

Harnessing People's Creativity: Ideation and Expression through Visual Communication

Elizabeth B.-N. Sanders and Colin T. William

Abstract

The people who buy and use the products we create are not typically invited to play in the fuzzy front-end of the development process because it is commonly believed that they are not creative. But participation early in the front-end is needed to drive truly human-centered product development.

We have learned how to harness the creativity of potential end-users very early in the development process. The research methods in this chapter explore not only what people say and do, but also what people make. The **say** methods are rooted in verbal communication and are used in situations such as traditional focus groups. Methods such as applied ethnography focus on what people **do** through direct or indirect observation. The **make** methods are unique in their ability to elicit creative expression from everyday people.

This chapter describes and shows examples of "make" toolkits we use to elicit creative thinking from people who will buy and use future products and services. It also outlines how all the methods (say and do and make) are used together in order to fully understand people's past, present as well as anticipated experiences with products and services.

The Current Situation

There is a widely held belief shared today by those involved in new product and service development that consumers are not creative. This belief has many variations including:

"consumers do not know and cannot express their needs and/or dreams."

"consumers cannot imagine or envision how their future could be different from the present."

"consumers cannot come up with ideas for new products or services to improve their lives."

"consumers cannot even recognize good ideas that are put in front of them in the form of concepts or prototypes."

This belief has come from many years of market research dominance in the product development arena. Traditional forms of market research rely on verbal communication between people, i.e., on what people **say**. The "say methods" are useful for getting an idea of what consumers can tell you and want to tell you in words, but they are very limited in the context of all the other methods that can be used to understand people's unmet needs and dreams.

Even the language that market researchers use to describe the people we design for, such as *consumers*, *users* and *customers*, puts them into roles with limited and very clearly defined boundaries. *Consumers are people who shop. Users are people who use products*

and services. Customers are purchasers. By putting people in narrow categories, we limit their ability to contribute creatively.

As a result, the people who will be buying and using the products and services we create have not been invited to play in the front-end of the development process. At best, they are invited to participate at the concept evaluation phase or in usability testing. Participation in the middle or end of the design development process is not enough to drive truly human-centered product and service development. To do so requires that we find ways to harness the creativity of ordinary people early in the design development process.

The Emerging Point of View

We have found that there are research methods and tools that everyday people can use to contribute in the front end of the process. We have seen, contrary to the prevailing point of view, that everyday people are creative when given appropriate “tools”. We can harness their creativity early in the development process.

Examples of the innate creativity of everyday people are becoming more evident daily. Desktop publishing by people not trained in design was the first sign. Now personal web sites are proliferating, as are web sites where people can, for example, design their own shoes or decorate their own t-shirts. On the non-electronic side, we see the rapid growth of activities such as scrapbooking and a renewed interest in folk art.

With the advent of new forms of electronic communication, people today have become more demanding “consumers”. They are in the position now to be participants, even innovators, in the new product and service design and development process.

The Opportunity: Harnessing People’s Creativity

Before talking about how we have learned to harness the creativity of everyday people, we need to define what we mean by creativity. We take a transdisciplinary view:

“Creative thinking in all fields occurs preverbally, before logic or linguistics comes into play, manifesting itself through emotions, intuitions, images and bodily feelings. The resulting ideas can be translated into one or more formal systems of communication such as words, equations, pictures or music or dance only after they are sufficiently developed in their prelogical forms.” (Root-Bernstein, R. & M., 1999).

We will use *ideation* to refer to the preverbal idea stage and *expression* to refer to the translation of those ideas into formal systems of communication.

According to Koestler (1964), every creative act involves *bisociation*, a process in which previously unrelated ideas are brought together and combined. He contrasts bisociation with association. Association refers to previously established connections among ideas. Bisociation involves making entirely new connections. According to Koestler, bisociation only occurs when the person has been thoroughly involved in the problem or situation for a long time. Koestler also emphasizes the importance of dreams, in that dreaming involves bisociation at an unconscious level.

