

# Web Tools for Creative Problem Solving

Erkki Rautama

University of Joensuu, Finland, <erkki.rautama@joensuu.fi>

Erkki Sutinen

University of Joensuu, Finland, <erkki.sutinen@joensuu.fi>

Jorma Tarhio

Helsinki University of Technology, Finland, <jorma.tarhio@hut.fi>

## Abstract

We consider how to support creative problem solving with the Web. We present an easy-to-use approach to employ Web browsers and telephones for collaborative brainstorming. The advantage of our approach is that it does not require any special tools or software. In addition, we introduce a scheme for a Web-based problem solving server, which provides the user with various accessories for problem solving. The server employs distant thinking models and auxiliary questions to enhance idea generating. It gives guidance, as well as controls the solving process.

**Keywords:** Groupware, WWW-based tools, brainstorming, problem management

## 1 Introduction

Creativity and problem solving belong to the core emphases in most educational programs, from basic education up to the academic studies. An active learner in a truly constructivist meaning builds his or her knowledge, skills, and attitudes by linking new layers to already existing structures. Much of this process takes place by solving meaningful and relevant problems in a creative way. However, a complicated application can bind human resources from the creative task itself and draw attention into technicalities. Therefore, the need for simple, light and easy-to-use tools supporting creative problem solving is obvious. These tools should be a transparent part of the environment where the learner is working anyhow.

In fact, problem solving skills form also a basis for life-long learning. Every day we meet with situations, which require skills of creative problem solving. There are many methods and procedures, which are developed to assist and enhance problem solving. Many of these divide the process into various phases. The phases are presented below.

1. **Identifying the problem.** It is necessary to find out the actual nature of the problem and gather all relevant information about it. Often the need for problem solving process arises from the events or consequences the actual problem has caused: Sometimes finding the basic cause behind the notable influences of it brings automatically an solution to the problem.
2. **Generating ideas** for solving the problem. If the solution is not obvious, usually the best way to proceed is to generate ideas. There are a number of idea generating methods, many of which are based on group working.
3. **Evaluating and processing the ideas.** After the generation phase, the ideas are considered thoroughly and sorted according to their probable effectiveness on the problem. The best ideas are developed further to the state where they are ready to be applied.
4. **Applying** the potential solutions and evaluating the result.

In real life, the problem solving process often requires repeating one or several of these phases multiple times. It is also worthwhile noting that even the original problem may change: the process gives new insights to the solver and makes him or her to see the problem from a novel perspective.

In this paper, we concentrate on creative or innovative problem solving (Fogler 1995) instead of *closed* problem solving (Forcier 1995, Scragg 1997). The attributes creative and innovative emphasize the art of the problem

solving process: it has to be *open* already at the identification phase. Also the process itself should be open to modifications of the preliminary problem. The emphasis is on the entire problem management process, not on searching for a single or even optimal solution.

Creative problem solving is more efficient in heterogeneous groups than as an individual project. The Web has extended the use of computers e.g. by making communicating easy with people world wide. Internet provides us with many tools, which can be applied with creative thinking to bring together individuals with similar interests or problems (Jonassen 2001).

We take a look into existing possibilities of information technology to support creative problem solving. Although there are dedicated applications, one can utilize the everyday software in the problem solving process. We describe how to use a standard Web browser along with telephone line to implement an environment for distance collaboration and cooperation. Our scheme can be applied in various situations, such as writing an article with a group of people physically far apart from each other. We also extend the horizon by sketching out an advanced problem solving server.

## 2 Technology supporting creative problem solving

There are several opportunities to support creative problem solving by information technology. In addition to dedicated software, like those for concept mapping, one can make use of standard applications, like spreadsheets. Besides the trivial uses of a computer for writing notes, preparing outlines, or communication, one can use it for obtaining information and for visualizing the problem with its background and solution ideas.

It has been shown (Gallupe 1991, Gallupe 1992) that computer-aided brainstorming is still more efficient than conventional brainstorming which is a helpful group method already in itself. Computer-aided brainstorming has at least the following advantages:

- Each member of the group can interact with others with his workstation.
- Members can create ideas at the same time.
- Members can evaluate ideas independently.
- The anonymity of a presenter and an evaluator of any idea can be preserved, if necessary.
- It is possible to get rid of the limitations of time and place.

