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**“MAKING VISIBLE THE INVISIBLE”
SEATTLE LIBRARY DATA FLOW VISUALIZATION**

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Abstract (EN)

“Making Visible the Invisible” is a commission for the Seattle Public Library. The installation consists of animated visualizations on 6 plasma screens located on a glass wall horizontally behind the librarians’ main information desk in the Mixing Chamber, a large open public space dedicated to online computer research. The 6 screens feature visualization generated by custom designed statistical and algorithmic software that map the flow of data received from the library's Information Technology center. The project focuses on data flow and the library as a data exchange center where the circulation of books can be made visible and expressed statistically.

Keywords: Data mapping, data classification, data visualization, digital multimedia art installation, the library as information, data exchange center

I. The Project Development of “Making Visible the Invisible”

1. We are Data

Our socio-cultural environment today is data driven. We collect, measure, conceptualize and evaluate numerically and statistically. We are demographic information, our body fluids and material are sampled, analyzed, our shopping and transit choices determine policies and structural reorganizations. We are data.

In what ways, can the collecting and processing of data be implemented as a cultural and aesthetic practice? What does it mean to use data as a form of artistic statement? The collection and juxtaposition of data as a means of aesthetic exploration can be understood as a form of meaning generating process, where meanings emerge through the organization of discreet elements according to rules not unlike linguistic structures, opening the way for narrative, metaphoric, and associative expressions. The art project discussed in this paper explores the library as a data exchange center where a correlation is made between the library’s holdings and the community. Is the library a breathing, living entity? Does it mirror the culture in which it exists in particular ways? Libraries as institutional bodies are regulated by institutional norms and conditions of their structure, but they also seem to discursively engage with the community in which they exist.

If the library is an exchange environment where data in the form of books are continuously circulating, classified, positioned in the real organizing space of the book shelf, signed out and removed for external reading, returned, lost or stolen, can the library and its holdings reflect or mirror the culture at large, can this be measured? Can the library define itself as a particular personality through the sum of its holdings? Can the library make visible the community’s overall personality based on the books currently circulating?

2. Background

The “Making Visible the Invisible” installation was conceptualized in response to a public call by the Seattle Central Library for artworks that address in some way the complex nature of the library as an information center and to artists whose work investigates social structures, people and systems (<http://www.publicartonline.org.uk/case/seattle/unbound.html>). The central Library had commissioned the architect Rem Koolhaas for a new building, and in response to the call, Koolhaas not only provided an innovative structural design but had in the process reformulated certain conventional aspects of the library environment. In particular he opened up enclosed spaces, organized book stacks into a continuous spiral, and wired librarian specialists who then were mobilized in the space to be reached anytime through wireless communication devices.



Fig. 1: Main Librarian desk in the Mixing Chamber with glass wall behind which will have 6 large screens for the visualization animations. George Legrady © 2004

Finalists for the “Artist Unbound” were invited to Seattle for a one week residency at which time we were introduced to the various layers of the library’s operations, giving us an overview of the library’s organization and structure including its mission, staffing, special programs, nature of the collections, explanation of services, the library’s particular political and social context. We met specialists who described their areas of expertise. The library wanted to commission works of art that would reflect on aspects of the fundamental nature of the library as an organizational structure. They were interested in exploring site-specific projects that might change over time, by engaging the site without necessarily aestheticising it.

In response to all of this, my proposal focused on the notion of the library as a data exchange center with an intent to visualize change in the collective data space. My proposal considered the contemporary library as an information data processing center where data flows in and out through the circulation of books and patrons, a network of independent actions that result in an emergent order at a higher level, somewhat like a complex organism: The composer Iannis Xenakis’ metaphoric reference to a “cloud of sound” comes to mind, a form that slowly transforms its shape based on the changes in the library’s circulation of books and holdings.

Data flow in the library is primarily active through the circulation of books checked out and returned, information that can be calculated mathematically and represented visually. From a cultural perspective, this is a good indicator of what the community of patrons considers interesting information at any specific time. Its visualization mirrors the collective mind of the community, and therefore can be considered as a form of feedback in the literal and symbolic sense. The project proposes to visualize these changes over time through processing the data, which is then to be presented electronically with the intent to create an artwork that is informative, provides a stimulating, aesthetic experience, and that reflects in real-time the dynamic nature of the library as an information resource, given that approximately 37000 books leave the library per day. Quantifying and visualizing these changes of activities over time also make visible the library’s functioning as a living entity.

3. Design Concepts

The conceptual development of the project was directed by the desire to create a dynamic artwork that spoke on many levels, combining aesthetic pleasure, presenting useful information, but also metaphorical reflections and interpretations that could engage everyone from the generalist to the specialist. During the weeklong orientation meeting, it became obvious that the library's clientele included a substantial percentage of regulars, people who would be witness to whatever information the artwork would display over time, and would therefore become familiar with the rules by which the visualizations would function. This made it critical to contextualize change of information over time, to feature the present in relation to previously collected data, and possibly to identify and define recurring patterns and relationships. At the brainstorming stage, various ideas about engaging the library public were considered such as collecting data from visitors' about their impressions on the returned books. In the end, the most immediate and accessible form of commentary and feedback seemed to be to quantify and visualize the circulation of books themselves and what the collective circulation of the hour might say about what the community is thinking at that particular time. "Make Visible the Invisible" emerged as the title for the project as the visualization of the circulation of books would provide an insight, a map of the collective choices. Individual clients would be able to reflect on the collective choices and see how their particular interests might be represented in the past hour's activities. Such a visual representation of the current circulating topics may reveal to the library visitor that they are engaged in a process at the individual level, which has a discursive interaction at the larger collective state.

