SEEDS at UBC – Cross-Campus Connections (2015-2016)

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Executive Summary

This project is an interactive general-reference map displaying the network of cross-campus inter-connections produced by SEEDS projects, for the years 2015 and 2016, conducted in partnership with SEEDS Sustainability Program, specifically David Gill. The map serves to illustrate SEEDS' mandate of bridging the academic and operational sides of the UBC Campus, through student projects aimed at promoting sustainability initiatives on campus. The purpose of the map is two-fold: i) to inform SEEDS staff of their work with a map useful in identifying patterns that emerge out of the cartographic representation of cross-campus project collaborations, and to determine future plans to expand their mandate across campus in area less targeted, as well as ii) to present students and others with an interactive map of SEEDS for them to explore and learn more about the Program and its accomplishments.

The map holds two types of features, represented in vector format: buildings (polygons), and links *or connections* (lines). The web-based software used in the making of this map is *Carto*, which provided the OpenStreetMap base map on which the two types of features were superimposed on. Two datasets were created in *Carto*, one holding the coordinates for the buildings, and the other the coordinates for the lines. These two datasets also contain all the textual and numeric information on specific buildings and links, ordered and calculated in a separate excel spreadsheet, the reference documents of the project, containing four tables providing information on each 'project', each 'partner' (conceptualize here as faculty member, and staff member), each 'building' and each 'link'.

The scope of the project goes beyond my allocated timeframe and current level of cartographic production. As such, clear parsing and filtering of the data was crucial in building the excel spreadsheet of SEEDS projects data, in order to minimize retrieval time and maximize maintenance efficiency in the future, when projects for 2017 and previous years will be added to the map. Further recommendations to improve upon the current map produced include creating a new layer representing the SEEDS themes accomplished, providing more depth to the *sustainability* component of SEEDS' mandate, as well as create

a new layer showing the chronological evolution of SEEDS projects (building on the *completion data* column of table 1 present in the excel spreadsheet that have not yet been included in the interactive map).

Here is the link to the interactive map:
https://tbobn.carto.com/viz/8f1f8d28-b440-11e6-944f-0e3ff518bd15/public_map

Introduction

The SEEDS (Social Ecological Economic Development Studies) Program is Western Canada's first academic-operational program to integrate student research on sustainability with faculty members' research experience, and staff members' expertise in advancing sustainability on the UBC campus. In the last 16 years since the launch of the program, SEEDS has become an important campus-wide cross-collaboration platform that both provides valuable research experience for students and insights into promoting sustainability on campus. Since 2000, SEEDS has facilitated more than a thousand projects linking students, faculty members and staff members.

This interactive map produced in the context of UBC's "Research in Cartography" course (GEOB 472) assists the visualization of the SEEDS projects network for the years 2015 and 2016, the product of cross-campus collaboration between academic and operational departments. The choice of representing only two years is a function of the limited timeframe for the completion of the project. As such, the project was designed to facilitate future efforts to represent all SEEDS projects, starting from 2000.

SEEDS' mandate is to *bridge* the academic and operational sides of the UBC campus through student-led projects, supervised by faculty and staff members. While the map was produced for the SEEDS Program staff to visualize established cross-campus connections - serving as a useful resource to identify future opportunities for collaboration which would further increase the impact of their mandate - it will also serve as a valuable resource for students and non-SEEDS staff to learn more about the program and completed projects in a user-friendly and interactive manner. In order to produce a map that visually represents the links that have been created through project collaborations, certain epistemological conditions

were chosen to make the connections stand out. The most significant of these conditions was assigning specific physical buildings on campus to faculty (academic) and staff (operational) members, reflecting their office locations. As such the map does not represent the location or nature of the projects in question, but only the links between office locations of the participants involved.

This report will provide an in-depth description of the interactive map produced for the SEEDS Program, entitled 'SEEDS at UBC: Cross-Campus Connections (2015-2016)'.

The first section provides a general description of the interactive. The second section presents the methodology used to build the map, closely following Ben Fry's Data Visualization Pipeline. The third section looks at the theoretical contributions used to produce the map. The fourth section presents the results that can be extracted from the map, useful for SEEDS staff. The fifth section discusses possible errors stemming from the methodology and epistemological conditions set. The sixth section discusses collaboration with Community Partner, and the seventh section presents an overview of maintenance and further recommendations to improve upon the current map produced in the context of this project.

Project Description

This interactive map visually illustrates SEEDS' mandate of bridging the academic and operational sides of the UBC campus through student-led projects, supervised by faculty and staff members. It was created using *Carto*, a Software as a Service (SaaS) cloud computing platform that provides GIS and web mapping tools for display in a web browser.