Some of the criticism against traditional, non-computerized brainstorming is based on the fact that the session seldom allows an individual member to deepen a fresh idea or develop it further. The pace of new-born ideas stops a brainstormer's personal cognitive activity, at least at the deep level (Kommers 2001). A benefit from applying Web-based technology in a brainstorming session helps in *distributing* it: a lonely thinker can concentrate on his or her ideas further, without a hindrance to the social process pursued by the others.

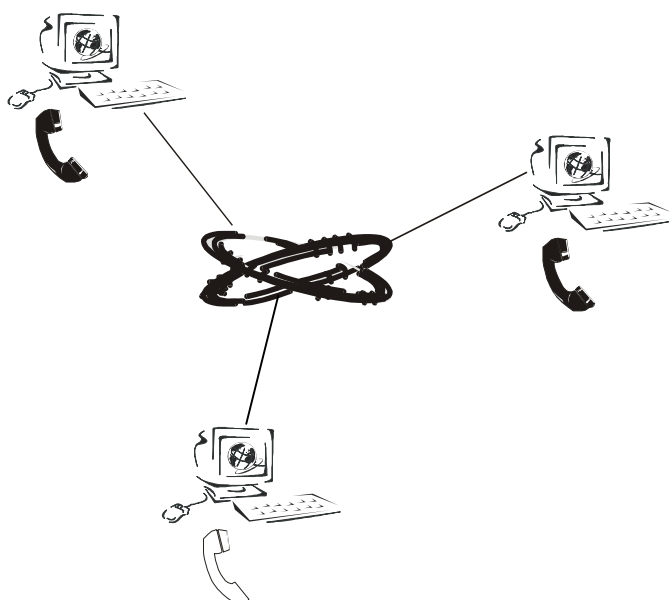
Actual programs (Cave 2001) for creative problem management do not themselves solve any problems, but they offer stimuli, associations, and questions, which aim to help the user to discover new ideas himself and to evaluate their applicability. These programs are more useful for beginners than for experts, because the programs familiarize the user with creative methods and even control the solving process. The simplest ones are made for writing and organizing memory slips. More advanced programs apply information search and randomness. The program may have a large text database, from which the user gets fresh associations or additional information on his problem.

An example of problem solving programs is Idegen++ (Idegen 1996), which helps to create new ideas with *distant thinking models*. The concept refers to various stimuli that are random or unrelated to the problem one is working on. The clue is to detach the thinking process from conventional solutions and make the solver more sensitive to totally novel approaches and perspectives. This is important because a conventional or traditional point of view is a major threat for creativity. As distant thinking models, Idegen++ shows pictures, video clips, sounds, and vivid sayings randomly from a large collection to create associations, which often lead to new ideas. Furthermore, Idegen++ presents questions to the user and controls the evaluation and the refinement of ideas.

### 3 Brainstorming over the Web

Various video and teleconferencing systems, as well as several teamware applications have been developed to enable on-line communication over the Internet. These systems suit very well brainstorming. Most of the systems require a fast network connection to function properly. Unfortunately they may be expensive and often require special equipment or software, which is usually difficult to find, obtain, and learn to use. Another shortcoming with systems of this kind is that they are incompatible with each other: if a person has system X and his or her partner has system Y, it is almost sure that they cannot utilize the tools to work together.

Especially computer applications, which are intended to support distance collaborative working, are usually loaded with too many functions and capabilities which make them difficult to learn. We found an easy and accessible method and have applied it to collaborative problem solving. All our scheme requires is a Web connection, browser and a telephone line. While our research group worked in several locations and our work required both discussion and problem solving sessions, we came up with an idea to combine the use of a standard speaker telephone, which leaves hands free for using a computer, and a standard Web browser (see Fig. 1). Each person taking part into the session edits a file containing their ideas in the Hypertext Markup Language (HTML) format, and the other persons are looking at the same files using Web connection. The conversation is done by phone.



