First International Conference on Design Creativity, ICDC 2010
29 November - 1 December 2010, Kobe, Japan

A Tool Set to Measure Creativity: Analyzing the Fitness of ABACUS as being the Complementary Tool for Linkography

Duwarahan Rajendra
North Carolina A&T State University, USA

Abstract. Creativity is hard to define. But from a very basic view point, it's nothing but a "transition of a perspective that has a value to attract a group of audience". Most measures of creativity are dependent on the personal judgment of the tester, so a standardized measure is difficult, if not impossible, to develop. The linkography tool has been studied to evaluate the creativity with some metrics like link density and entropy. But novelty and usefulness are not considered for measures in the latter approach. Inspired by the way how man came up with a tool to quantify things, I am considering the same ABACUS (the old calculator) in this paper as being a tool to compliment Linkography. But with a proper modification in the future we might come up with a tool that justifies our quest.

Keywords: Abacus, "human-sensor data fusion", Linkography, Thinking assistant, "controlled data"

1 Introduction

Design by face-to-face (closely coupled) mode is superior to media-involved (loosely coupled) one (Kan, WT and Gero, 2005). This quote has been going for a very long time. Increasingly designers work across geographically distant locations, groupware and collaborative software have been developed to support temporally and geographically dispersed work teams. However, despite these developments, face-to-face interaction remains one of the most important elements in developing ideas. Some other studies suggested that with the introduction of technology, designers will adapt their activities accordingly(Salter and Gann,2002),. These studies on team designing were mostly done at a macroscopic level and were not able to differentiate microscopic design behavior. In order to develop tools that support the process of distant collaboration, a closer look at how design teams design is required as we currently have insufficient knowledge about these activities. Why work teams are important in this paper? As far as the "creativity" process is concerned, it is a conglomeration of minute ideas that is harmonious with time. Thus in order to measure the creativity, we are creating a design team environment that brings clarity what we are trying to measure. As a byproduct we can get a glimpse of 'optimized team performance".

Goldschmidt (Goldschmidt, 1990) proposed to use Linkography to assess the design productivity. Kan and Gero (Kan, WT and Gero, 2005) suggested adopting information theory for measuring creativity in Linkography. The basic concept is the higher entropy reflects a richer idea generation process in the sense that degree of uncertainty has similar meaning to the design creativity. A dense links merely implies high participations and are not requirements for the generation of creativity. They considered the Linkography to be a good venturing point when it comes to creativity. They removed the linking lines leaving the nodes and treated each link as a point in 2D dimension. Then they analyzed the scattering distribution of links by calculating the means and standard deviations of X axes. The linking length is determined by maximum of Y and mean value reveals the depth of discussion.

For creativity, is it a team that we are in need of or else a single designer who is a genius or a capable person that we are in need of? Gabriela Goldschmidt investigated to see which is more profitable? There was not that much of a difference though! The conclusion was that, it is immaterial to the discussion whether or not division of labor is established or not. A single designer has to work on several expertises invoking the implicit roles as opposed to a team designer who should be interested in the adhoc or permanent expertise in an explicit role. But to establish a science we need to go the microscopic level.

As far as the measure of creativity is concerned, the individual and the group both must be measured in tandem. Because in order to bring out the implicit roles of a designer we need the collaboration get going.

This paper brings out the "ABACUS-Linkography" tool set to measure creativity while bringing out the possibility of an optimized "team design". A breakthrough for teamology or team

science is also revealed with a quantitative account. As a starting point, perspective of "face to face collaboration" was analyzed properly, i.e. minutely as possible. For that an active approach has been adopted as opposed to the usual passive manner, i.e. making a protocol while the design is going (Video and audio) with natural language and then basing the whole research on this documentation. This is error prone and demanding for improvements. The change over to the active approach gave some promising results.

2 The Reasons for Replacing "Linkography" with "ABACUS-Linkography"

The linkograph construction is at the mercy of experts and passive in nature:
Instantaneous documentation is a must. This will take away the need for a passive documentation which made the whole process very time consuming and cognitively demanding. And also this move will increase the objectivity.

