Aesthetic Techniques for the Visual Display of Information

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***Abstract*—IGERT summer research, conducted by August Black and George Legrady is described and summarized, emphasizing the methods of the research and showing visual samples of the results.**

***Index Terms*—IGERT, research, visualization, data analysis, aesthetics.**

I. Introduction

The main objectives of this summer's research were to develop visualizations of static and time-based data sets for the purpose of mining out un-perceivable information and knowledge. For this research, there are two separate projects involved. One is the Seattle Public Library project, where call numbers of books are being recorded and the amount of checked-out books per half-hour, per Dewey decimal category are to be tracked and visually displayed in quasi real-time. The second project is concerned with Pockets Full of Memories, where quantifiable descriptions of objects have been collected from exhibitions in Paris, Rotterdam, Linz, Budapest, and Helsinki. The task, here, would be to find criteria and mechanisms for searching the database and displaying the results in the form of multiple graphic visualizations.

The guiding principles are inherently artistic, however, and so being, the research should provoke aesthetic as well as informative results. To do this, a large space of possible visualizations must be "scanned", articulated, and evaluated. "Scanning" in this sense, means looking at the various sorts of informative aesthetics that make up our contemporary visual landscape. Articulation is then the production and materialization in the form of software sketches that display the "gist" of a visual representation. Evaluation is the process of assessing the visual to see what, if anything at all, it says about the data it represents and to define in what respect it shows something new or enlightening. Through this, an aesthetic statement should be formed that paints a picture of the data in such a way that it can hold the attention of an audience.

Another thing that can be said about the research is that it was done according to methods more associated with studio type work (i.e. as a work of art), so there is no hypothesis to test or objective outcome to establish. The research can be seen as a preliminary stage for a larger production, one that will be actualized and made public.

II. Aesthetics, Truth, and Information

Data and information, as well as the algorithms that are chosen to format, categorize, or measure that data, have no visual identity per se. The crux of the research is to interpret the data in a way that can be seen on a 2 dimensional flat screen. This is not always easy given that most data is naturally multi-variate. [11] Also, given any set of data, it is impossible to show all things about that data in one visual representation. Mapping characteristics from the data to observable characteristics in an image requires some sort of bendable distortion. Small things like scale and perspective can easily twist how one views the information attained from the data. [10] Additionally, choosing what aspects of the data to show places heavy editorial constraints on the outcome and this certainly frames how information is to be exposed from the data source. The visuals can only project truth to a certain degree, and it is within this degree of freedom that aesthetics for the piece should be derived.

On the one hand, an attempt is made to present the data in a way that illustrates important features. By basing much of

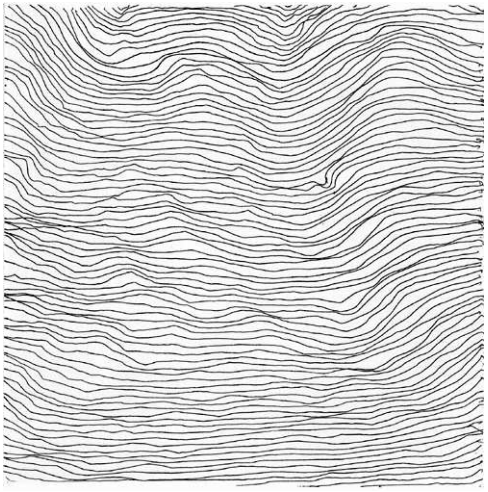

Fig. 1. ©Sol Lewitt - No Straight Lines. [9]

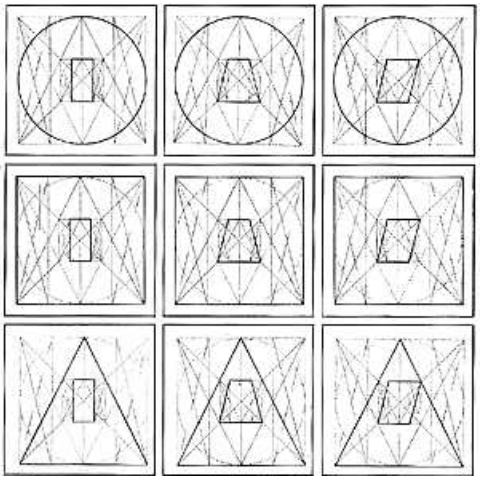

Fig. 2. ©Sol Lewitt - Geometric figures within geometric figures. [8]