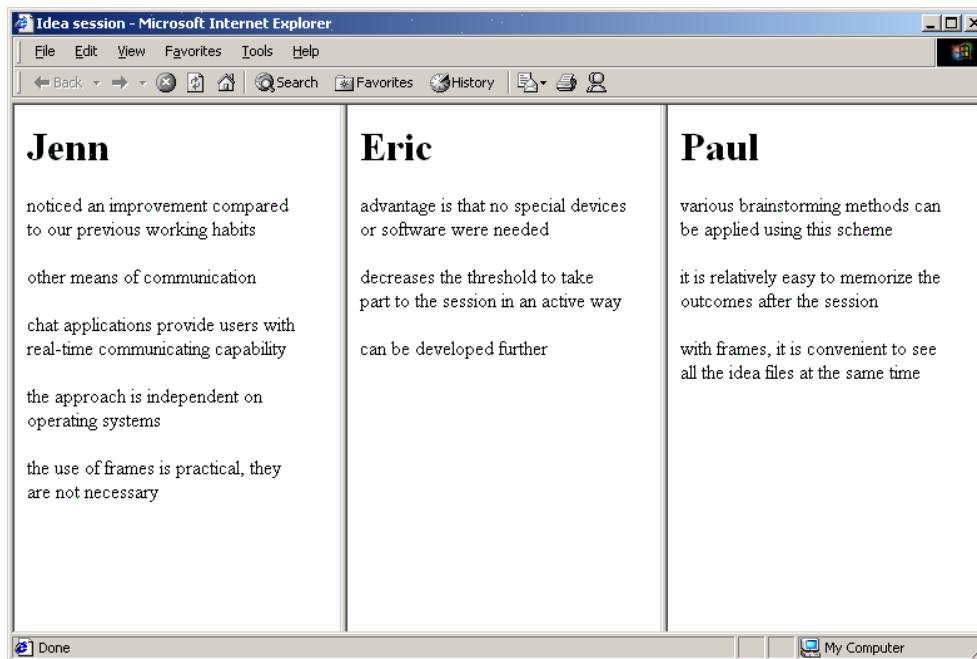
**Figure 1.** *Our brainstorming setting.*

The individual idea files have to be saved in a location where it is accessible by a Web server. Usually the appropriate place is the HTML directory of the user account in the server of the Internet service provider. The idea file of each participant is saved after each editing action. In addition, the file contained a meta tag for automatic reloading of the page. Alternatively, the reload command could be applied after each update in the remote location.

Current Web browsers support the use of frames. This means that a browser window is divided into several parts showing different Web pages. With frames, it is convenient to see all the idea files at the same time. One of the participants maintains an HTML file containing a frame with a reference to the idea file for each participant (see Fig. 2). A frame can also be dedicated for other purposes: it could contain a Web page related to the subject of the session, where the participants can find background information. It is also possible to let every participant build their framed view personally. Although the use of frames is practical, they are not necessary, because the idea files could be seen in separate windows.

We found this method easy to use. An advantage is that no special devices or software were needed. Moreover, the approach is independent on operating systems and Web browsers. In addition, we noticed an improvement compared to our previous working habits: It is not always easy to read the screen of a computer when there are

more than two persons sitting around the machine. Each person had now a screen of his or her own, so that it was easier follow the remote editing than local editing made by another person on the same machine.



**Figure 2.** A view of an idea session.

Our approach also decreases the threshold to take part to the session in an active way. Everyone can prepare their ideas individually taking all the time they need and then publish them for the others. We also noticed that common interruptions are much less annoying, since they affect only one of the participants. It is relatively easy to memorize the outcomes after the session (even after a long period), since the progress of it can be checked from the session Web page. It is more probable that one forgets or loses the ideas if they are originally in paper pieces.

The basic scheme can be developed further. For example, various brainstorming methods can be applied using this scheme. The only difference and one of the advantages is that the participants can be located virtually anywhere in the world, assuming that they have Internet and telephone connections available.

Our method is not in any way restricted to or aimed only at distance collaboration. It can also be applied when all participants are present in the same room. In this case the telephone connection is, of course, needless.

The Internet offers also other means of communication, which could be applied to brainstorming. Various chat applications provide users with real-time communicating capability. However, the chat services usually are aimed at casual discussion like conversation thus not being suitable for e.g. working on shared documents. Usenet newsgroups work like online bulleting boards. The users can leave messages for others to read and reply. It is possible to deliver even long documents but the messages only present a certain version of the document. There are also tools to enable voice conversations. In our scheme the phone line can be replaced with such a tool. In Table 1, we compare IRC and Usenet news with our scheme.