4. Artwork Location

The site-specific approach to art practice consists in creating a work that engages in dialogue with its physical, spatial and institutional context, reflecting and commenting on the condition of its situation. Visualizing the flow of information in a library could potentially be situated at a number of locations such as entrances or hallways, but the most relevant location seemed to be to position it where visitors were most engaged in the processing of information collecting. Following conversation with the architects, the glass wall partition behind the librarians' desk in the large, open computer filled information center titled the "Mixing Chamber" seemed the most

appropriate as this space represented the greatest activity of research and traffic. Installed behind and above the librarians at their information desk, the electronic visual panels reverberate culturally familiar signage encountered at movie theaters, museum entrances, and airport check-in counters.

5. The Basic Ingredients: Books As Data with Metadata & Their Organization

During the past two years, we have been working closely with the Seattle Library's Information Technology (IT) center to define the parameters and processes by which to access the library's data related to the approximate 2,000,000 books in the collection. The IT seems to us to be at the core of the library's operation, the heart of the circulation system if considered as a kind of organism. The IT's work is to maintain the information flow, to systematically classify and keep track of the library's holdings, and have precise records of the flow of books going in and out, including tracking delinquencies, losses, etc. Given the critical importance of the IT department in the operations of the library, the library had to first evaluate if the data flow and related work demands of this artistic project would impact negatively on the library's normal operations prior to providing us access to data. As a result of meetings with a small team consisting of the librarian responsible for the labeling of circulation items, and the IT systems analysts, the decision was made to provide hourly information about the in and out circulation.

For our visualization, we are concentrating on books and media, labeled according to the Dewey Decimal Classification System (<http://www.tnrndlib.bc.ca/dewey.html>), as their numeric labels provide ideal metadata for doing statistical analyses of book circulation over time. Metadata can be simply defined as data that describes data, or provides information about the content, quality, condition, and other characteristics of data and is usually in a form that can be numerically processed, for instance, date, size, titles, keywords, any other alphanumeric or classification coding, that contextualizes a book in relation to other books. The Dewey Decimal Classification System consists in the organization of book topics into 10 main classes: Generalities (000-099); Philosophy & Psychology (100-199); Religion (200-299); Social Science (300-399); Language (400-499); Natural Science & Mathematics (500-599); Technology & Applied Sciences (600-699); Arts (700-799); Literature (800-899); Geography & History (900-999).