Cartographically, the map displays two kinds of features: polygons representing each building on campus and lines representing the links (bridges) connecting buildings that share a common project, superimposed on a OpenStreetMap base-map provided by *Carto*. Categorization of these buildings and links were chosen on the basis of the participants' status, either being a faculty member, a staff member, or both. After having assigned each partner a status (based on each project, as one partner [John Madden] is both a faculty member and a staff member, with two office locations), buildings in which participants have

their offices in were color-coded based on whether they were only faculty members, only staff members, or both (only Buchanan E, Geography building and CIRS contained both faculty and staff members). Similarly, the categorization of the links followed the same logic.

The interactive nature of the map is reflected in the possibility of toggling on and off multiple layers to increase visual contrast between the links, as well as displaying textual and statistical information regarding the projects and links. To avoid static textual information, information regarding building names, participants' departments, and number of projects is displayed when hovering over specific buildings. Similarly, information regarding the type of link, the buildings and departments involved, and the number of common projects between those buildings is displayed when hovering over specific links.

When clicking on a building or link, a *pop-up* or *infowindow* appears, adding to the information displayed through the hovering tool, the partners (faculty member or staff member) involved, the number of partners, the number of faculty members, the number of staff members, total number of projects completed (for now only 2015 and 2016), 2016 projects and 2015 projects.

Seven layers are present on the map in order to increase readability of the links.

1. Buildings layer
2. All links layer, as the name suggests, contains all the links between buildings;
3. Bridges layer represents only the faculty-staff links;
4. Staff Bridges layer represents only the staff-staff links;
5. Faculty Bridges layer represents only the faculty-faculty links;
6. 1 Common Project represents the links which contain only one common project;
7. 2+ Common Projects represents the links which contain more than two common projects.

Methodology: steps in Data Visualization Pipeline

Ben Fry developed a Data Visualization Pipeline (or Process) as a comprehensive set of steps involved in representing data, consisting of 7 steps: acquire, parse, filter, mine, represent,

refine, and interact.[1] Following these steps in the confection of the interactive map, they assisted with structuring the different steps taken to transform data from the SEEDS Sustainability library available online into an interactive network map of UBC.

Acquire

This first step was to acquire the necessary data to create the map. Two sources of data were used:

- Attribute data: SEEDS Sustainability Library
- Spatial data: UBC GeoData for the building polygons, found on UBC's GitHub page

The polygon dataset of UBC's building is the foundation for the map, on which the attribute data from the SEEDS library was integrated into.

While David Gill, Community Partner, provided me with a queried excel spreadsheet of SEEDS projects, I decided to work directly with the online library in order to build comprehensive spreadsheets to maximize retrieval time and to minimize maintenance in the future. The spreadsheet he provided me with was used in the first stage to identify each partner's (defined here as both faculty members and staff members) building.

Parse and Filter

Since I manually created the excel spreadsheet based on the SEEDS library website page, which were subsequently structured in four tables, the parsing and filtering stages occurred concomitantly. Four tables were created, each presenting a stream of information useful in building the interactivity of the map.

1. 'project' table

First, I created a 'project' table, listing every SEEDS project for 2015 and 2016. It contains information on the project's completion date, the students involved and their numbers, the

[1] Fry, B. (2007). Visualizing Data: Exploring and explaining data with the processing environment.

partners (faculty and staff members), the building links per project, and the departments involved in each project.

2. 'partners' table

In order to clarify information on each partner, I created a 'partner' table, listing every partner involved in SEEDS projects, with information on their status (faculty or staff member), their assigned building, and their departments.

David Gill played a significant part in this section of the parsing process, by looking through the data in order to proof-check whether each participant was assigned the right building.

3. 'buildings' table

The third table on 'buildings' details information on each building, including the partners involved, the number of partners, the number of faculty members, the number of staff members, the departments involved, the number of departments, the number of projects completed, and the number of links to other buildings. This table serves as the basis for editing the information presented when clicking on each building on the map.

4. 'links' table

The 'links' table details the individual links each building entertains with others across campus. It serves as the basis for the links layer, and includes the statistical information that can be of value for the SEEDS Program staff.

Mine

The mining step of the data visualization pipeline consisted in filling up the tables created in the filtering process, the most time consuming part of the project along with the *represent step*.

I created four table for reference, in order to rigorously account for various types of interrelations between projects, partners, buildings and links, all present in the interactive

map. They also serve to facilitate maintenance, retrieval and editing of the map's information.

On *Carto*, I created two datasets, each one representing a different spatial data feature. The first one is the building polygon dataset, which contains all information regarding each building based on their relations to SEEDS projects. The second one is the polyline links dataset, based on the number of shared common projects between each building. The information represented was extracted from the excel spreadsheet.

Represent

The building polygons were imported into *Carto*. Its dataset attribute table integrated the information filtered and mined from the previous steps in the data visualization pipeline.

Since *Carto* can only support one type of feature per dataset (polygons, or lines, or points), I had to create a different dataset to create the links between buildings, and manually drew them between each building that shared a common project.

