An Approach to Visualization Design for R&D Information Management

Chaturong Sriwiroj
Dr.Kittima Mekhabuncahkit
Information Technology, Graduate School, Sripatum University, Bangkok, Thailand.
chatuw@gmail.com
kittima.me@gmail.com

Abstract

This paper we want to propose a visualization design framework for R&D information management. We attempt to formulate the successful of using suitable visualization tools to handling scientific data which has a complex and large amount of data set. This framework design and develop are base on empirical study in research and development institution, by used data in specific topics and specific activities in scientific task patterns and to find a way to understand the qualify of using visualization tools in order to represent relationships contained in the data faithfully including meaningful contained in the data and efficiently. We contribute on information management for interaction and perception and cognition and sense making on visualization by using this conceptual design framework.

Key Words: Information Management, Information Visualization, Visualization Tools, HCI, Usability Test, User Experience

1. Introduction

Visual representation of information requires merging of data visualization methods, computer graphics, design, and imagination. Since 1987 as the year where is information visualization started. Visualization is more than a method of computing. It is a process of transforming information into a visual form enabling the user to observe the information. Thus, information visualization uses techniques of computer graphics and imaging and process to represent data. And relying on visual computing and display it involves human beings. So, information visualization has to take into human perceptual and cognitive capabilities, human variations, and task characteristics. The successful of information visualization can reduce the time it takes to get the information, make sense and enhance creative thinking. Nowadays, the field of information visualization is getting more specialized; submitted work often consists of incremental results. This could be a signal that is getting more mature. Several researchers have presented [1]. The overviews of current challenges we need to give the standard rationale of information visualization field. And the most of data that used in visualization, information is usually abstraction. Information visualization should be representation relationships contained in the information faithfully and efficiently. Information visualization was considered vital and highly promising for the scientific process. Nowadays, much progress has been made. But many of new information visualization tools and new methods are not used in the real world situations. The information visualization exploration is a process of data that makes it possible for researchers to obtain insight in these data in an efficient and effective and include the way to detect meaning and interesting features and patterns in a short time. Many information visualization tools available today have been optimized for conventional displays and interaction devices and user interaction. And the many issues are mentioned several times, including handling of complex and large data sets, uncertainty, validation, integration with the process of the user, and a better understanding of the information visualization process.

2. Literature of review

Information visualization is an effective way to easily comprehend large amounts of data. And information visualization is alternative way to effectively communicating information. Visualization transforms large amounts of data into images revealing important aspects of the data, which often leads to profound levels of insight and understanding. Information visualization has its roots in scientific visualization. Card et al [2] definition an information visualization as using computer supported, interactive, visual representation of abstract data to amplify cognition and propose, the following ways to amplify cognition: shift work from cognitive to perceptual system, reduce searching, and enhance recognition of patterns. To visualize information, source live data is diversified according to objects.

The data is classified into the following three types: 1. quantitative data, including place, time or amount; 2. ordinal data, including evaluation; and 3. nominal data, including general documents. This live data is transformed into data arrays according to purposes of visualization. Several arrays of prerequisites, such as relevance, hierarchy or adjacency of data must be prepared.

Visualization becomes the most powerful when the scientists are allowed to interactively explore the data. The representation of information visualization as well as the perceptual, cognitive and involve capabilities of human end users. Information visualization methods allow the extraction of relevant data from complex data sets and represent them by using graphic computing techniques, language processing. When talk to information visualization one thing importance that is patterns. The patterns propose to explicitly represent design knowledge that is understood implicitly by skilled practitioners. Jeffrey [3]. Introduce design patterns describing for information visualization present a set of twelve as follows; 1. Reference Model: Separate data and visual models to enable multiple visualizations of a data source, separate visual models from displays to enable multiple views of a visualization, and use modular controllers to handle user input in a flexible and reusable fashion, 2. Data Column: Organize relational data into typed data columns, providing flexible data representations and extensible data schemas, 3. Cascaded Table: Allow relational data tables to inherit data from parent tables and efficiently supporting derived tables, 4. Relational Graph: Use relational data tables to represent network structures and facilitating data reuse and efficient data processing, 5. Proxy Tuple: Use an object-relational mapping for accessing table and network data sets and improving usability and data interoperability, 6. Expression: Provide an expression language for data processing tasks such as specifying queries and computing derived values, 7. Scheduler: Provide schedulable activities for implementing time-sensitive and potentially recurring operations, 8. Operator: Decompose visual data processing into a series of composable operators and enabling flexible and reconfigurable visual mappings, 9. Renderer: Separate visual components from their rendering methods and allowing dynamic determination of visual appearances, 10. Production Rule: Use a chain of if-then-else rules to dynamically determine visual properties using rule-based assignment or delegation, 11. Camera: Provide a transformable camera view onto a visualization and supporting multiple views and spatial navigation of data displays, 12. Dynamic Query Binding: Allow data selection and filtering criteria to be specified dynamically using direct manipulation interface components. An information visualization tool has the purpose of creating an interactive visual representation that transforms abstract data in a way that may be promptly understood by the user and may be used for tasks such as identification, multivariate correlation, search, exploration and communication. The visualization tools can be extremely useful in the scientific field, since a significantly data set is abstract and difficult to be understood.