The "entropy" gives an idea of creativity based on the fact that if complexity is involved then there is a one-to-one correspondence with the nucleation of creativity (Kan, WT and Gero, 2005).
Measure of chaos can be a measure of creativity. Why so? And what kind of randomness are we talking about? Even simple programs can lead to complexity. Having said that, it is also understood that how sure are you going to be that the existing randomness was because of the new ideas and not the fixations or other noise prone activities that man is capable of?

Linkography can't give a system view as one might expect:
Synthesis and integration are hallmarks of good design, as the product must respond to so many different requirements while maintaining a holistic nature. Therefore, it is believed that links among design moves are of great consequence to the design process. But the truth is each requirement may have different view of implementing things. Thus not analyzing design moves with substitution and ambiguities in tandem makes the Linkography look naïve.

There is a need for a counterpart in sketching:
We know the importance of sketching for we know how much a trial and error technique can be a useful tool in a designing environment. Now I believe there needs to be another tool to compliment sketching in the mode of "ABACUS", to construct ideas that don't have a shape grammar embedded in it.Consider the game of chess. There is a winner and a loser. But the game is transparent enough to the audience that they can see that the players are making the move in the board by using their mind. To interpret themselves the chess players are using the real world materials. I believe we need to create a similar circumstance to bring out the creativity. ABACUS model can act as thinking assistant. This indirect tool can act as a predecessor to the much famed "telepathy"-a mind to mind correspondence.

Parallel processing should be there in decision making. Only sequential decision making has been considered when you consider the idea of linking the design moves:
Little bit of an anachronism is good thing for creativity. All design decisions don't have to be in a sequential style.

3 The Implementation of the "ABACUS-Linkography" System

There are three important stages that make the implementation a success. They are as follows

a) Initial solution phase:

We need the visionaries to set up a solution first.Initial solution is very important as it brings the experience of previous encounters in a design session and an inflated solution space as opposed to a scratch start.

3.1 Visionaries:

Design initiation can't be a team effort. There was a "Harvard Hughes". And there is Steve jobs, Bill gates and etc. Maybe there are two "Google" personals. Thus initiation of any design relies on one to very few, so to speak. Initiative is very important for a design and with a conjured up "system design" in the imagery the visionary takes the next step. That is the implementation stage. A visionary realizes the concurrent tasks to be done and realizes the need of a team. Roles that the visionary thought he is capable of doing can become complex asking for explicit roles. These implicit and explicit roles are considered as the inside and outside agents respectively.

3.2 Inside agents and outside agents:

Inside agents are the implicit roles associated to oneself, where the cognitive paradigm comes into play. We can create implicit members just like we create regular team members. And outside agents are

the normal team players. Visionaries are the inside agents who decides to venture out and end up forming the explicit roles to ease the workload. Thus it is important to understand that all we are trying is to capture and measure the creativity that is involved after the inception of the main idea envisioned by the visionary. Thus this paper is not about measuring the creativity of a visionary.

Human sensor data fusion is a tool that was introduced to cope up with this situation (Duwarahan R, 2010). Thus it is important that the guys involved in the making of initial solution of the design session should do enough preparation with the human sensor data fusion. The visionary is well equipped if we has the "human sensor data fusion model at his disposal. The following figure gives a glimpse of it.

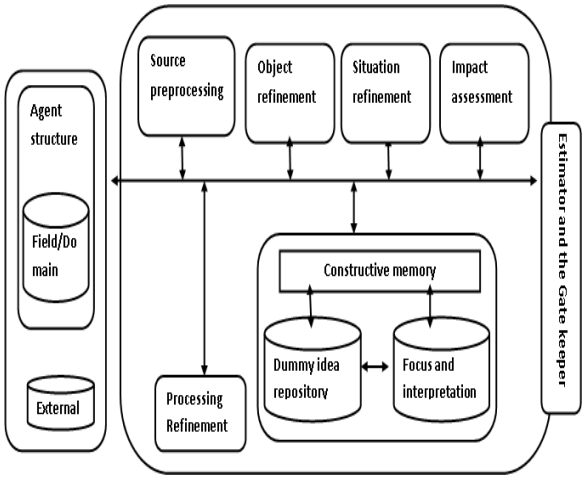

Fig. 1. the human sensor data fusion

b) Specifying the boundary conditions:

Seeing things from customer's point of view is very important. It is important that we understand how we can target them or how we adapt ourselves?Time limit is another boundary.

