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A NOVEL APPROACH TO RELATING RESOURCE EXPENDITURES TO ACADEMIC UNITS

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Abstract

The North Carolina State University (NCSU) Libraries supports the research and teaching activities of a wide variety of departments and colleges at NCSU. These departments have different characteristics and diverse research interests. Through this pilot project, we used data about our expenditures and about academic departments at NCSU to help us understand how our spending on resources relates to the departments we support. The data collected fall into two main categories: department data, which include enrollment statistics, degrees awarded, faculty and student counts, and research grants; and library acquisitions data, which include expenditures and quantities acquired of monographs, as well as expenditures on serials, databases and e-resources. In order to connect the library acquisitions data with the departments data we created a mapping between the subject portion of the library's fund codes and departments. By creating a data model and storing the data in a database we've developed a platform on which we have built flexible tools for visualizing and analysing the data through a variety of means, including custom visualizations, a web portal, and database queries. Using this data and the visualization techniques, we hope to learn more about and improve the way we develop a collection that meets the manifold information needs of NCSU's students and researchers.

Expenditures Data

We collected library expenditures data about electronic and print resources. Portions of the library budget devoted to salaries and other overhead were not included. Most of the expenditures data were collected by running reports within our Integrated Library System (ILS). Expenditures for spending on materials acquired through our approval plan were gathered from our vendor's reporting system. The expenditures data include dollar amounts spent on different materials types (approval plan monographs, firm order monographs, serials, and databases), and quantities purchased of approval plan and firm order monographs. Further, the spending within each category is divided among approximately 129 different fund codes that identify purchases by subject. Two academic years' (2006-2007 and 2007-2008) worth of expenditures were collected for the most recent academic years with complete data.

At NCSU the fund codes are four letter codes that identify a broad or narrow subject area. The codes are used for collection planning, allowing us to allocate and track funds across different subject areas. Some fund codes are very broad (e.g., General Science -- GSCI) and some are narrow (e.g., Entomology - ENTO). Collection managers have the flexibility to spend more or less in a given subject area as the need arises. As items are acquired a fund code is assigned that best matches the subject area of the item. Fund codes were developed to avoid a too neat, one to one relationship between library funding and academic units. The work of many of our departments is interdisciplinary, and resources in various subject areas may be useful to multiple academic departments. The subject fund codes were developed to express the research and academic strengths and the cross-disciplinary nature of research and teaching at NCSU.

Academic Department Data

At NCSU the Office of University Planning and Analysis (UPA) collects and manages statistics about students and employees of the university. Basic reports are available on UPA's website. We were able to work directly with UPA to acquire data specific to our needs. In order to capture a data-centric view of departments at NCSU, we requested and received headcounts for each department across a number of factors: counts of tenure track and non-tenure track faculty, enrollment (broken down by master, bachelor, doctorate, and associate degree programs), degrees awarded (also divided by master, bachelor, doctorate, and associate levels).

Because research grant income is a major source of research funding at NCSU we also collected total research grants awarded in dollars for each academic unit. We were able to harvest this data from the website of NCSU's Sponsored Programs & Regulatory Compliance Services, which tracks research grant proposals and awards.

Associating Subject Identifiers and Departments

Without much further effort the data we collected could tell us a few specific things. With the departmental data we could easily compare departments across a number of factors, including number of enrolled graduate students, number of PhDs awarded, and research grant awards. With the expenditures data we could see how our collections expenditures are distributed across about 129 different subject areas.

In order to make the data work harder, we made logical connections between the expenditures and the demographics data. Doing so enabled us to examine how our materials expenditures are distributed across academic departments at NCSU. We were most interested in whether previously unrecognized patterns would emerge. For instance, we might be able to see whether the library spends more on materials that support departments that bring in more research grant research dollars.

To establish a connection between expenditures data and department data we created a mapping between each department and the fund codes that describe subjects related to its research and teaching activities. Of course, this is not a straightforward exercise. Some fund codes are quite broad and likely apply in spirit to many departments. However, it is possible that only a portion of the materials purchased within the fund are truly relevant. Also, some fund codes may only be tangentially related to the work of a department. Creating a mapping between our fund code subjects and departments was an exercise in judgment. It was an iterative effort shared among several collection managers. We continue to refine the methodology for mapping departments with fund codes.

In creating the mapping we followed several rules. A fund code subject identifier can be applied to more than one department. We assigned the full expenditure amount associated with the subject identifier to every department to which the subject identifier is mapped. This was done for ease of analysis of the resulting data, because we can never know with certainty the proportions of the collection that align with each department's use of the collection. We tried to find a balanced approach to the mapping, not being too liberal or too conservative in relating subjects to departments. The danger in each case would be over- or under-inflating our expenditures related to different departments.

In discussions among collection managers, we established that there is utility in creating multiple mappings depending on the purpose of the analysis being undertaken. To help us understand our spending in specific subject areas we might want to be very strict in our mapping and exclude very general fund code subjects altogether. Doing this would help us to see our spending in very specific subject areas more clearly because general funds tend to be large and overpower smaller more specific differences among smaller fund codes. On the other hand, for talking with departments about our spending on resources that relate to their research and teaching work, we might want to be somewhat more liberal, not to artificially inflate the amount we claim to spend, but to give a more general view to the broad range of resources that we purchase that can support the work of a department.