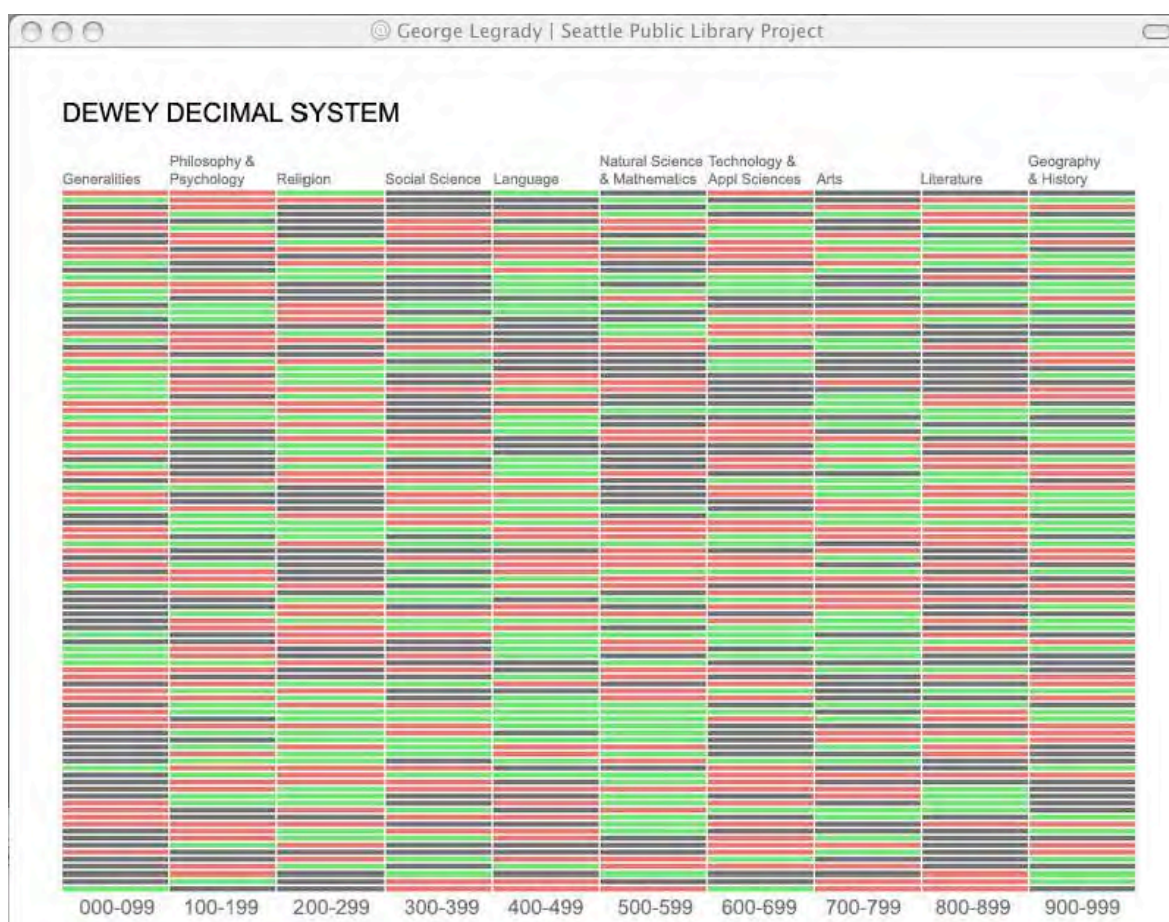


Fig. 2: Dewey Decimal Classification Lay-out. (<http://www.mat.ucsb.edu/~g.legrady/glWeb/Projects/spl/spl.html>)

These main categories are subdivided into divisions, for instance, 610, for medical sciences, and 620 for engineering, with the third number represents a section, such as 611, human anatomy, 612, for human physiology, 613 for personal health. Each book is then given a specific coding, for instance “Untangling my chopsticks” has the Dewey label 641.5952, placed in the 641 “Food & drink” section. Each book has additional metadata defined through the Marc format (<http://www.loc.gov/marc/>), a standard for the representation and communication of bibliographic and related information in machine-readable form. Both the Dewey and the Marc are maintained by the US Library of Congress.

Our building block for generating the visualization consists of accessing such information for each book that is checked out which we are receiving, once per hour in the XML format. An entry for a title looks like the following:


```

<transaction>
  <itemNumber>1531202</itemNumber>
  <bibNumber>2180049</bibNumber>
  <ckodate>2005-04-20</ckodate>
  <ckotime>16:55:00</ckotime>
  <ckidate>2005-05-06</ckidate>
  <ckitime>18:21:00</ckitime>
  <collcode>nanf</collcode>
  <itemtype>acbk</itemtype>
  <barcode>0010045801205</barcode>
  <title>Untangling my chopsticks a culinary sojourn in Kyoto</title>
  <callNumber>641.5952 R358U 2003</callNumber>
  <deweyClass>641.5952</deweyClass>
  <subjects>
    <subject>Cookery Japanese</subject>
    <subject>Japanese tea ceremony</subject>
    <subject>Kyoto Japan Social life and customs</subject>
    <subject>Food habits Japan Kyoto</subject>
  </subjects>
</transaction>

```

Such a description provides us with the item's unique descriptors such as the barcode, item number, when it was checked out and returned, where its situated in the library's collection, what type is it (book, cd, tape, etc.), its title, Dewey numbers, and also subject keywords that allow us to make associative comparisons of the item to other items checked out during the hour, or over a longer period of time. To create this associative relationship between all of the books checked out during the hour, we create a database parsing the titles to retrieve main words, and then retrieve the subject keywords to arrive at a list of words that represent the hour's circulation. These words' overall frequency of use are calculated, and then used to create a 2D visualization map showing the relationships and hierarchy of words. Viewers at the library can identify at a glance

the most relevant topics that have circulated in the preceding hour based on these keywords and their relationships between them.

6. Data Processing & The Organization of Data

A fundamental component of this artwork is the extensive investment in data processing production followed by design through computer code. Artistic practice has a long history of arriving at aesthetic resolution through the exploration of the plasticity of the material. In the case of custom designed software, form is achieved through a combination of predefined expectations in conjunction with experimentation to arrive at a new and interesting outcome. In this way, data processing as an art practice can be thought of as a time intensive form of exploratory writing where the outcome is a consequence of the experimentation of how the syntax of mathematical models are applied and perturbed. In contrast to the visible physical presence of the materially based artwork, software design is a process that is hidden from view.

But prior to the experimentation, standardized procedures have to be determined by which the incoming data is collected and organized over time, and this work requires careful planning and appropriate expertise. Rama Hoetzlein and Mark Zifchock are the engineers responsible for the technical design of the organization, processing, and visualization of the incoming data.

Each book in the library has a radio frequency legible barcode tag embedded in it, which is read, automatically at the checkout station without need for human interaction. The information is immediately entered into the library's database. The library delivers the list of books in XML format sequenced according to their checkout time. The project's server retrieves this list, parses it for title/keyword clustering, and stores it according to the date stamp. The sum of the data is then processed to arrive at day, month, and year aggregate values. These, the keyword frequency indexing, and the Dewey values are stored as source data for the visualizations which are generated through algorithms and then visualization using Mark's designed open source Mercury/DirectX software. For all this to happen the data is calculated on a dedicated server and forwarded to 3 client computers each of which have 2 large LCD panels connected for visualization.