Imagine an equation which is used to solve for a variable called "Metric of creativity":

Complex system equations are normally solved by non –linear differential equations. Well design activity involved with creativity is a complex process. Thus it is important that we try to solve the problem in a reductionist's perspective hoping that with an initial solution and boundary conditions we will be able to analyze the situation properly.

Instead of entropy calculation we will be able to come to different combinations of parameters that is associated with CM (critical moves) and L.I (link index)

Solving the equation with The "ABACUS-Linkography" model:

In order to create demanding environments, we need to create a competitive environment that demands and motivates the designers involved.

The play field looks like the following figure:

Opponents (A) – These members come with the ideas. They can always switch between each divisions of the design. This is an "idea searching" side

Opponents (B) – These members always opposes the members in group A. This is a "threat searching" side.

Third man- they track the record, summarizing, quantifying with abacus and putting up the strength diagram.

Fourth man- these people are very important as they will be drawing the linkography and the double headed linkography.

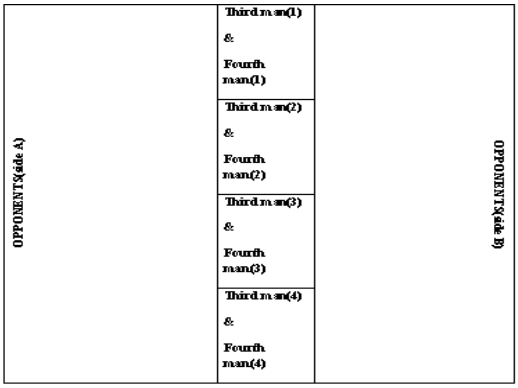

Fig. 2. The design room specification

4 The ABACUS

The ABACUS mimics the old calculator of china but at the same time it has two aspects.

- The Idea side- design moves
- The Ambiguity side- Ambiguities and Substituitions

The fig 3 A) shows the ABACUS and its counterpart Linkographs. Number of grooves represents the number of divisions initiated by the initial solution and the boundary conditions. The division which has least importance will have the "Least significant groove" (Usually the right most). Then the most significant would be the left most one. The ABACUS can give the impetus needed for "linkography" technique.

4.1 The Double headed linkograph, strength diagram and Linkography:

In the process of developing a design solution, the design moves are to be a conglomeration of back links and fore links. The back links has so many meanings to it as opposed to fore links. *Double headed linkograph, which is shown in fig3a),* is one way to analyze the continuum of fore links and back links. Because design moves are surrounded by ambiguities, they should be addressed as well in tandem. After the design completion, still the ambiguities can linger and can serve as "hysteresis" for the next design task. Just like design moves, ambiguities can be expressed as a combination of new ambiguities for a certain design move and backward ambiguity. But the event of ambiguity can happen in the event of a back link of design move or fore link of a design move. This applies to back link of an ambiguity move too.

The *strength diagram,* as shown in fig 3B-b) can be a help to formulate the initial solution for the next design session. *The" complete design" linko graph,* as shown in the fig3C-c*)* is a summary of all the design moves which can be taken into account for the creativity and productivity of the whole design session.