Many tools tried to get more adaptable to human perceptions through more interactive user interfaces. There are many factor effects to user perception such as 1. Visual perception is the processing of input stimuli based upon reflected wavelengths of light from which our brain constructs internal representations of the outside world [4]. 2. Given the same input image, different subjects might interpret the picture differently. 3. Humans have a limited ability to discriminate between colors, on the order of 300,000 colors [5].

Information and data visualization tries join the power of human visual perception with the power of the computer processing, so that a data set can be quickly represented and understood. Although usability studies for visualization techniques are being reported for example Schaffer [6] present another proof of the usefulness of Fisheye techniques more such studies are needed formal definitions and theories of what constitutes a good visualization will be develop. The research in scientific information visualization makes use of interactive representations, typically visual, of abstract data to reinforce cognition. Visualization tools have proven to help information analysts with discovery and confirmation tasks, the goal of usability test supporting reasoning is made even more compelling when collaboration is involved. The primary goal of a usability test is to derive a list of usability problems from user behavior.

3. Research and Development Institution

The nature of research and development refer to the reinvention of innovation and knowledge is fundamental to the increasing shift toward a knowledge-based economy [12]. The research and development institution has a duty way to develop a knowledge base and innovation potential. The research and development institution has according to the organization that to creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. The concept of research and development institution for work has a special economic significance apart from its conventional

association with scientific and technological development. R&D investment generally reflects a government's or organization's willingness to forego current operations or profit to improve future performance or returns, and its abilities to conduct research and development.

The big problem for R&D institution for management is an allocate funds and measuring and improving the R&D effectiveness [13]. The public funding has been a necessary condition for the very existence of the R&D institution [14] and the public expect gains in R&D efficiency and effectiveness to be realized as a result. In this study we empirical in public research and development institution; National Science and Technology Development Agency under financial supported by government. This institution to in deep commitment to apply science and technology (S&T) to enhance the nations economic and social development. And have a programs focus on cutting-edge research, design, development and engineering, and offering significant opportunities for cooperative activities and investments involving the business community and academia. And this institution is also active in technology transfer, training, and providing laboratory services. Through its programs, this institution brings a multi-layered and multi-faceted approach to deploying scientific and technological discoveries and advancement to serve national needs.

In detail this institution is an organization which could be comprised of several research centers and laboratories and to have a specific characteristic that have many level of data, complex data, data disperse in many step of work process. The acknowledgement of information in organization should be done in sufficient and comforting. Thus the understanding and recognition in data have less. How to provide an executives user or user who must to use data in regularly day work can reach and perceptive about data or information in their organization an efficiently. In the way of manage an information organization for bring existing data to meet the highest usefulness. We can use information visualization in process of managing this specific data by take the information management theory to apply with specific work patterns of research and development institution and apply with visualization tools for support in managing information, collect disperse data, comprehend data, perceive data meaning, include reach to data and bring data to the highest usefulness.

4. Framework

In this section, we propose a generic framework on selective suitable scientific visualization tools for manage R&D information organization management. First, the major ingredients are identified; secondly usability test assess are associated. The framework can be used to identify some aspects, patterns and trends. The framework of scientific information visualization is presented and benefit is established. The uses of the framework for selected suitable scientific visualization tools and understanding why the users are used or the users are not used in practice. And include to find a new framework in general.