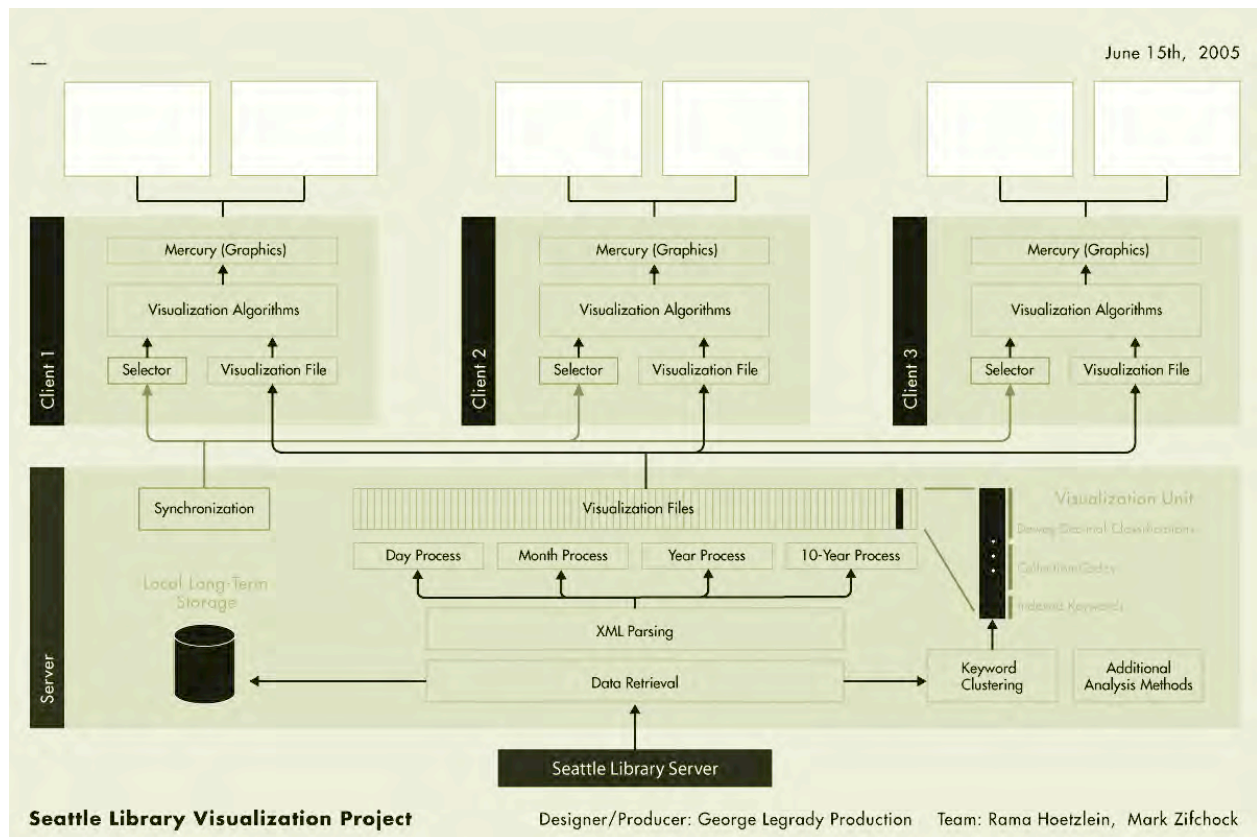


Fig. 4: Data Flow Map, Rama Hoetzlein, Mark Zifchock

7. The Data Visualization

The chronological development of the project consisted of a series of steps from concept development (fall 2003) according to which the commission was awarded. This was followed by a 2nd concept development (winter 04), then extensive visualization research throughout spring, summer and fall of 2004. The library replaced their Operating System in early 2005, so our winter and spring work was to re-adapt the format we developed for our web-based data study. The final production phase occurred this summer (2005) with technical design production at the start and an intensive rapid prototyping visualization production at the end. Research in visualization was undertaken in summer (2004) with August Black, media artist and system administrator, (http://www.mat.ucsb.edu/~g.legrady/glWeb/Projects/spl/spl_black.pdf) and then was picked up in late fall 2004 by Andreas Schlegel, interaction designer (<http://www.sojamo.de>), who developed the webbase environment to monitor the flow of data

from the library book circulation.

One of the key design concerns for this project was to achieve a balance between visualizing the data to provide meaning, with a primary investment into the exploration of the aesthetics of visualization, i.e., to go beyond illustration but maintain legibility in some way to reveal and make visible through the forms, animations, and visual events patterns that may be submerged in the data. The project was driven by the questions of what is at the boundaries of legibility in visualization, what systems, rules, references, models, can be developed within a pure basic research approach to formulate new forms of visualizations? Much of the investigation of how visual language works can be described as focused on the rules of its syntax, the definitions of the symbols it uses, the formal aspects where complexity is created through appropriate juxtapositions, contrasts and organization of visual elements (color, shape, text, sequences, etc.) that if orchestrated in particular ways have a strong communicative impact.