To harness people's creativity we need to support both ideation and expression. Here is the four-step framework we use:

1. Immersion
2. Activation of feelings and memories
3. Dreaming
4. Bisociation and expression

The **immersion** step lasts from one to several weeks and takes place in the natural context of the experience being studied, usually the participant's home or place of work. We guide the participants in daily self-documentation of their thoughts, feelings, and ideas about the experience being investigated. We may also ask them to observe and document their current behavior as well.

The next three steps take place in face-to-face meetings, either individually or in groups. First we engage the participants in one or more "exercises" with "toolkits" that have been designed to evoke and **activate related memories and feelings**. The research tools we use for the activation exercises are predominantly visual, and are discussed in greater depth later in this chapter.

Then we invite them to participate in an exercise with a toolkit designed to encourage their **dreaming** about their future or an ideal experience. Again, the research tools are predominantly visual.

In the final **bisociation and expression** step we invite them to bring expression to the ideas they are having. This is the most exciting part – we have seen people express completely new ideas for products or services within a few minutes. It is as though they are ready to explode with ideas. The exercises/toolkits that we use for this step are deliberately abstract and ambiguous.

Different Approaches to Learning: What People Say, Do and Make

The research methods in this chapter explore not only what people say, but also what people do and make. Typical approaches to learning about people focus on what they say and do. As mentioned above, the **say** methods are rooted in verbal communication, such as through traditional focus groups. This can generate a lot of information, but it is limited to what people are able to put into words. Methods such as ethnography focus on what people **do**, through direct observation or through logs and diaries. Such methods also provide much information about behaviors, but they often lack in accessing people's underlying motivations or emotions.

The make methods described in the next section look at what people **make**, with creativity-based research tools you give them. Make methods enable creative expression by giving people ambiguous visual stimuli to work with. Being ambiguous, these stimuli can be interpreted in different ways, and can activate different memories and feelings in different people. The visual nature liberates people's creativity from the boundaries of what they can state in words. Together, the ambiguity and the visual nature of these tools allow people much room for creativity, both in expressing their current experiences and ideas and in generating new ideas.

Examples of Creativity-Based Research Tools

In this section we'll give you, the reader, examples of research tools that allow participants to use their natural creativity to express their ideas. These include pre-meeting tools for use before a group session to facilitate immersion, tools for activating memories and expressing emotions, tools for mapping processes and routines, and tools for bisociation and expression of ideas and ideals. The array of possible tools is limitless, and you should not constrain yourself to those outlined in this chapter. Experiential research tools are not "one size fits all", and you should develop tools for each project with that in mind.

Pre-Meeting Immersion Tools

Mailing participants some tools in advance of a group meeting can enhance the quality of the meeting that takes place. Participants can think about issues to be discussed and about their own experiences. Below we highlight three pre-meeting tools, which can be used individually or together in one booklet.

- Workbooks

A workbook can contain different types of questions, such as demographic information, opinions and information about things people own or use. This lets you learn details about the people without using up meeting time, and thus is suited to less discussion-based issues.

Hands-on exercises also can be included; these can be completed and brought to a meeting, or mailed back to you in advance (the latter allows you to develop more relevant follow-up questions). Assigning exercises ahead of time in workbooks can save time at the meeting, but it is important that you give enough workspace and clear instructions. Also, make exercises as interesting as possible to increase the chance of people completing them.

- Diaries / day-in-the-life exercises

These methods give people space in a workbook to record and become immersed in experiences. This can attune them to details about activities they might normally take for granted. For instance, a diary of commuting experiences might have people record the amount of time spent in the car each day, amount of time spent stopped in traffic, and how they felt and occupied themselves during commuting downtime.

In a day-in-the-life exercise, people outline their typical day, either specific aspects (e.g. use of computers for work and leisure, workspaces, etc.) or across the board. This exercise can be useful in identifying opportunities for new ideas, as people can explain their experiences and the emotions attached to them.