In the following sections, a first step toward such a framework is presented. And exhibit how to the usability test assess the value of information visualization. The information visualization can mean a technology, to a specific technique, or to the visual result. The information visualization is considered as a technology, that is as a collection of methods, techniques, and tools developed and applied to satisfy a need, then standard measures apply. A scientific visualization tools has to be effective and efficient. For example, analysis of a chemistry data set may produce an encoding for a promising lead compound for the design of drug. Proper information visualization tools can manage the data set to communicate how to modify existing compounds to obtain the promising lead. For the next an example, some information visualization tools can supporting to examine DNA repair within the intact cell to visualized. For the next an example when scientist have a large-scale data of bioactive chemicals oriented to drug development are being accumulated and due to the difficulties inherent in understanding such large quantities of data, information visualization techniques are increasingly attractive. A scientific visualization tools which have a technique for represent of large-scale hierarchical data, for the visualization data of bioactive chemicals. The scientist can select it for suitable with his task. And for the next an example some tools such as Line Graph Explorer: is an interactive visualization for large collections of line graphs to motivating and inspiration is in the domain of molecular biology and more specifically in protein and DNA analysis using gel electrophoresis. In this section divides into two of design step.

4.1 Design Object & Relationship definition of object: Project mean a process or step to turn an idea or work request into specifying scope and objectives, identifying resources assigned to perform the work, and determining project approach and milestones and descriptive project approach to plan the activities.
Activity mean the process of decomposing a project into a number of tasks which are needed to complete the deliverables. In each the project have a set of

activities that will be performed in the project by useing resources to meet the objectives. Task mean part of a set of activities which accomplish a job and a problem or an assignment. User Group mean worker that we classify by computer use experiences. Relationship mean the associated between object such as one to many, many to one, many to many.

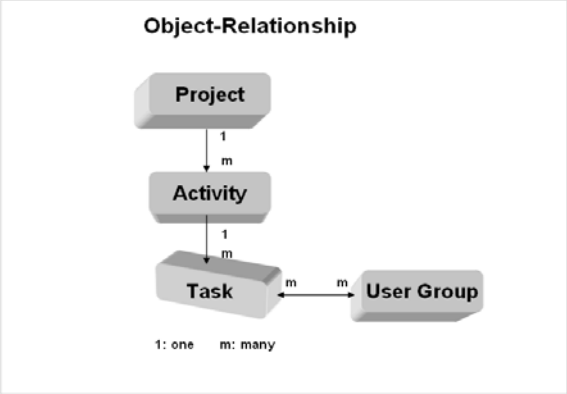

Figure 1 shows the Object-Relationship established.

4.2 Design Usability Test for keep the result of each category of user groups testing in each visualization tools and the usability test ranking.
A project in this table can run from *1* project to *i* project. An activity in each project can run from *1* activity to *i* activity. A task in each activity can run from *1* task to *i* task. The user group can categorize to 6 category, OP: Operation User, RS: Researcher, PMG: Project Manager, LMG: Laboratory Manager, SMG: Senior Manager, EXC: Executive. And Tools can run from *1* tool to *i* tools. We classify any activity according to project and classify any tasks according to each activity. Many tasks we will describe directly support formulation of on activity in each project define. In each tasks user be able to relate data sets to the realms in which decision are being made. The users can selected and used scientific visualization tools for suitable with his task. We evaluate visualization tools in each category of user groups by based on the qualitative weight and sum approach. The qualitative weight and sum (QWS) [10] is a well established for the evaluation of software products. It establishes and weights a list of criteria. QWS is based on use of symbols. There are six qualitative levels of importance for the weights, frequently symbols are used: E = essential, * = extremely valuable, # = very valuable, + = valuable, | = marginally valuable and 0 = not valuable. The weight of a criterion determines the range of values that can be used to measure a product's performance. For a criterion weighted #, for example the can only be judged #, +, | or 0, but not *. This means that lower weighted criteria can not overpower higher weighted criteria. To evaluate the results, the different symbols given to each product are counted. Example results can be 2*, 3#, 3| or 1*, 6#, 1+. The product can be ranked according to these numbers [11]. We apply this approach to evaluate visualization tools in a way where the essential criteria are assessed. And according to the QWS approach the value are summarized for each usability test by building the number of each symbol and the evaluation value of the visualization tools are calculated equivalently. The evaluation results of visualization tools for each subcategory in each user group are present in Table 1. the maximum values represent the values, which can be achieved at maximum per subcategory.