In the end, visualization decisions emerged out of the process of organizing the data through a rapid prototyping approach with aesthetic choices resulting through the conversations taking place between the artist, designer, and the programmer in response to experimentations.

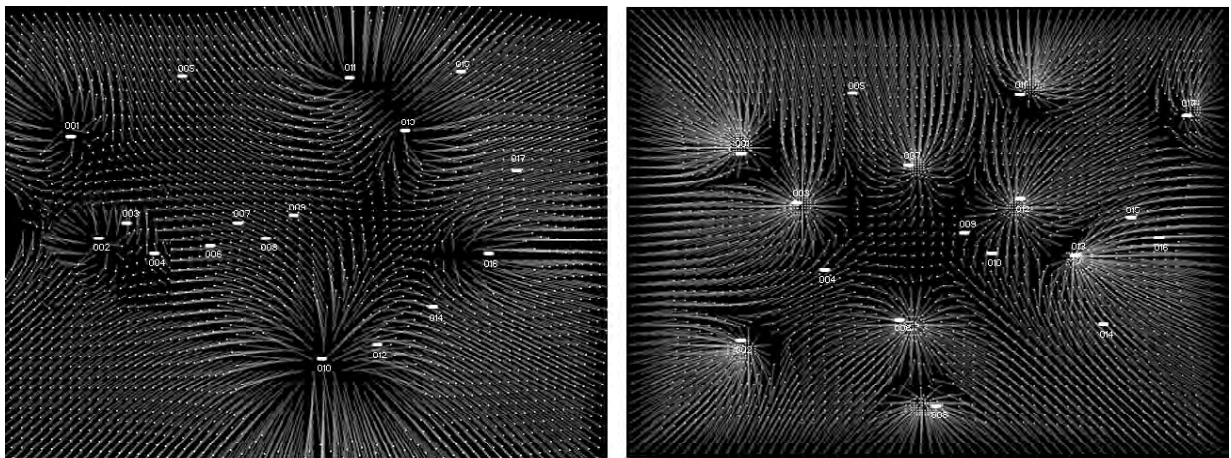


Fig. 5: Studies in Visualization, Andres Schlegel, <http://www.sojamo.de>

8. Current Visualization Studies

The following visualization studies came out of studying the data we have been receiving during the past four months and build on the tests and design prototypes developed last year.



Fig. 6: Animation 1: Numbers

Visualization I: Numbers Animation

The most apparent information to visualize are the numbers that show by the hour revealing change. Each of the six screens features both the current values for the past hour, and then the days' total. The far left screen features all the items that have been checked out of the library in the past hour. The next screen shows the total of Dewey coded items checked out. The third shows non-Dewey item. The fourth features all books checked out, the fifth, shows DVD's and the sixth, all non-book media such as cds, videos, etc



Fig. 7: Animation 2: Floating Titles

The second animation features book titles in their chronological order of being checked out. They come on screen on the far right and slowly float towards the left, fading in scale and brightness as

they move to the left. Their position on screen is determined by variables such as Dewey numbers, and they are connected to each other as if part of an architecturally defined structure.



Fig. 8: Animation 3: Dot Matrix

The dot matrix visualization consists of mapping the ten main categories from left to right and then subdividing them into their 100 divisions, each representing a topic. Beginning with the first checked out title to the last in the hour, each title “comes on stage”. If they have a Dewey number they burst out of the location of their Dewey category represented by grey bars, which then get increasingly brighter with each title that belongs to that category. If the items have no Dewey classification numbers, they drop from the top and evaporate to the bottom.

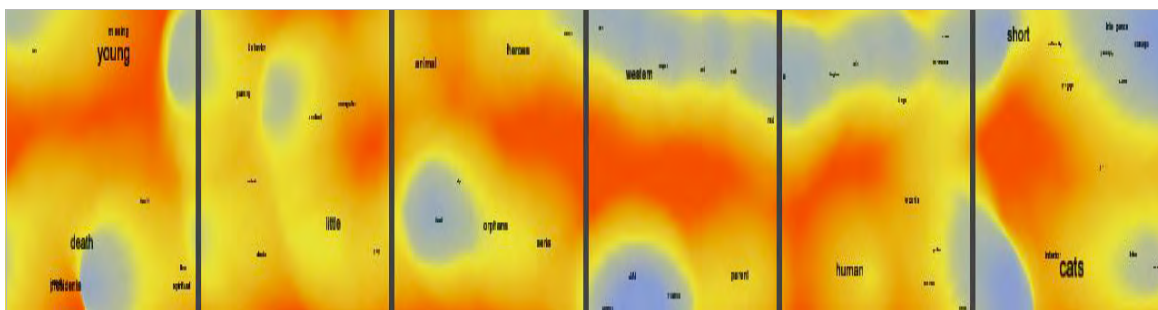


Fig. 9: Animation 4: Keyword Frequency 2D mapping

Keyword Frequency indexing is a process by which the main words of book titles and subject keywords from the Marc listing are collected and sorted according to their fitness determined by repeated uses. By also recording the keywords’ connections to the books’ Dewey category affiliations, metadata is generated that allows for a 2D spatialization that visualizes hierarchies and relative relationships.