- Send a camera home

Both workbooks and diaries can be enhanced by giving people a camera to document their experiences. They take pictures to document specific aspects of their lives, and mount them on workbook/diary pages to show what they do. This adds a level of richness to text-based methods – as the saying goes, a picture really can be worth a thousand words. So, for instance, a picture of a workspace can give you deeper

insight into the ways people organize their lives and their stuff.

Two options for this are the disposable camera and the Polaroid camera. The former is cheaper, with minimal loss if a participant is dropped from the study. One downside is that participants must leave time to get film developed. Polaroid cameras and film are much more expensive, but they allow people to take and evaluate pictures on the spot. Further, people can immediately annotate the picture.

Tools for the Group Meeting

Below are just a few examples of tools that can be used within group meetings. These tools can also be used individually. They are designed to allow participants to use their previous immersion to stimulate creative exploration. Again, these are only examples to which you shouldn't feel constrained.

- Collages

Collaging allows people to articulate experiences through pictures and words. Collaging involves giving people a set of picture and word stickers and a space on which to arrange them according to your instructions (see figure #).



Figure #: A sample collage set, and people creating collages in a group.

Collaging is ideal for activating feelings and memories, as well as for dreaming. The stimulus set should not be too precisely defined – some stimuli should be ambiguous enough in meaning to allow participants to impose their own interpretation to facilitate creative expression. A collage exercise for our commuting project might give people a workspace divided into two halves, with one for expression of emotions surrounding current commuting experiences, and the other for dreaming about the emotions of commuting in the future.

There are four steps to developing an effective collage toolkit: brainstorming, pilot testing, refinement and production.

Brainstorming

In brainstorming ideas for a collage toolkit, the goal is to provide the participants with the means to communicate across a wide array of experiences. The challenge, then, is in selecting stimuli – words and pictures – which will not only cover experiences you might anticipate, but others you won't. For this reason, the stimuli must be intentionally ambiguous, so as to allow the participants to impose their own

meanings. Moreover, you should involve as many people as you can in your brainstorming sessions, to expand the horizons beyond your own experiences.

The brainstorming session will focus on selecting words and pictures for use in the toolkit. Words are the easier part – anyone can brainstorm words that reflect their experiences. Some sample words for our commuting project might include “traffic”, “thirsty”, “waiting”, “music”, or “boring”. In fact, you should ask at least three people to brainstorm words in order to get a good variety.

Words by themselves, however, are fairly narrow in scope, and that is what leads to the importance of pictures. Brainstorming an image set will be crucial in enticing your participants to communicate. Images can come from anywhere, e.g. magazines or personal photographs. What is important is creating a set that will be evocative. A picture of a person in a car is relevant to our project, but it won't necessarily evoke discussion or emotions. On the other hand, images such as a picture of a traffic light, a cup of coffee, or a jagged speech bubble filled with “ @#\$%&*! ”, will be more potent, more real. But at the same time, you should include images you may not imagine to be part of the experience. Including a picture of a serene scene might evoke someone to talk about their ideal, stress-free commute. So the idea is to cover as broad a range of emotions and experiences as one can, even if they may not fit the expected model of the experience.

On the practical side, you should already be anticipating how you will present these images and words to people. If you plan on giving people sticker sheets of pictures and words, then plan out what size stickers you will use, so that you can anticipate how large or small your images need to be. One image may seem perfect but when reduced down to sticker size, it may not be intelligible. On the other hand, if you choose to use paper sheets of images, you can use larger or nonstandard shapes of images (see “Production” for more on this).

Here are a few rules of thumb for what to include in a collage set:

- ~ a balance of positive and negative images and words,
- ~ a balance of abstract and concrete images and words,
- ~ both natural as well as man-made things, and
- ~ people of all types: male and female, young and old, racial balance, etc.