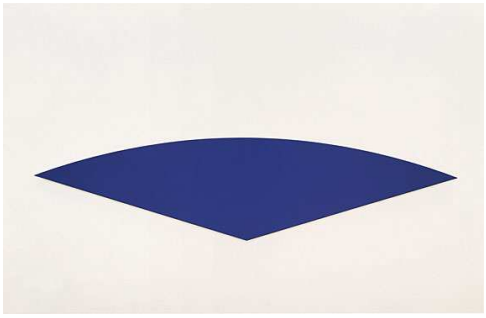

Fig. 3. ©Ellsworth Kelly - Dark Blue Curve. [3]

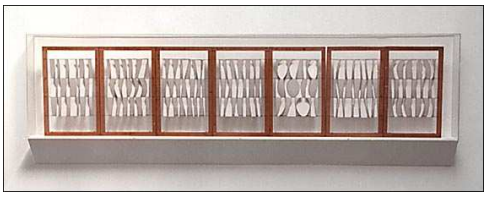

Fig. 4. ©Ellsworth Kelly - Sculpture for a large wall. [4]

the visual outcome on standard plotting mechanisms such as histograms, bar charts, and scatter plots much of the informative aspects of the data remain in tact. But, on the other hand, a larger visual context is considered. Figures 1 through 4 show a small sampling of the vast amount of visual references that go into framing this research as a work of art with elements of design and a general look and feel.

III. Pockets Full of Memories

> ”Pockets Full of Memories” is an interactive installation that consists of a data collection station where the public takes a digital image of an object, adds descriptive keywords, and rates its properties using a touch-screen. The data accumulates through-out the length of the exhibition. [6]

This project involves the quantitative description of everyday objects. Gallery-goers are asked to put personal objects on a scanning station where an image of the object is scanned and placed in a database. He or she then must describe the object using an entry form on a computer. The person can give the object

Fig. 5. Pockets Full Of Memories - installation at Pompidou Center, Paris. ©George Legrady

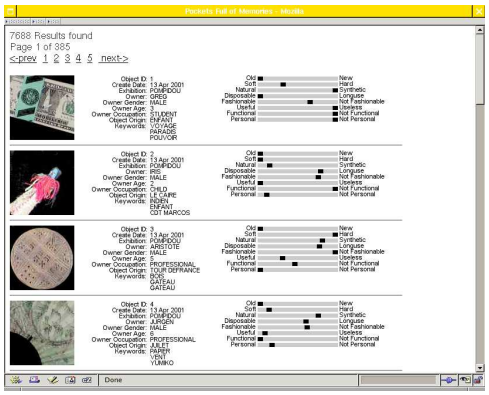

Fig. 6. Pockets Full Of Memories - data browser.

keywords and assign it scaler values between two descriptive captions: Old - New, Soft-Hard, Natural-Synthetic, Disposable-Long Use,Fashionable -Not Fashionable, Useful -Not Useful, Functional- Not Functional, Personal - Not Personal.

Since it’s initial premiere, Pockets Full of Memories has accumulated over 7000 pieces of data. The data analysis will focus on showcasing relationships and differences in the collective perspectives of all of the communities represented through the contributions from the exhibitions in their respective cities of Paris, Linz, Budapest, Rotterdam and now in Helsinki. However, for the time being, most of the work has been to merge the databases from the 4 exhibits into a single data warehouse. Additionally, a web browser was written that can search and display the entries. [7]

Initially, the research was to span both projects evenly - Pockets Full of Memories and the Seattle Public Library. But, as time went on and our tasks unfolded in front of us, the urgency of the library project took precedence, leaving little time for Pockets Full of Memories. Now that the data warehouse has been constructed, visualizations of the data can be created, time permitting.

IV. Seattle Public Library

This project is a proposal for an installation in the mixing chamber of the Seattle Public Library that will visually map on a daily basis and over time the circulation of non-fiction books, revealing the collective reading interests of the library’s patrons. The project’s intent is to create a work that reflects the dynamic nature of contemporary society, a work that is informative and provides a stimulating, aesthetic experience. The visualization will be displayed on 6 plasma screens positioned horizontally across the span of the 24’ glass structure behind the librarians’ reference desk.

The numerically labeled topics (call numbers), as well as the semantic relationships (titles), and associative relationships(group of books checked out by a single person) will be recorded every half hour, mined for potential patterns, and graphically displayed on the 6 plasma screens.

Figures 9 through 22 show images of the various software sketches produced during the summer. Figures 9-11 are web applications that can be used to browse the data on demand.

Fig. 7. photo ©2004 The Seattle Public Library.

Fig. 8. The mixing chamber inside the SPL where the plasma screens will be installed. photo ©George Legrady.

