visual parameters has to be a univocal relationship; otherwise, if more than one data value is mapped onto the same visual parameter than it will be impossible to distinguish one value’s influence from the other. On the other hand, there can always be visual parameters that are not used to map information, as long as there is no need for them to be utilized [11].

Possible metaphors when representing EA’s are the 3D city metaphor, the solar system, process illustrations, a factory, the periodic table, etc. since there are widely known but also due to their specific properties and variable complexity.

7. PRACTICAL EXAMPLE: “The cITy”

An example of a visual metaphor that could be utilized on the proposed system is the city metaphor. Cities are very complex spatial environments and yet, people are used to navigating within cities. They know how to get information, how to reach particular destinations, and how to make use of the infrastructure. Furthermore, cities possess a unique set of navigational tools that lend themselves to creating sub-metaphors. A city metaphor makes this existing knowledge about a structured environment available to the user of a computerized information system [5].

This city must be prepared for the EA data we want to represent. Enterprise information is multi-dimensional, subject to constant change, highly related, abstract (e.g. business processes, applications) and concrete (e.g. IT components, employees).

Our city is composed of blocks, each of one composed of several buildings with several stories. We consider that this city could be used in many EA representation efforts. Therefore, we will demonstrate it with the applications architecture. Let us assume that an application is embed in a system (of applications) and that it contains several modules. Each module has its own functionality. Additionally, an application has several properties we would like to see represented. Table 1 makes the bridge between the city metaphor and the applications architecture.

<table>
<thead>
<tr>
<th>City metaphor</th>
<th>Possible use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td>System (or other application aggregator)</td>
</tr>
<tr>
<td>Story</td>
<td>Module</td>
</tr>
<tr>
<td>Base story</td>
<td>Base module of an application</td>
</tr>
<tr>
<td>Story interior</td>
<td>Module details</td>
</tr>
<tr>
<td>Building position within the city</td>
<td>Arbitrary system property</td>
</tr>
<tr>
<td>Block pavement color (or texture)</td>
<td>Arbitrary system property</td>
</tr>
<tr>
<td>Building position within the block</td>
<td>Arbitrary application property</td>
</tr>
<tr>
<td>Building height</td>
<td>Number of modules</td>
</tr>
<tr>
<td>Building shape</td>
<td>Arbitrary application property</td>
</tr>
<tr>
<td>Building roof shape</td>
<td>Arbitrary application property</td>
</tr>
<tr>
<td>Roof color (or texture)</td>
<td>Arbitrary application property</td>
</tr>
<tr>
<td>Story position</td>
<td>Arbitrary module property</td>
</tr>
<tr>
<td>Story color (or texture)</td>
<td>Arbitrary module property</td>
</tr>
</tbody>
</table>

Besides the dimensions described above, we can add an arbitrary number of dimensions through interactivity: for example, displaying application information, when the user passes the mouse over a building. Additionally, the user could dynamically map the metaphor to the city, according to its preferences of visualization. The only concerns should be that size, position and shape dimensions should be used when representing discrete variables. On the other hand, color (or texture) should represent continuous variables.

Another benefit of this metaphor is that we can explore it to higher levels. For example, we could use a taxi to travel through the blocks (Figure 13), or an elevator to explore an application interior (e.g. their relations with business processes, etc.).

![Building position within the city](image2)

**Figure 13 – “cITy” navigation**

Finally, we would like to stress the possibility of different views: for example, the helicopter view (Figure 14) would display an overview of the city, giving an overview of the enterprise applications. This way, visualization would stress the roof shape / color and the building shape. However, if the user zooms into a block, he can analyze the details about the system it represents; getting an overview of the applications the system contains (Figure 15).
8. CONCLUSION

It is now clear and straightforward to think of visualization as a leading method for communicating within the organization: solving problems, supporting decision-making, justifying arguments, assimilating complex structures, among many other endings.

Nowadays, most people misunderstood EA modeling with EA visualization. This approach has many problems, but the most important one is that most part of the stakeholders does not feel comfortable looking at lots of boxes and arrows. Instead, they would prefer representations with more real objects and situations that speak their language and have the correct level of detail.

In what concerns the city metaphor, we think it comprises a highly expandability and structured system as well it provides a comfortable environment where the user feels the will to explore and learn in a natural way. In short, it clearly helps people understanding of EA models. Finally, despite we used the city metaphor to represent the applications architecture; it could be adapted to other types of architecture. The important is to keep the consistency and follow the best visualization practices.

However, the presented system still needs a better formal language definition. Future work will better define the language between domain and visual artifacts. Additionally, the city metaphor could be better explored as well as other metaphors with many potential.

9. REFERENCES