Once a large set of ideas has been brainstormed, the set will inevitably need to be narrowed down. Overwhelming participants with an immense toolkit is not recommended. Reduce the set to a manageable level, certainly no more than 100 words and 100 pictures, and preferably 150 of the two combined. Distilling your set to manageable proportions will be a challenge, but it will be helped if you can spot redundancies. In our example, a picture of a clogged highway and the words “traffic jam”, both address the same thing, so it may be better to discard one or the other.

At this stage you may not need to narrow down your set all the way. If you get rid of the most obvious redundancies, then you can solicit help in the next stage to narrow the set further.

Pilot Testing

It is imperative to try out your instructions and picture/word set on a few pilot subjects to get their feedback. While your instructions may seem obvious to you on paper, they may seem vague or unclear when spoken aloud to a person unfamiliar

with the task. Remember, people aren't asked to do this kind of task everyday, so it is important to make sure in advance that they understand it.

During a pilot test you will run a few people through your task, preferably people who don't know about your project. Within your pilot test, you should try to approximate your test conditions as much as possible. So if your target is to complete a task in 20 minutes, then you should try to do so in your pilot test also.

Where a pilot test may deviate from your plan is in soliciting feedback. When the pilot test people are trying to build their collage, you can ask them about what they are thinking– are there any concepts they'd like to express, but for which they can't find an image or word? Any images or words they think are redundant? This can be done as they look, when their thoughts are fresh, or after they are done. The latter will allow you to deviate less from your test plan.

Pilot testing can be invaluable in finishing out your toolkit. Almost always it will lead you to make subtle changes to your instructions. Also, you will get a clearer idea of the completeness of your stimulus set. You should be prepared to do a few pilot tests, and to change instructions and toolkits on the fly as you conduct them, especially if you are just beginning to learn these new tools and methods.

Refinement

Once you have run your pilot tests, you should make refinements to your toolkit. Narrow down the image/word set again, if it isn't already at a manageable level. If you make major changes, don't be afraid to run another pilot session. They seldom take much time, and the enhancements to your toolkit can be major.

Production

Once your toolkit is finalized, you can proceed with production. You should have already given consideration to how you want to present your images to people, and there are costs and benefits either way.

Sticker sheets allow participants to work more quickly, and are less cumbersome; however, sticker sheets can be expensive, and they place strict limits on image sizes. Moreover, if you choose small stickers, people observing the groups through a one-way mirror may be unable to see the images as participants talk about what they have created.

The other option is to print your **images and words on sheets of paper**, and have participants use scissors to cut them out and glue sticks to paste them down. This method is less expensive, and it allows more freedom with image sizes; however, it also requires more time and effort for participants to create a collage this way. In producing your collage toolkit, you should make several extra copies to give to those observing the session. Be sure to have enough supplies (e.g., scissors, glue, tape, colored markers, etc.) for everyone.

- Cognitive mapping

Cognitive mapping allows people to map out processes and events, or their understanding of categories or systems. Cognitive mapping toolkits usually contain a poster board and symbolic shapes, which can be used to map out connections, clusters or hierarchies of concepts (see figure #). Words may also be included. These tasks let people express and develop bisociations in thought processes and

structures. The toolkit provides people a medium that channels and simplifies their ability to express complex concepts.