The rest are animated demonstrations and can only be viewed as moving images. For this report, screen shots are provided.

V. Conclusion

What was conducted this summer is the first phase of a multi-phase project. At this point, the goal was to explore the characteristics and shape of the data being analyzed and produce multiple visualizations. But, the project is continuing its development until it will be installed in February of 2005. The next stage is to evaluate the positive and negative aspect of what has been done so far and compose a final draft.

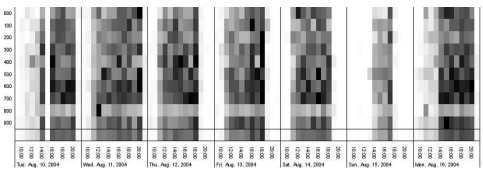

Fig. 9. SPL - histogram of amount of books checked out per hour over a week. Time is plotted in respect to Dewey categories. The lightness or darkness of a given unit represents the amount of books taken out in that category for that hour. With the default settings, black will represent a maximum value and white will represent a minimum value.

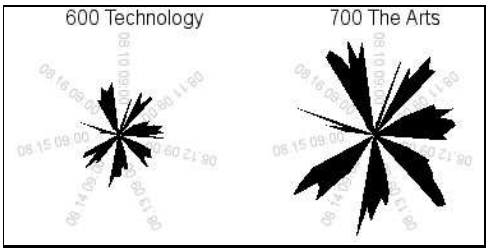

Fig. 10. SPL - Radar splatter plot showing 7 days worth of data in the 600's and 700's. This plot allows one to view any number of days together in one leaf-like image. The relationship between the days is emphasized.

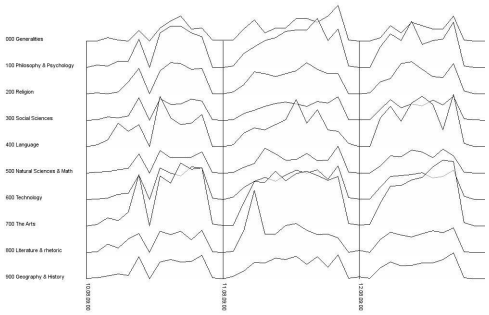

Fig. 11. SPL - waveform of amount of books per hour over 3 days. The waveform plot can show values that are not limited to the 8-bit grey scale values of the histogram.

Acknowledgment

This research was conducted with Professor George Legrady and exists as it is through dialogue with him. Also, thanks are due to Professor Tobias Hollerer for his suggestions and critique.

References

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[7] G. Legrady. Pockets full of memories. http://pocketsfullofmemories.com/.

[8] S. Lewitt. Geometric figures within geometric figures. http://www.parasolpress.com/lewitt_2.html.

[9] S. Lewitt. No straight lines. http://www.crownpoint.com/artists/lewitt.

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[11] E. Tufte. *Envisioning Information*. Graphics Press, 1990.

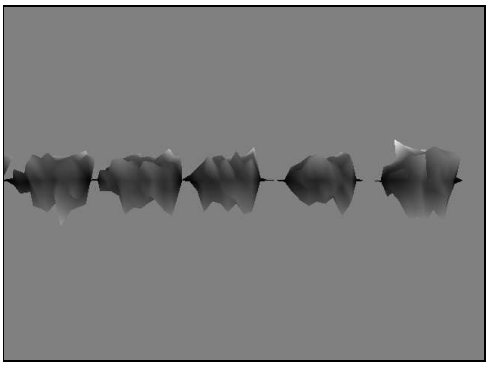

Fig. 12. SPL - OpenGL blob plot - Time is plotted along the center axis. The peaks around the radius are the amount of books checked out in a Dewey category. There are 10 points around the centered axis, each for the 000's, 100's, 200's, etc. The more books checked out for a given hour in a given category, the more white it's peak will be.

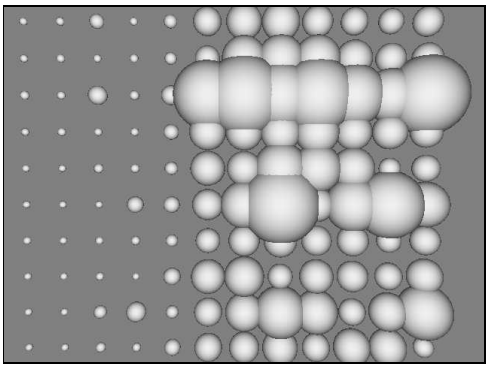

Fig. 13. SPL - OpenGL simulated voronoi histogram. Using overlapping spherical shapes where size of the sphere is dictated by value for that unit, this "clotting" histogram builds a general abstract form of a day's worth of values for outgoing books. From left to right is time in hours from 9:00- 20:00. From bottom to top are the Dewey categories segmented by the 100's. At most times, the diagram will "bulge" around the 700's category.