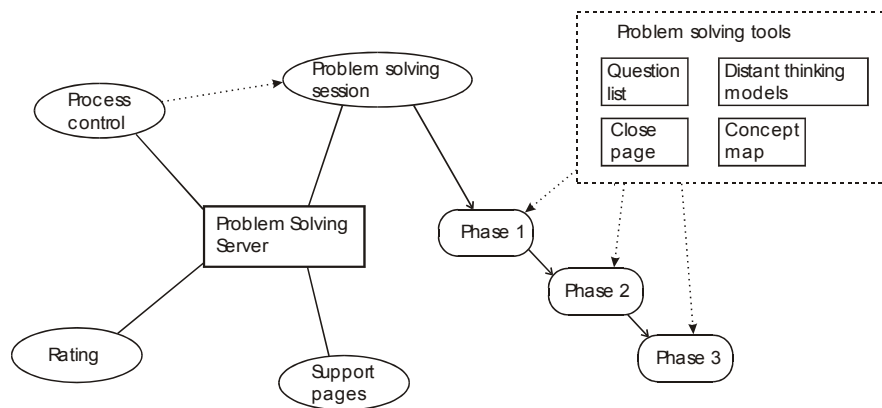
**Table 1.** Comparison of basic communication tools.

	<i>Real-time</i>	<i>Document sharing</i>	<i>Voice conversations</i>
Chat applications, IRC	Yes	No	Yes/No
Usenet news	No	Yes	No
Our scheme	Yes	Yes	Yes

## 4 Problem solving server

We have extensively used Idegen++ at our local problem solving sessions. Though it is a valuable resource leading to useful innovations, it has some shortcomings. When the user encounters the same distant thinking model for several times, it loses its effect. Another problem is that the program controls too tightly the solving process, which is undesirable for experts. In other words, the program follows a fixed path which is not always relevant for all problems and situations. In addition, the user observes only the local stage, which may make the user feel himself or herself as an outsider in reference to the whole problem solving process.

Based on our experiences we present a design for a better system working on the Web (see Fig. 3). The system works as a Web server providing several services. We call it PMA for Problem Management Assistant.



**Figure 3.** *The structure of PMA.*

**Customized process control.** PMA offers several options for controlling a problem solving session and shows a visual overview of it. One may let PMA lead the whole process, which is applicable for novices. Even a novice user can have certain amount of control over the process if the system offers a helper or wizard function. The wizard guides the user through the process and gives in appropriate stages alternatives to choose from. Expert users may select which phases they like to have and in which order. The selection can also be done during the problem solving process by letting the user choose after each phase whether to continue with another phase or stop the process. The user could e.g. define in the beginning the amount of new ideas he or she wants to come up with during the problem solving session. The system then keeps a track of the process and ends it at a point where enough ideas have been generated. The analysis provided by PMA could even be extended to qualitative issues like relationships between ideas. This means that not only the number of ideas but also the structure of the entire idea construction could be evaluated. A network of strongly interrelated ideas might indicate a more creative approach than a plain sequence of ideas. For this kind of quantitative evaluation, PMA might make use of techniques similar to analyzing concept maps.

**Distant thinking models.** Like Idegen++ PMA applies distant thinking models. The Web contains a huge collection of pages to be used as distant thinking models. This feature is implemented by giving a link to a new Web page. The server keeps track of the shown pages so that the same page (or a similar one) is not shown too often. The searching is done with standard Web search engines and it is based on picking randomly a few words from a long word list and on including or excluding a certain topic. The user may rate the pages he browsed, in order to help PMA to serve him or other users better in a similar situation.

**Close pages.** Besides distant thinking models, PMA tries to find pages that are close to the problem in order to provide the user with possible alternative views of the problem. To find close pages PMA uses Web search engines. One especially useful engine for this purpose is the Digital Integrity service ([www.findsame.com](http://www.findsame.com)), because it matches not only a few keywords but rather a longer text content. Thus the search criteria can be e.g. the description of the problem possibly combined with the ideas generated so far.

**Question lists.** Lists of predefined questions is one the standard techniques of creative problem solving. For example, in developing newly found ideas further, one may ask:

- Can you expand it?
- Can you reduce it?
- Can you divide it?
- Can you add something to it?
- Can you combine it with something else?
- Can you replace it?
- Can you turn it over?