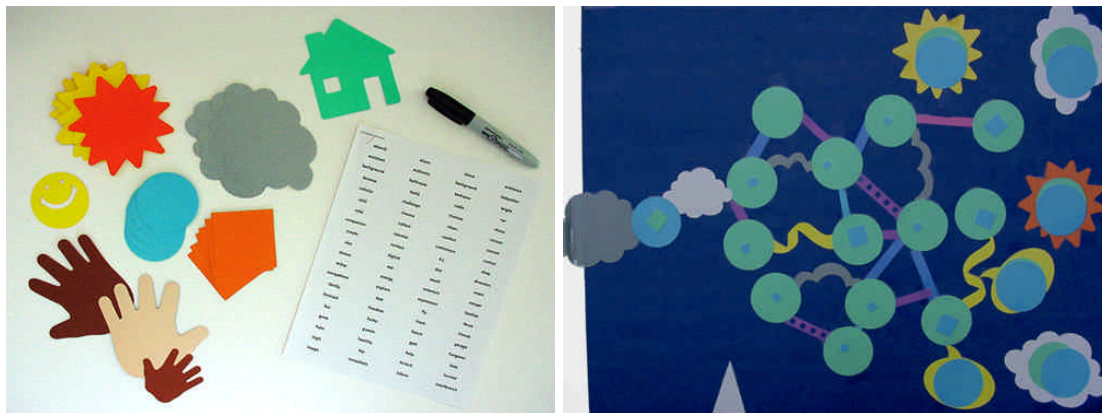


Figure #: A sample cognitive mapping kit and a completed cognitive map. A complex structure like that on the right would be difficult to express in words.

To continue with the example of a study of commuting experiences, a cognitive mapping task could be used to have people embody and map out their ideal commuting experience for the future. Sample shapes could symbolize the home, the “cockpit” of the car, homes of potential carpoolers, places to get coffee or breakfast, shapes for side roads, main streets, highways and work; also included could be colored word stickers to symbolize emotions. People could be asked to map out their ideal experience and associate emotions and times with each step.

The general process of developing a cognitive mapping toolkit is much the same as that for developing a collage toolkit. That is, you will still follow the same brainstorming>pilot testing>refinement>production procedure. The major differences lie in anticipating the workspace people will need and the kind of shapes that will help them express their ideas. The shapes in figure # above include a house, a cloud, sun shapes, circles, and hands. As mentioned above, the bright orange and yellow shapes might be used to reflect positive emotions, whereas a grey cloud may be very negative. The shapes may be used literally or they may be used metaphorically. It is advisable to include very simple shapes such that many different interpretations are possible for each shape.

For the development of your mapping toolkit, it can be useful to go to an art supply or a hobby/craft store and buy a broad sampling of colored shapes available. You will probably also need to produce some shapes of our own. Your brainstorming with colleagues will help to put together the appropriate selection. You can use your pilot sessions to get feedback, and to see which shapes people use to express themselves.

In selecting word stickers, the procedure will be essentially the same as for developing a collage toolkit; however since cognitive mapping is better used for addressing experiences at a more specific level, you will want to make your selections more concrete (i.e., less ambiguous) than for an emotion-centered collage. This will allow you to start pulling out specific areas of opportunity in looking at what people are doing, thinking and feeling today.

As with the collage toolkit, be prepared with extra copies of your toolkit for your audience.

- Velcro-modeling

Velcro-modeling allows people to embody and express their ideas in low-fidelity, three-dimensional models. Ideal for use after other tasks have been used for immersion, activation and dreaming, Velcro-modeling allows people to actively embody their ideas in a hands-on manner. A Velcro-modeling kit will consist of shapes, buttons and other items (see figure #) that are ambiguous in purpose, maximizing the opportunity for people to imagine and impose their own thoughts in the expression of their ideas. In this case, however, the basic “building blocks” (i.e., the larger dark gray components in the upper right corner of the kit photograph) are three-dimensional forms covered with material to which Velcro will stick. The smaller control elements (i.e., the white and the colored button-like shapes in the same photo) are three-dimensional as well. Some are purchased and others are custom made. All the smaller control elements have Velcro on the back so they can stick to the gray forms. We also supply extra Velcro dots so that people can stick the gray forms to one another.



Figure #: A sample Velcro-modeling kit, and a father and son collaboratively creating an ideal model using this kit.

For our commuting example, we might create a model cockpit for a car with surfaces coated in Velcro. Participants could arrange specific controls or features according to their needs and to the needs of their passengers, to create and describe the ideal cockpit for the everyday commuter.