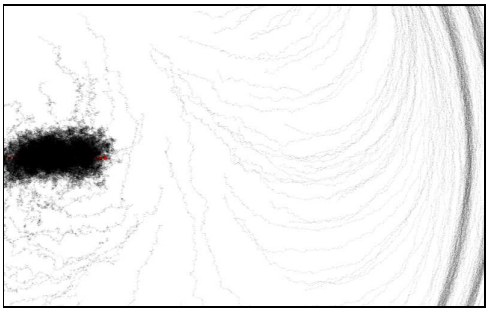

Fig. 14. SPL - stochastic walking fuzziness. Lines are drawn on the screen that are attracted to certain target areas. The target areas are the red points. They represent values for outgoing books. The image that is formed can be layered to build up a blackened smoky picture of daily, weekly or monthly data.

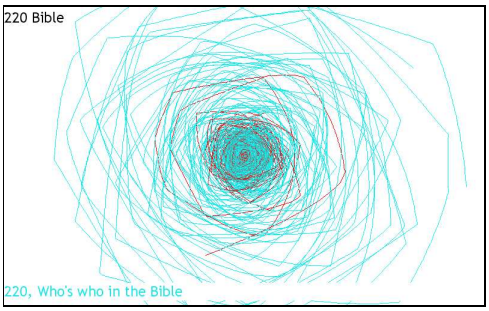

Fig. 15. SPL - stochastic spiral display. The daily data (log of all circulating books, circa 37,000) is interpreted. From this spiral shaped lines are created based on the characteristics of that Dewey category. Each line represents a single entry (book, CD, audio tape, etc.). The longer the line, the longer the book has been out in circulation. The incremental angle of the line segments is determined by the type of entry - books will have the largest angle increments. A bright blue line means that the call number of that book is closer to the minimum call number within that step size of Dewey call numbers. For example, if we take a Dewey category based on a step size of 10 (ex 50-¿59), a call number of 50 would be bright blue. A call number of 59 would be bright red. And, a call number of 55 would be grey. All the lines are plotted one on top of the other.

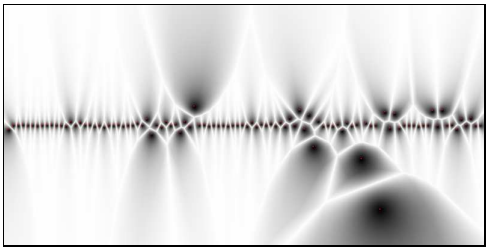

Fig. 16. SPL - voronoi image, 100's over the 10's. This shows a voronoi images (not a graph or diagram) based on a distribution of points within the image bounds. The images are constructed using a simple function to compute the closest and next closest point out of our initial setup of points. it does this for each pixel in the image. The resulting pixel value is the distance of the (closest divided by the next closest multiplied by 255. The red points represent Dewey categories segmented by the 100's and 100's. They are displaced from 1/2 (height of the image), based on the amount of books taken out in that Dewey category. The image of the 100's is overlapped with the 10's.

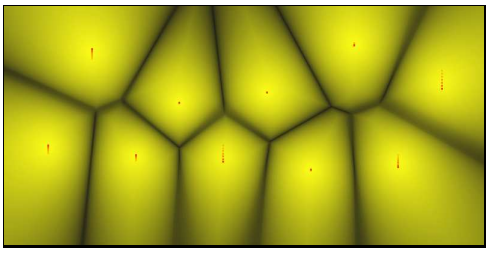

Fig. 17. SPL - voronoi diagram. Similar to the previous voronoi example, now with variables for color, interpolation of one set of data to the next (good for making animations), fade type, and whether or not to plot the actual voronoi tessellation. Tessellation diagram is drawn using a modifi ed version of Steve Fortune's line-sweep algorithm. [1, 5]

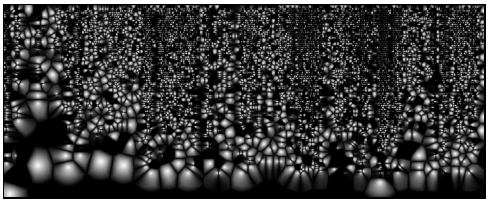

Fig. 18. SPL - voronoi diagram of circa 37,000 books in circulation on 08-18-2004. The voronoi tessellation which we see on screen is rendered around imaginary Delaunay points representing each and every book that is currently in circulation. This image shows approximately 37,000 entries. Each Delaunay point represents a single book entry. From left to right, the Delaunay points are plotted according to the respective call number of the individual book, 000 to 999. The Delaunay point is then displaced from the top of the screen according to how long it has been out of the Library at that date. The Delaunay point for a book that has just been checked out will at the very top of the screen, where points representing books that have been out for over three weeks will be plotted nearer to the bottom of the screen.