PMA holds several lists for various purposes. Moreover, PMA lets the user propose new questions. The system asks other users to evaluate new questions and only good ones are preserved permanently. For each list, PMA applies variation. The order of questions is not fixed and not all questions are shown every time. The user also has an option to skip a question or stop the phase at any point.

**Animated conceptualization of the problem.** Concept mapping (Novak 1984) is one of the techniques for the problem identification phase. PMA includes a tool to present the problem (together with related information) as a concept map in order to help the user in perceiving better the relations of the details. The map is created by using a concept map editor provided by PMA. To extend the uses of a concept map to support idea generation, the tool includes features that change the outlook of a map. The map can be looked at from different angles, with several layouts, and with various filters, which hide selected or random parts of the map. The view can also be focused on selected or random concepts. The tool connects random temporary concepts to the map in the same purpose as distant thinking models.

**Support pages.** PMA provides the user with a collection of support pages. Besides operating instructions with examples, these pages contain a tutorial on creative problem solving, useful links, a list of literature etc. The most frequently asked questions with answers are presented as a list. The users can also communicate and discuss about their problems with each other by using a discussion forum.

**Rating.** PMA contains an easy feedback mechanism for the users. The services are rated based on this feedback. The show-up of services is based on the rating. Services are automatically adapted by gathering information about use frequencies – the most used services are offered first to a new user. PMA can be used anonymously. However, a user can create a user profile for him/herself. The profile consists of basic information of the user along with his/her preferences gathered either with a question form or automatically by the system. User profiles allow more advanced services such as bringing similar users together. Or even better: the system might help in gathering heterogeneous groups to work on a problem that is crucial for each partner.

**Success stories.** In certain case-based reasoning systems, the goal is to identify already solved problem instances that are similar to the one not yet solved. Accordingly, PMA users could share their success stories in solving hard problems. The system could then help a newcomer to approximately match a related problem with its solution. Possibly, the newcomer could develop this solution further on and help in building the PMA user community a resource for distributed expertise.

## 5 Concluding remarks

Our method of using the Web for collaborative working fits well several problem solving settings. It is free and the set up can be made in a few minutes. Because each participant already works with a Web browser, the threshold to search information from the Web and to use other Web services during brainstorming is lower than in a conventional setting.

The method fits especially well the idea generating phase. Conventional methods often rely on writing ideas on pieces of paper or e.g. on a blackboard. While using the Web as a substitution of these, all the ideas are available to the participants at the same time. The ideas can also be written down in peace, without disturbance from the actions of the others.

Our concept of a Web-based problem solving server opens ways to use intelligence in supporting creative problem solving in a novel way. We are planning to apply open source policy for our software in order to let the real users develop such services that are meaningful for them. By the rating mechanism, we can keep the most useful services in the foreground.

**Acknowledgments.** This work was supported by the National Technology Agency.

## References

- Cave, C. (2001) Resources for creativity and innovation. [www.ozemail.com.au/~caveman/Creative/](http://www.ozemail.com.au/~caveman/Creative/) .
- Fogler, H., LeBlanc, E. (1995) *Strategies for Creative Problem Solving*. Prentice-Hall PTR.
- Forcier, R.C. (1995) *The Computer as an Educational Tool: Productivity and Problem Solving*. 2nd edition. Merrill – Prentice Hall.
- Gallupe, R.B., Bastianutti, L.M., Copper W.H. (1991) “Unblocking brainstorming” *Journal of Applied Psychology* 76, 137–142.
- Gallupe, R.B., Dennis, A.R., Copper W.H., Valacich, J.S., Bastianutti, L.M., Nunamaker, J.F. (1992) “Electronic brainstorming and group size” *Academy of Management Journal* 35, 350-369.
- IdeGen++ (1996) *The user's manual*. CAC-Research Oy.
- Jonassen, D. (2001) “E-learning to solve problems” Keynote speech at Ed-Media 2001, Tampere.
- Kommers, P.A.M. (2001) A personal communication.
- Novak, J.D., Gowin, D.B. (1984) *Learn How To Learn*. Cambridge University Press.
- Scragg, G.W. (1997) *Problem Solving with Computers*. Jones and Barlett Publishers.