It is not possible to cover the creation of a Velcro-modeling toolkit in this short chapter. Most pieces are custom-designed and the collection of a full set may take years. We started with a small set and still find the need to add on to it every time it is used. Contrary to the toolkit sizes prescribed for image collaging and cognitive mapping, it is best to have very large Velcro-modeling toolkits. For example, for a group of four or five people, we might use hundreds of gray forms of many shapes and sizes together with hundreds of smaller components. At the point at which Velcro-modeling is used, people usually have ideas in mind and they quickly scan through hundreds of components to find those that best fit their ideas. A Velcro-modeling toolkit for an individual would be smaller, but still offer plenty of choice in components so that the person could quickly give form to any ideas that come to mind. Velcro-modeling is a very powerful tool for allowing ordinary people to express their dreams. It is often the case that people start grabbing pieces and using them intuitively before we can even finish giving the instructions.

Guidelines for Using Tools

Selecting Tools

With so many tools available, it is important to develop a plan for using them. Getting the most out of tools requires having defined goals about what you want to learn, and a procedure that builds towards those goals. In developing your methodology, you should think about your goal, then pick tools that will facilitate people's thinking and talking about their experiences. In doing this, consider the following issues:

- Which research tool or tools will access what you want to learn?

Consider the aspects of experience you wish to access. As discussed in the preceding section, different tools are better for accessing cognitive vs. emotional aspects of experience. Certain tools can access people's ideal experiences and ways for them to realize those ideals. Your goals will help dictate the types of tools you will use.

- What do you want out of the tools?

Different tools yield different results. Some are more useful for the discussion they generate. For instance, collages enable storytelling, as participants talk about their collages. On the other hand, with Velcro-models the artifacts have greater importance. These artifacts may be a primary goal, e.g. to serve as inspiration for designers. But even then, the discussion of the models can be extensive and can serve as an important source of inspiration.

- In what order should the tools be presented?

This issue is very important to the results you will get. Often the results of a tool will be incomplete unless participants have thought about the experience situation being investigated in advance. You can handle this by sending a workbook and camera to each participant before the meeting. This allows them to pay more attention to everyday life experiences, priming them for participation in the group discussion. Similarly, having participants create a past-present-future collage will prime them for thinking about specific ideal experiences or products.

A good approach to deciding on the order is to follow the four-step framework described previously. Work from the general to the specific – start with current experience, explore it in greater depth, then use this as a baseline for evaluating and/or creating new ideas. Below is an example of tool ordering for our hypothetical study of commuting experiences for exploring automobile cockpit design:

1. Immerse people in their everyday experiences of commuting via a workbook and camera.
2. Open the group meeting with discussion of things they noticed while filling out the workbook.
3. Have them create collages about the emotional aspects of commuting today vs. in the future in order to activate their feelings and memories.
4. Have them create a cognitive map of the ideal experience of commuting to encourage their dreaming.

5. Have them work with a Velcro-model car cockpit to support bisociation and expression. For example, they could remove elements that inhibit their ideal experience and add elements that would enhance the experience.

The Discussion Guide

Having created a general order for using tools, you can now draft a discussion guide, the formal instructions for running the meeting. This should cover the order of events, specific instructions for each part of the meeting, amount of time for each exercise, goals for each tool and follow-up questions. This guide is useful for standardization, both from session to session and across different people who might be running sessions.

In writing your discussion guide, consider your goals and the time available. It is no small challenge to learn about people's experiences in two hours while giving all participants the opportunity to speak. Outline specific instructions for your tools and estimate the time needed for each. Be generous and realistic about this: estimate time for participants to introduce themselves, to discuss any homework you gave in advance, to carry out each exercise, and time for each person to talk about what they create in each exercise.

Next you should run a pilot session using the discussion guide and prototype tools. Recruit volunteers and run them through. Keep track of the time for each exercise and discussion, and get feedback from your volunteers on timing issues (too much time or too little for each exercise?) and instructions (clear, unclear?).