Refine

After having drawn the links (lines) connecting each building that shared a common project, with its coordinates appearing in the dataset, I had to edit the CSS code for each one of them in order to manipulate the color and width depending on the type of link (bridge, academic-academic, operational-operational) and the number of common projects:

Figure 1: Links weighting method

Common Projects	1	2-4	5-7	8-11	12+
Line Width	1	2	4	6	9

Interact

Having entered all the information into the two datasets on Carto, the interact step of the data visualization pipeline consisted in choosing which columns to activate, and create the additional layers which isolates the different types of links.

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Theoretical Contributions

The production of the map followed certain theoretical principles regarding cartographic representation and data visualization advanced by authors such as Ben Fry, Edward Tufte, Terry Slocum, and Alberto Cairo, which participated in increasing the quality of the visual components of the map. Although the cartographic complexity of the map is minimal, the choices made nonetheless have strong theoretical foundations.

As mentioned above, Ben Fry's Data Visualization Pipeline served as the methodological basis for the map's construction[2], although I did not faithfully follow each step in the given order, but jumped from one to the other. In retrospect, I believe that following the steps one by one provides an extremely thorough methodology, but is less thrilling since the first couple steps do not integrate visual representations.

[2] Fry, B. (2007). Visualizing Data: Exploring and explaining data with the processing environment.

Edward Tufte's five principles of analytical design also played a significant theoretical role in the process of designing this map.[3] The *first principle* of analytical design [comparisons] is echoed in the choice of colors for the different kinds of building categories displayed (dark blue, red and light green). The choice of these colors were inspired by Terry Slocum's *Thematic Cartography and Geovisualization* chapter on Principles of Color, in which he discusses how colors are processed by the human eye. The Cone cells of the eye can process three types of colors (blue, green and red), from which all the others variations of colors are derived from.[4] As such those three colors maximizes contrast which is why they were chosen in this map. The *second principle* of analytical design [causality] is inferred by the links connecting buildings together, the most visually impactful aspect of the map. The *third principle* of analytical design [multivariate analysis] played a significant role in the production of this map. Tufte argues that "nearly all the interesting worlds (physical, biological, imaginary, human) we seek to understand are inevitably multivariate in nature" and therefore, "reasoning about evidence should not be stuck in two dimensions".[5] As such while the temporal dimension of the data (project completion dates) has not yet been integrated into the map (but present in the spreadsheets for future reference), the multivariate principle is present in terms of the information present in the popups, to support the polygon and polyline features on the map. Therefore, variables in the map include: building and link type, description of partners (names, status, numbers), and links to project reports (including statistical information available per year). The width of each link, while not determined exactly by Flannery's scaling which is usually applied to proportional symbols (also called perceptual scaling), was inspired by it in order to produce a clear visual contrast between each type of line, referenced in figure 1 on the previous page. The *fourth principle* of analytical design [integration of evidence], which Tufte describes as "completely integrate worlds, numbers, images and diagrams", is clearly highlighted in the map, with substantial statistical information calculated from the spreadsheets produced in the first steps of the data visualization pipeline. Additionally, hyperlinks toward project reports makes the map a

[3] Tufte, E. R. (2006). Beautiful Evidence.
[4] Slocum, T. (2009). Thematic Cartography and Geographic Visualization: 177
[5] Tufte, E. R. (2006). Beautiful Evidence: 129

repository of evidence, easily accessible through several clicks of the mouse. Further recommendations for improving the map consists of creating another layer which portrays the SEEDS themes achieved per building, with the corresponding images (SEEDS themes include biodiversity, buildings, climate, community, energy, finance, food, health, land, materials, procurement, transportation, waste, water, wellbeing). An infographic could also be a useful addition that strengthens Tufte's fourth principles, in order to visualize the statistical information calculated through the map. But given the time constraint for this project, these two steps were not undertaken, but kept in mind when producing the map. The *fifth principle* of analytical design [documentation] was taken very seriously, and statistical evidence produced was greatly enhanced by the methodic documentation of information related to each project, each partner, each building and each link.

Alberto Cairo also proved to be a valuable resource in terms of presenting the visual information on the map. The very dense amount of links in the all links layer does not allow us to easily determine particular patterns, which is something Cairo alludes to in his book *The Functional Art*.[6] Indeed, the choice of displaying the links information in different layers aids us in better identifying particular patterns and increases the visual contrast created by seeing both ends of the line.

Results

The final version of the interactive map contains a lot of information useful for the SEEDS Program, and is designed such a way to easily update the visible information. Not only does the map visually represent the weighted connections between the different buildings in which SEEDS partners are or were located in, it presents easily extractable statistical information on each building and link between buildings (also providing a hyperlink to project reports).

[6] Cairo, A. (2012). The Functional Art: An introduction to information graphics and visualization.