Table 1: Evaluation Results of Visualization Tools for each Subcategory in each User Group.

Information Visualization Tools i	Project i						..	Project$_2$										
	Activity i							..	A$_n$	..	A$_1$	..	A$_n$					
	Task i						..	T$_n$										
	User Group i					..	U$_n$											
	OP	RS	PMG	LMG	SMG	EXC												
	User-friendliness Support Documentation Assistance Technical Fun Zoom Filter Details on demand Ranking	User-friendliness Support Documentation Assistance Technical Fun Zoom Filter Details on demand Ranking																
Maximum values	# # + + * * * | 2	# # + + * * * | 2																
Gravi++	+ | + + # + * | 2	+ | + + # # * | 2																
Taxon Tree	+ # + + + + # 0 2	# # + + # | # | 1																
Double Tree	| | + 0 + # + | 3	# | + + + # + | 2																
Tree Plus	| | + 0 + * # | 3	| + + + + * # | 3																
Ecolens	0 # 0 + # # + 0 3	|# | + # # + 0 3																
Fisheye	# # + + # # + | 1	# # + + * # + | 2																
Heiank Vie	+ + | + * # | | 3	+ + | + * + | | 3																
..																		
Tools n																		

$i = 1..n$

The results in visualization tools specific way, due to the use this an approach, a pairwise comparison of all visualization tools are necessary to determine the ranking. Because these comparisons do not result in a sequential order, the visualization tools need to be grouped in to clusters.

5. Discussion

This paper presents idea bring to design framework and bring to apply to utilize. In the best places of the information for corporations and organizations to interface information visualization technology and designing information visualization environment which can be used to share information among projects and tasks.

We need to define task focus in information visualization which more or less inherently leads to the utilization of methods which focus on evaluation of performance in terms of user task, such as time to complete a task, numbers of error, learning time etc. We control experiment and more informal users and focus on level user task. We measures such as precision and recall, response time, measuring the number of items that can be visualized. An information access the visual usability test some specification tools has been carried out with user experience. The usability test evaluation of an information visualization technique can be done by evaluation of the visual representation and the interaction techniques. We looked in many metaphors used in many task have a rule-based and event-condition-action event handler specify and we see how these manifested the behavioral specifications and how suitable these were for end users in many kind of task which information visualization techniques attempt to support.

The visualization techniques enable users to interactively explore complex structural relationships between the information objects. An examples for hierarchy representations [7]. There is a variety of automatic methods introduced by graph theory to explore structures. General work has been done to determine the complexity of graph-theoretical algorithms and to estimate their efficiency and effectivity for practical data sets [8]. Furthermore, these framework have been applied and refined for practical design application fields, such as biotechnology for example the usage of some scientific visualization tools have a techniques to generalized interval graphs to solve the physical mapping problem that occurs when sequencing fragments of DNA [9]. A technological viewpoint is adopted, where the value of information visualization is measured based on effectiveness and efficiency. Although various promising techniques for visualizing information has been proposed and several visualization technique has been proved to be really useful by extensive usability studies.

In the usability test assess we concern some techniques such as metaphor, there are much styles of metaphor for information visualization and some tools in order to represent abstract information and interactive form using techniques. The utilization of metaphors in order to represent such information can add some meaning to the result of the user's search quickly and intuitive understanding of the results.

We now turn to discussing many tasks that information visualization tools should support for complex decision making and using and learning. A benefit of this framework it will be assist tool for support users in order to select suitable information visualization tools for each tasks.

5.1 discuss Framework : The better understanding of the insights of the framework can be used to control the following steps of the visualization pipeline for selection tools and mapping for generate visual user group representations. Furthermore, this provides a powerful task basis to create overview of process in generate project, activity, task, usability test evaluation results as well as detailed displays.

5.2 discuss Visualization Tools: Starting with a general overview image representing of a data set, zooming is applied to focus on regions of interest. For an example, user groups do usability test with some tools and this tool use technique pan and zoom visualization. The zooming can be seen as moving, whereas panning relates to changing the viewpoint, panning could be performed by moving the head with a see through display. The zooming may relate also to changing the level of information. As soon as the user has panned the object of interest in sight, they can zoom in to the object to reveal more details. with pan and zoom visualizations, the user's primary task and interaction are related to easy to use that tool in task.