Based on these sessions, make changes to the guide. When estimating time, remember that in a group you will have more people than in your pilot session. If you run too long, consider putting certain exercises into the workbook for participants to do in advance and bring with them to the meeting. If you still run too long, explore ways to meet your goals using fewer tools.

You also can change instructions that were unclear or didn't meet your goals. Good feedback from pilot subjects can lead to changes to both the instructions and the tools themselves, such as suggestions on stimuli that should be added to the exercises. Seeing the tools in action will provide you with insight for refining them for better discussion and results.

Having modified your procedure, test the full discussion guide again for time, and test any modifications to instructions that you make. After a few rounds of testing and iteration you'll be ready to go.

Results of creativity-based research

Just as the toolkits support the creativity of everyday people, the artifacts people make from the toolkits support the creativity of designers. We often find that the design team members keep the artifacts such as collages, cognitive maps and Velcro-models to surround themselves with during their own ideation and expression activities.

There are methods for both qualitative and quantitative analysis of the data from the say, do and make approaches. The most basic methods will center on identifying the items that occur most frequently on collages or in transcripts. Such items can serve as a starting point from which to go back to transcripts (i.e., the written protocol of what people said in the group meetings) to look for recurring themes.

More powerful statistical methods include cluster analysis and the use of Pathfinder Associative Networks (Schvaneveldt, 1990); these can be useful for identifying patterns in data. A discussion of the analysis of data could fill a chapter or even a textbook to itself, however, so it is beyond the scope of this chapter.

Conclusions

To drive truly human-centered product and service development requires that we harness the creativity of ordinary people early in the development process. Although this chapter had focused on the role of the “make” tools, it should be clear from the example that a carefully planned execution of all three categories of methods (say and do and make) is needed to develop a successful understanding of people’s unmet needs and dreams. It is in the convergent territory that lies at the intersection of what people say and do and make that the useful insights can be found.

We have focused on the use of the make tools for a number of reasons. First, because they are new and because we have found that these tools are the most effective way we know to elicit the creativity of everyday people. Use of the make tools has the added benefit of resulting in artifacts such as collages, mappings and Velcro-models. Designers and other members of the development team can quickly become immersed in the minds and hearts of their potential end-users when they hear people talk about the artifacts they have created with the make tools.

The methods and tools described in this chapter have been used to drive and inspire the design development of products and services in many different industries: consumer, computer, medical and industrial. The Zip Drive by Iomega that was introduced in the mid 1990’s is one of the better recognized results of this approach.

References and related readings

BUZAN, T., & BUZAN, B., 2000, *The Mind Map Book* (Millennium Edition) (BBC Worldwide Ltd., London).

CAPACCHIONE, L., 2000, *Visioning: Ten Steps to Designing the Life of Your Dreams* (Penguin Putman, New York).

GARDNER, H., 1983, *Frames of Mind: The Theory of Multiple Intelligences* (Basic Books, New York).

HORN R.E., 1998, *Visual Language: Global Communication for the 21st Century* (MacroVU, Incorporated, Bainbridge Island, Washington).

KOESTLER, A., 1964, *The Act of Creation* (Hutchinson & Co, London).

McCLOUD, S., 1994, *Understanding Comics: The Invisible Art* (HarperCollins, New York).

McKIM, R.H., 1980, *Experiences in Visual Thinking* (Brooks/Cole, Wadsworth, California).

ROOT-BERNSTEIN, R. and ROOT-BERNSTEIN, M., 1999, *Sparks of Genius: The 13 Thinking Tools of the World's Most Creative People* (Houghton-Mifflin, New York).

SANDERS, E.B.-N., 2000, Generative Tools for CoDesigning. To appear in Scrivener, Ball and Woodcock (Eds.) *Collaborative Design* (Springer-Verlag, London).

SCHVANEVELDT, R.W., 1990, *Pathfinder Associative Networks: Studies in Knowledge Organization* (Ablex Publishing, Norwood, New Jersey).