Two other animations currently in progress explore visualization of change over time, and change over long time so that the project can show to the regular library visitors, how the flow of books from the various categories leaving the library have had decreasing or increasing circulation.

II. From Data to Structure

1. Data as Cultural Information

My research and projects since 1973 have steadily addressed the ways technological media, information processing and its representation inherently influence and mediate the content that passes through it. Beginning with investigations about the properties of the photographic medium to current interests in data processing and its multi-linear expression through interactive mixed realities installations, my practice has addressed algorithmic investigations for both image and data processing, the analysis and design of multi-linear narrative form, the role of metaphor in digital media representation, integrating motion sensing as a way to investigate the potential of the active participant as an influential component of the multimedia interactive event. My contribution to the field, since the early stages of the digital media arts' formation into a discipline, has been in intersecting cultural content with advanced data processing as a means of creating new forms of narrative experiences, expressed through data collection, data processing methodologies and data visualization.

Two other projects to be described have as common elements the procedures by which data becomes cultural information. The initial step is the recognition that data organization is a process by which to create meaning. This is followed by the search, collection and organization of data, which then must be described according to a system of rules, today labeled as metadata, which is data about data, for instance a library catalog card that describes a book. In the comparison of the two projects presented here, the selection of data moves from the artist's choices to that of the spectator, meanwhile the artistic "voice" shifts from the data to its organizing structure. The projects also include a transition from "hardwired" relationships to that

of a relational database which organizes according to the metadata, eventually replaced in "Pockets Full of Memories" by a neural-net based, self-organizing algorithm which is also known as an unsupervised learning algorithm that aims according to its mathematical structure to achieve an order that may not be initially defined at the start of the organizing process. Whereas conventional database information tend to be made available according to need and access privileges, (think of the ATM, or access to library holdings) the spectacle nature of public museum exhibitions demands that the data and its organization processes become visible and staged. This is made meaningful for the public through narrative and choreography strategies for the visual display of the information.

2. Catalogue of Found Objects, 1975



Fig. 10: Catalog of Found Objects, 1975

(http://www.mat.ucsb.edu/~g.legrady/glWeb/Projects/fo/found_obj.html)

In 1975 I stood at a vacant lot, contemplating photographing the visually intriguing texture of disorganized detritus, weeds, discarded objects and general chaos representative of such transitional spaces that accumulate a history of their own through the build-up of junk randomly contributed by passers-by. Instead I began to study the range of objects present, and collected a

sampling of them that were of varying degrees of cultural interest, portable, and could be considered representative of the consumer culture from which they came from. I took them back to the studio, spent some time classifying and grouping them, then photographed them against a common backdrop that gave the impression of classified data through its resemblance to computer printout paper. Through the subject matter of this photographic work consisting of a 2D matrix of 30 images, grouped into 6 hanging panels, a vacant San Francisco lot became transformed into an archaeological excavation site. At that time computers were not available outside of specialized labs for digitizing and image processing. Nor was there metadata and neural-net simulations, nonetheless I produced a work that parallels in many respects the digital data based projects I have been doing since then, in particular the recent, titled “Pockets Full of Memories”.

My classification methodologies relied on aesthetic, syntactic and cultural decisions. I proceeded to cluster the objects and sequence their groupings according to what made sense in terms of the interrelations of the objects within the range of the sum of all the elements. A system and lexicon came into being, resulting in an ordered state from the initial set of unrelated data. My approach reflected what the anthropologist Claude Levi-Strauss described in the opening chapter of his book “The Savage Mind”, that any classification is superior to chaos and even a classification at the level of sensible properties is a step towards rational ordering . . .The decision that everything must be taken account of facilitates the creation of a “memory bank.”ⁱ Even though an order was achieved through the relations based on the objects’ properties, the overall impression of the work is a consequence of an orchestration based on aesthetics. Two divergent modes of ordering were superimposed on one on top of each other guiding the viewing experience not unlike studying a film one frame at a time where each image is a sequence to the next. Through this viewing process, a narrative evolves as one assembles the subject matter considering the play of relations. This assembling has a cultural basis in the signifying semiotic and linguistic aspects of cultural objects as data, and the analysis of the context by which the data is situated.

The assembly and processing of data have been with us since the dawn of history but have exponentially become integrated into our lives databases, being one of the most dominant features of how we organize, our society from credit card records, to supermarket transactions, to

statistics and academic and scientific research. In “A Principle of Data Mining”, the authors define data mining as “the analysis of observational data sets to find unsuspected relationships and to summarize the data in novel ways that are both understandable and useful”ⁱⁱⁱ This refers normally to data that have already been collected where the goals of the data analysis have not influenced the initial collection process.

12 Pockets Full of Memories, 2001-2005



Fig. 11: Pockets Full of Memories Map of Objects, CornerHouse Gallery, Manchester, 2005

Conceived as an installation on the topic of the archive, memory and audience participation, "Pockets Full of Memories" was commissioned for the main floor gallery space of the Centre Pompidou Museum of Modern Art, Paris, where it was exhibited throughout the summer of 2001. The installation has since then been featured at the Dutch Electronic Arts Festival, Rotterdam, February 2003; the Ars Electronica Festival, September 2003; the "Aura" exhibition organized by c3, Budapest, October 2003, the Museum of Contemporary Art Kiasma, 2004, and Cornerhouse Gallery, Manchester, 2005.