5.3 discuss Usability Test: The evaluation of usability test of information visualization tools should be consider to that visualization tool had provided techniques to allow users to perform the following tasks: such as 1. General View: the user needs an overall view of all analyzed data, based on the selected parameters for the visualization. 2. Zoom: the zoom technique is important because it allows focusing on the analyzed data. Semantic zoom also allows the user to visualize more details to the visualization. 3. Filter: users frequently need to reduce the size of data sets by reducing the number of attributes. One of the most efficient ways is the use of

dynamic queries, which is basically a technique that allows the user to select data without the use of any kind of command lines. 4. Details on demand: when users are exploring a data set, user will need to see details about one item in particular.

The usability test is accomplished through user testing which lead us to the problem of defining the set of user tasks and the evaluation of information visualization techniques should be based on empirical testing of both the visual representation and the interaction mechanisms. For example, usual and critical aspects of visual representations are object occlusion and visual disorder, while visual disorientation is caused by changes in the visual representations due to some user action. Thus, often there are situations when one aspect interaction affects the other visual representation. All such characteristics should be verified in order to evaluate a specific visualization technique. In the usability test that; a user who is responsible for making decisions will need efficient tools to help him perform his tasks in a very fast, simple and precise way.

6. Conclusion

In this paper, we introduce an approach to design framework with information visualization for manage an information organization in work of research and development. We attempt to summarize and to provide an overview of these challenges.

As we have show, the development framework supported users to select suitable scientific information visualization tools for work visualized area fulfills requirements in each tasks in order to allow users can manage their data or information by turning data or information into a visual shape to easily understood by the users, and making it possible for users to generate new knowledge about the relations between the data or information in the area of scientific research and development. The field of scientific information visualization is getting maturing and the many sciences problems have been solved and an understanding of the purpose and meaning of information visualization is needed. And we can usability test assess what a good scientific information visualization is viewing information visualization as a scientific discipline. The evaluation of information visualization tools descends from an emphasis on a user's ability to represent data of interest and operate on them independently and too often successful decision making and user experience intentional and specific support for tasks.

7. Reference

[1] C. Johnson. (2004). “Top Scientific Visualization Research Problems”. IEEE Computer Graphics and Applications, vol. 24, no. 4, pp. 13-17, July/Aug. 2004.

[2] Card S.K., Mackinlay J.D., and Shneiderman B. “Readings in Information Visualization: Using Vision to Think”. Morgan Kaufman Publishers, 1999.

[3] H. Jeffrey. (2006). “Software Design Patterns for Information Visualization”. IEEE Transaction on Visualization and Computer Graphics, vol. 12, no. 5, september/october 2006.

[4] R. Cook. “Visual Perception. From Comparative Psychology: A Handbook”. Garland Publishing.

[5] C. Morris. “Psychology: An Introduction”.10th Edition, Prentice Hall.

[6] D. Schaffer. (1996). “Navigating Hierarchically Clustered Networks through Fisheye and Full-Zoom Methods”. ACM Transaction on Computer-Human Interaction (TOCHI), 3(2),162-188, June 1996.

[7] Lamping, J., Rao, R. and Pirolli, P. (1995), “A focus+context technique based on hyperbolic geometryfor viewing large hierarchies”. ACM Proceedings of Computer-Human Interaction (CHI95); Denver, Colorado, USA, pp. 401–408.

[8] Girvan, M., and Newman, M. (2002), “Community structure in social and biological networks”. PNAS 99(12), 7821–7826.

[9] Zhang, P. (1994), “Method of Mapping DNA Fragments”. United States Patent No. 5667970.

[10] M. Scriven. (1991), “Evaluation Thesaurus”. Newbury Park, CA: Sage Publications.

[11] G. Sabine., & L. Beate. (2002), “An Evaluation of Open Source E-Learning Platforms Stressing Adaptation Issues”.

[12] BC. Lisaon., and R. Göran., and S. Pike. “Designing a Funding Mechanism in a Government R&D Organization: Applying the Intellectual Capital Lens “

[13] R. Burkhart. (1995). “Survey results to the three & biggest problems”. Industrial Research Institute, Washington, DC.

[14] S. Luis. And C. Laura. (2003). “Coping with environmental pressures: public research organisations responses to funding crises”. Elsevier Science B.V.