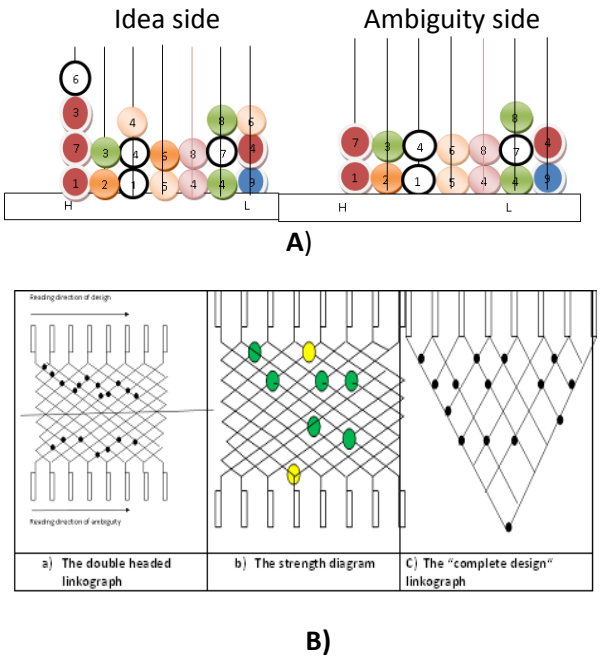

Fig. 3. The ABACUS-Linkography system

5 A Simple Case Study

The following is where the ABACUS is used in its full use among 2students, who imitated to be in the "Apple" company and discussing the issue of antenna fix that gave big trouble and the new program outfit for a new phone launch.

Each of them given an ABACUS system to play with and then both are asked to discuss things about the design. I conducted myself as the third man and the fourth person.

Table1: Design moves

Creativity	**Designer**	**No. of Moves**	**L.I.**	**%CM3**	**%< CM3 of all CM3**	**%CM3> of all CM3**
High significant grooves	Kassahun M.	18	0.4	11.54	21.3	78.7
	Anjabi K.	16	0.5	22.54	56	44
Least significant grooves	Kassahun M.	40	0.8	28.3	43	57
	Anjabi K.	50	0.9	35.6	36.7	63.3

Table2: Ambiguity moves

Creativity	**Designer**	**No. of Moves**	**L.I.**	**%CM4**	**%< CM4 of all CM4**	**%CM4> of all CM4**
High significant grooves	Kassahun M.	29	0.38	48.21	31.3	68.7
	Anjabi K.	18	0.42	45.65	46.35	53.65
Least significant grooves	Kassahun M.	1	0.1	18.21	72	28
	Anjabi K.	2	0.12	15.65	14	86

Above two tables showed us that there are not that much of a correlation between a design move and ambiguity. That is one design move may be surrounded by myriad amount of ambiguities and vice

versa. But still we can't ignore the fact that they play an important role in making a design move.

Thus the CM (critical moves) is calculated for both the ambiguities and design moves while the L.I (Link index) is also calculated for both design moves and ambiguities.

Higher L.I and higher CM percentage for design moves shows high creativity in least significant areas.

As far as the ambiguities are concerned, the opposite happened. The high significant topics were having more ambiguities and less design moves.

There were so many ambiguities remained, which can be used as hysteresis for the next design session.

Still the ambiguities involved in the high significant topics need more scrutiny. And I am confident more parameters can be derived from this setup in the near future.

6 Future Works

From the "Abacus- Linkography" system there seems to be so many parameters that we can harvest. Thus the measurement system looks promising. It is my understanding with much more modifications we can create an instantaneous "creativity" capturing system, with measure of collective intelligence and measure of team collaboration as by products. This will all lead to an "optimized team design" from the depths of cognitive paradigm.

Simpler systems can turn into an interesting one (A journey to 1000 miles steps starts from one single step).And what is the lower limit to understand the ingenious creative idea? The lower limit is considered the "control data". And these data accumulates into information and the right combination of information is captured as knowledge.

I am also planning on improving the "ABACUS "deployed, into a sophisticated one as the following,

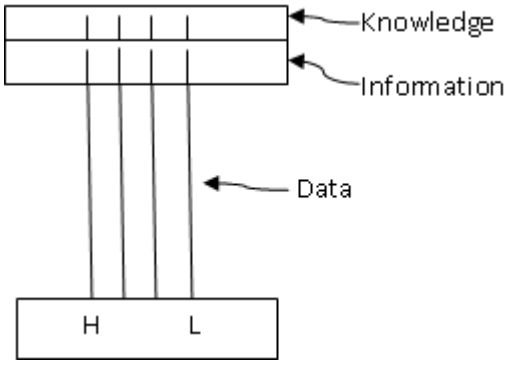

Fig. 4. The modern ABACUS

Apart from the ABACUS construction, the human sensor data fusion needs to be in the track of sophistication for we need honest signals that pass the manipulation circle.

We are also conducting research to see whether the essence of face to face collaboration, the free flow of speech and ideas is being impeded by this method.

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