(<http://www.mat.ucsb.edu/~g.legrady/gIWeb/Projects/pfom2/pfom2.html>)

"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 touchscreen. The data accumulates throughout the length of the exhibition. The Kohonen self-organizing map algorithm is used to organize the data on a continuous basis, moving the images of the objects into an ordered state according to similarities defined by the

contributors' semantic descriptions. The archive of objects is projected large-scale on the walls of the gallery space showing various visualizations such as the objects positioned in the 2D matrix, their movement over time, and textual descriptions. The audience can also interact with the data online to access descriptions of the objects and to contribute comments and messages to each object from anywhere in the world.

At the start of the exhibition, the database is empty but grows through the public's contributions. The algorithm organizes the data throughout the exhibition to arrive at a final ordered state at the end of the exhibition. The phenomenon of proceeding from small local actions (each contribution) to arrive at a final ordered state is called emergence as the order is not determined beforehand but emerges over time through the local interactions generated by the algorithm each time a new object enters the database. In this sense, the system has been defined as 'self-organizing'. This project positions to the foreground a range of permutations of data as a conceptual entity beginning with data as organizing system, data as expression through individual contribution, data as cultural artifact through scanning, semantic description, and attribute rating; data as processed information, classified, organized, visualized in the exhibition space and the internet, and as subject for commentary, to be contributed through the internet. The accumulation of data and metadata collected over time in various international cities has made it apparent that this artistic project would only be half-complete without the analysis of the collected data following the culmination of the exhibition and installations component. This work has been intermittently active and is continuing at this time, with greater emphasis in the near future through potential collaborative work with research individuals from Geography, Statistics and Information Science.