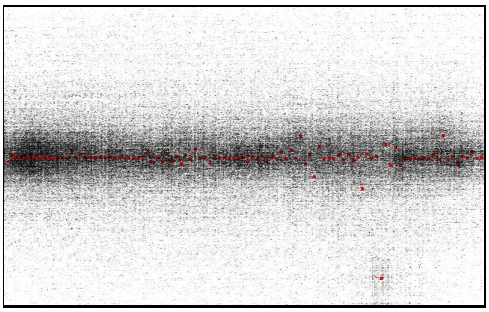

Fig. 19. SPL - genetic algorithm. [2] A genetic algorithm was constructed to breed and mutate dots on screen that would eventually converge on a target point. The resulting images show a Xerox-like blur around dots representing amount of books. This image shows the Dewey categories split by the 10's (red dots) for one hour's worth of data. Hourly images can be layered or animated to show variation.

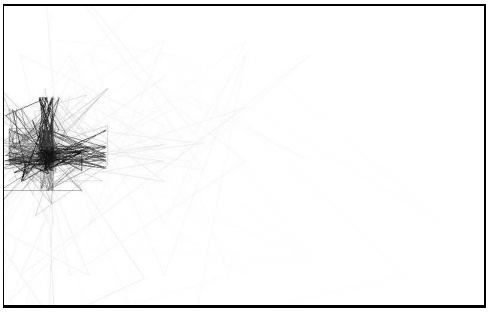

Fig. 20. SPL - genetic algorithm with lines. A similar algorithm is used to converge on a target area within the image, only now line segments are drawn through each successive population. The line segments are painted darker as the generations go from one to the next.

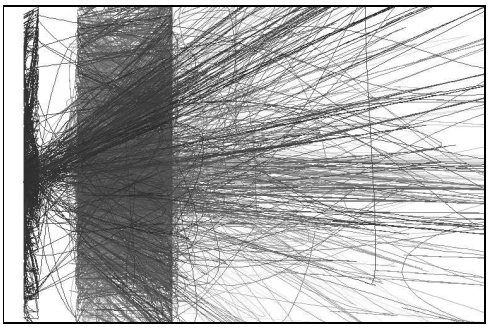

Fig. 21. SPL - genetic algorithm with bezier lines. The chromosomes are characterized by a set of x coordinates, a slope and a intercept. the y coordinates will be calculated using the line function y= m*x + b (where m = slope and b=intercept) Each line then acts as Bezier handles, for shaping the curve. Each "generation" is a single curvy contour with multiple Bezier handles (the lines) in between.

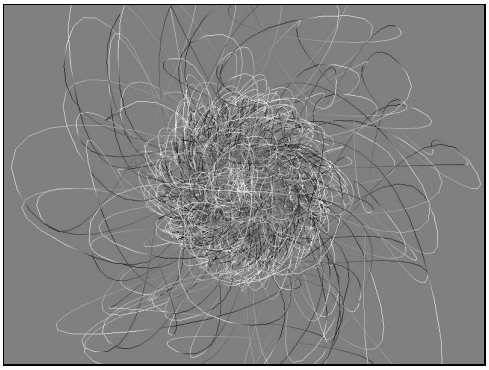

Fig. 22. SPL - OpenGL bezier blobs. SPL daily data for a Dewey category segmented by the 10's is used to draw this 3D image. The blob is formed by a single line split up into bezier line segments. Each line segment represents a single entry and can be seen as a black to white color transition on the line. The line starts at the center and rotates and grows outward. The radius is incremented based on the length of the books title (multiplied by some random variation). The angles in the y and z direction are based on whether the item is a book or CD or DVD.

August Black has an awful habit of calling himself an artist. Previously, this has meant making marks on paper and later on canvas. Now, this means almost anything concerning material, concept, and form. His research is based in the overlap of media, focusing mostly on the kinds of audiences that are created and induced by emerging conventions of observation and involvement.

He works in radio, television, software, networks, comics, text, and projected sound/light. Collaborating with others on various free radio stations in Austria, he's devised a technique for performing live radio on a shoestring budget from networked locations outside of the studio, transforming the location at hand into material and subject for conceptual play.

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