Here is an overview of some of the statistical findings:

Total projects in 2015 and 2016: 185

Projects in 2015: 92

Projects in 2016: 93

Number of Partners: 169

Number of buildings involved in SEEDS projects: 47

Number of individual links between buildings: 124

"75% of links between buildings have only one common project"

"CIRS is connected to 31 only buildings through project collaborations"

The map shows that most of the links are between academic and operational buildings, but also connects academic buildings together and operational buildings together. Those links however do not mean that the project in question only had one type of collaborator; it just means that a connection was made between them. As such, the usefulness of the map is not limited to SEEDS Program staff in their assessment of their activities; the map can also serve as a way for students to explore SEEDS projects across campus in an interactive way.

It is worth mentioning that close to the end of the project, I decided to modify the data organization for the project, representing projects per year rather than per academic year. Indeed, this choice added a lot of hours of work to the project, but I believe it was worth while in the long term maintenance of the map, as I added 50% more projects than originally present, to pave the way for a chronological presentation of projects in Carto.

I had to go through every project report on the SEEDS library to identify the projects' completion date. This way, adding new projects to the dataset and map will be easy in the future.

Errors and Uncertainty

The most important source of error and uncertainty derives from the allocation of particular buildings to particular partners, usually chosen on the basis of their office locations. Indeed, the map does not represent the geographical location of projects, but the location of the

partners, not even the students involved. This epistemological choice was decided upon with David Gill during the first meeting, in order to engage in a manageable project.

Furthermore, another important source of uncertainty is the absence of reference to students. Student names have not been integrated into the map (but are nonetheless listed in table 1 of the spreadsheet, therefore easily includable) for legal purposes, as it was noted that there could be some problems with including student names in a database not located in Canada. Further confirmation of this point is needed, as the integration of student names greatly adds value to the interactive map.

Choices in terminology were taken to clarify the different aspects of SEEDS projects. Faculty and staff members, also identified by academic and operational partners respectively, are referred to by the term PARTNER. The term should not be confused with 'Staff and Partner', which refers to external to UBC collaborators which have been mentioned but not represented in the map. This could be a source of further research to integrate into the map. Indeed, these choices are not harmless, and consolidates certain aspects of the underlying power in maps. For example, drawing from critical cartography, which holds that every cartographic decision involves a statement on power relations, can clearly be seen in the choice of not representing the students, the main contributors in most cases to the production of each project.[7] As such, while faculty and staff members are the linchpins between students and SEEDS, this map overemphasizes their role and underemphasizes students' work.

Collaborating with Community Partner

It was a pleasure collaborating with David Gill, my principal contact with SEEDS program. We met regularly throughout the months of October to December (at 7 occasions) to discuss my progress and elements that SEEDS staff wanted to be illustrated in the map. David was always a great resource, responding to my concerns and questions in a timely fashion. It was also a formative experience, as working to produce a particular product, given my

[7] Crampton, J. and Krieger, J. (2005). An Introduction to Critical Cartography.

limited experience in conducting such projects, and very rewarding to see the end results illustrate the vision for the map David and I discussed in our first meeting.

Map maintenance and further recommendations

The spreadsheet represents the core dataset for this map. All additions must go through the spreadsheet in order to minimize translation errors.

There is a precise set of steps to take to maintain the database:

1. In table 1, add new projects and translate the information from SEEDS library into the columns
2. If new partners are present, add their information in table 2
3. Modify table 3 accordingly, changing the counts for each building, adding a new building row if need be. The changes must first be done for the given year, and then updating the information for all years.
4. Updating information on the links between buildings
5. After having updated the spreadsheet, update the information on the map based on the changes done in the spreadsheet.

To add new links between buildings on *Carto*:

In the all links layer, click on add feature. Draw the link by clicking on the first building, then the other. The link will not appear at first, but a new row will appear in the data view. Add the link name in the new row that appeared, with a unique link ID number. Then in *cartoCSS*, add new field with the unique link ID (by copy-pasting a previous link in code), and edit the appropriate link width and color. Click on apply style. The link will appear.

Further recommendations for this map consists in adding projects for previous years. Additionally, more layers could be added, in order to diversify and strengthen visual presentation of SEEDS information. As such, SEEDS themes can be created in a new layer, as well as the chronological evolution of projects using the completion dates.

Bibliography:

Cairo, A. (2012). The Functional Art: An introduction to information graphics and visualization. New Riders.

Fry, B. (2007). Visualizing Data: Exploring and explaining data with the processing environment. O'Reilly Media.

Tufte, E. R. (2006). Beautiful Evidence. Graphics Press.

Slocum, T. (2009). Thematic Cartography and Geographic Visualization. Pearson.

Crampton, J. and Krieger, J. (2005). An Introduction to Critical Cartography. ACME.