3. Algorithmic Visualizations, 2003-2005

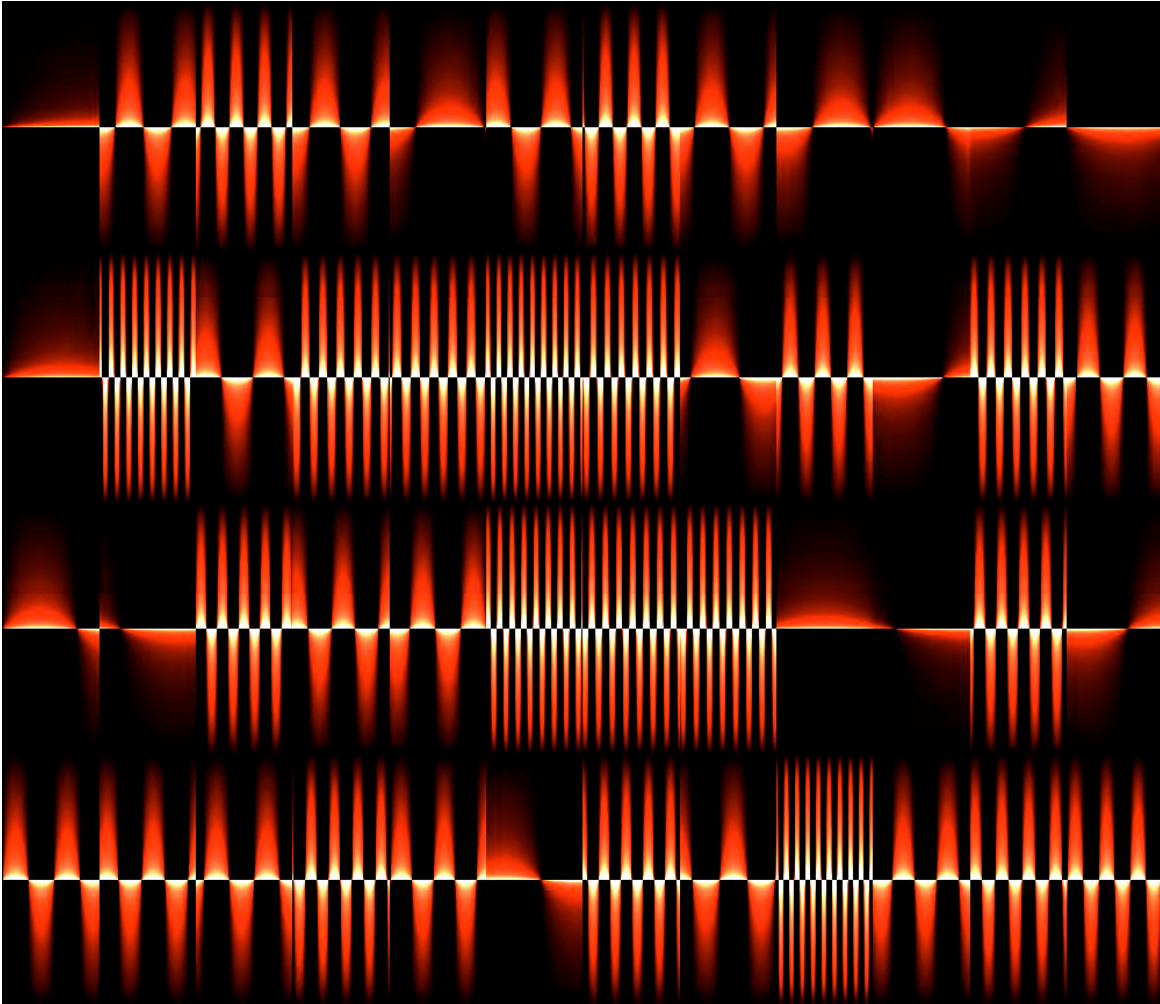


Fig. 12: Algorithmic Visualizations

(<http://www.mat.ucsb.edu/~g.legrady/glWeb/Projects/algo2/algo2.html>)

The last project to be presented in this discussion is a direction begun in the “pre-photoshop” mid 1980’s at a time when I first encountered the opportunities to explore photographic representation through digital technologies. My search in bridging computer generated processes with photography at a time when technologies for producing digital images were not readily available, led me to surveillance and satellite image processing computer code literature, which resulted in experimentations with extended explorations of mathematical processes related to noise and randomness such as frequency modulations, 2D convolutions, adaptive algorithms, neural-net implementation, pattern matching, leading to studies in image coherence, perception, enhancing visual concepts about the new digital image.

These approaches had strong potential metaphorical values for conceptually exploring the relationship between images, syntax, language, and technological processes, in particular through the programming of randomness and visual noise, derived from discipline specific interests at the time such as Information Theory, and fractal research related to Chaos Theory. I was particularly interested in the question of the veracity of the photographic image, when it became obvious that digital alterations in images could take place without leaving behind traces.ⁱⁱⁱ The process of the artist writing computer code which generates an image raises interesting questions of authorship, complicating the question of where the artistic voice occurs: in the writing of the computer code, or in the expression of the code when the image is generated. The images in “Algorithmic Visualizations” are a continuation of a series of experimentations begun in the mid 1980’s to produce images that were created purely through computer programming language, as at some point in the process of investigating what could be possible through image processing algorithms, it became obvious that the original referent photographic image I was transforming through the algorithms could in fact be left out, resulting in abstractions that were pure expressions of the algorithm itself, as if the noise to be filtered out from a song, would become enhanced and replace the song itself.

The series of projects reviewed in this paper began with cultural artifacts in search of an organizing system. The artifacts were identified, and their cultural values appreciated and the search focused on linguistic, syntactic methods by which to define relationships, sequences and hierarchies of meaning. With the integration of digitization into the process of assembling data and information, cultural artifacts became translatable into numerically evaluated data, and encoded with metadata as a way to describe them. As a result, the data could then be compared and classified through basic mathematical operations of addition and subtraction, and numeric comparisons. This led to a search for greater complexity, expressed through emergent and self-organizing algorithms that could express relationships between the data based on more complex mathematical calculations, primarily possible as a result of the increased speed of the technologies. From the simple to the complex, these projects have focused on the relationship between cultural data and its organization defined through its structure and the activated mathematical processes. The final project diverges from this direction, as it shifts full attention to the process itself, without a real need for data and cultural artifact. The power in this approach as

we know today, is the innovative potential of mathematical processes to lead us forwards in terms of conceptual, aesthetic and design directions. The complexity of the organizing principle, and the noise within the system becomes the cultural artifact that emerges.

Biography

George Legrady is Professor of Interactive Media in the Media Arts & Technology Graduate program at UC Santa Barbara. He has previously held appointments at the Merz Akademie, Stuttgart, San Francisco State University, University of Southern California, California Institute of the Arts, and the University of Western Ontario. His digital interactive installations have been exhibited internationally in Western and Central Europe, North & Central America and Japan. He has received awards from Creative Capital Foundation, the Daniel Langlois Foundation for the Arts, Science and Technology, the Canada Council, and the National Endowment for the Arts.

His contribution to the field since the early stages of the digital media arts' formation into a discipline has been in intersecting cultural content with data processing as a means of creating new forms of aesthetic representations and socio-cultural narrative experiences. Interactive digital installations such as *Equivalents II* (1992), *the Anecdoted Archive from the Cold War* (1993), *Slippery Traces* (1995), *Tracing* (1997), *Transitional Spaces* (1999) and *Pockets Full of Memories* (2001) chart the evolution of this approach through the 1990's. Current projects at this time integrate algorithmic processes as a means to data visualization through semantic categorization and self-organizing systems, interactive art installations, and mixed realities collaborative narrative development. For further information, please refer to:

<http://www.georgelegrady.com>

ⁱ Claude Lévi-Strauss, *The Savage Mind* (Chicago: University of Chicago, Press, 1962), 15

ⁱⁱ Hand, Mannila, Smyth, *Principles of Data Mining*, (Cambridge: MIT Press, 2001), 1

ⁱⁱⁱ Legrady, George "Image, Language & Belief in Synthesis", in "Critical Issues in Electronic Media" Penny, ed. NYU Press