Storing the Data

In general, collection management librarians at NCSU use spreadsheets for data storage, sharing, and analysis. There are advantages to this. The learning curve is relatively shallow. Spreadsheets can be opened, manipulated and saved by nearly anyone with a basic computer. Additionally, shared drive space makes it simple to share data. Spreadsheets, however, lack the enforceable data structure of a database and can make data updates unweildy. A database is too much overhead for many data projects. For this project, we chose to use a MySQL database to manage and store the data for this project. There are costs and benefits to this approach as well. Setting up and mainaining a database requires some expertise with database management systems and a server environment for hosting the database, and can make access to the data difficult if tools are not built on top of the database for everyday users of the system. However, by using a relational database we were able to create a robust and flexible data structure that could be updated with relative ease each year. Data output from a relational database is also quite flexible. Queries can be written to extract specific data elements. The results can be exported in a variety of formats, including spreadsheets. Additionally, with the data stored on a server in a MySQL database we were able to experiment with other access methods, including a web portal written in PHP with embedded data visualizations using Google's Visualization API.

Utility

Hand writing SQL queries to access data in a database can be tedious. To provide easy access to the data stored in the database we built a portal using PHP and Google's Visualization API. The portal is dynamic. One can select departments to compare and a page of charts and tables is generated based on the user's selections. This was designed as a general purpose tool for exploring the data.

As an example of the kind of information available in the portal, let's suppose I've selected to compare an average department for the 2007-2008 academic year with the Entomology department for the same year. The portal page will refresh and the tables and charts will be populated with the requested data.

From the table view of the data it is relatively easy to compare Entomology with the average of all departments. Entomology has significantly lower enrollment than the average department, but almost 1 million more dollars in grant income. The library's expenditures on materials related to the teaching and research interests of the Entomology department is also generally lower than expenditures for an average department.

	Average Dept. (2007-2008)	Entomology (2007-2008)
Faculty Count	25	23
Enrollment	422	47
PhD's Awarded	5	4
Grant Income	\$1,882,768	\$2,680,159
Total Expenditure	\$601,786	\$357,134
Monograph Expenditure	\$73,845	\$29,008
Serial Expenditure	\$354,055	\$202,128
Database Expenditure	\$173,887	\$125,999

A chart view of the data shows the same thing at a glance. In all categories of resource expenditures, the libraries spends less on Entomology than it does on the average department. It is important to remember, however, that these results are highly dependent on how fund codes are mapped to academic departments.

One way to map expenditures onto a department is to simply divide the expenditures on resources by the various demographic counts of a given department. This gives a ratio of expenditure to constituent size. The ratio number itself is not particularly meaningful, but it facilitates comparisons across departments. For instance, the chart below shows the expenditures per faculty member for the average department and for Entomology. Overall, the library spends less per faculty member in Entomology than it does in other departments. This is true across all spending categories (monographs, serials, databases).

However, when expenditures are divided by the enrolled students head count, it appears that the library is spending significantly more per student in Entomology than it is on the average department, likely due to there being many fewer students in the Entomology Department compared to the average department.

Spending per PhD student is generally lower in Entomolgy, however spending within databases is very close to the average department.

By comparing grant income with library expenditures we are not claiming any causal link between library expenditures on resources and grant income, nor are we suggesting this as a

measure of return on investment. However, it is a way of comparing library expenditures with the research dollars coming into various departments. To make this comparison we divided the department's grant income by the NCSU Libraries' expenditures on resources related to the department. On average, a department takes in \$3 of grant income for every \$1 spent by the library on resources that relate to the work of the department. In comparison the Entomology department brings in \$8 of research grant income for every \$1 spent by the libraries on resources related to its research and teaching activities.

One can also compare between two departments the relative proportion of resource expenditures by different material types. Entomology is very similar to the average department in this regard, with nearly 60% of expenditures devoted to serials, nearly 30% devoted to databases, and about 10% spent on monographs.

Although we do not have quantities purchased for serials and databases, such information was easy to add to the database for monographs. We purchased about 1,100 monographs related to the work of an average department in 2007-2008. The Libraries purchased about 300 books related to the work of the Entomology Department.

However, it is worth noting that the monographs purchased that relate to Entomology were somewhat more expensive than average. For the average department the cost per monograph was under \$70; for Entomology the average cost per monograph was over \$90.

The portal is useful for making comparisons between two specific departments or between a department and the average. This can be useful for exploring specific cases, but often it's desirable to get a broader view of the data. One weakness of the portal is that it makes it difficult to see all the data at once. Several other visualization techniques were used to try to expose more of the data in single views.

Department Motion Chart

A motion chart is interactive and can show changes over time across as many as six different variables. In the chart above the six variables are number of PhDs awarded on the y-axis, library expenditures on resources on the x-axis, grant dollars awarded represented by the diameter of each circle, department represented by each circle, college represented by the color of each circle, and time using the slider under the x-axis. The motion chart makes it relatively easy to identify outliers. In the academic year 2007-2008, the Wood and Paper Science Department had high grant income but low library expenditures on resources and no PhDs awarded. The Biomedical Engineering Department also awarded no PhDs, brought in less in grant income than Wood and Paper Science, but the library spends a much larger amount on resources related to its research and teaching.

Department Motion Chart

Moving the slider at the bottom of the chart from 2006-2007 to 2007-2008 shows changes across all variables between the two years. The four labeled departments are shown with data points for both academic years, connected by lines. I have added arrows to show the direction of change. Library expenditures on resources dropped from 2006-2007 to 2007-2008, in all but one department in the College of Education – the Department of Mathematics, Science and Technology Education. It is also notable that this department also has the lowest graduate enrollment of the four departments, which has remained much the same between the two academic years.

It is a significant challenge to represent a large data set in a way that is meaningful and useful. Another method we developed to try to expose the utility of the data is a customized HTML table. The table lists each department, the amount the library spends on resources related to its work, research grant awards, graduate enrollment, PhDs awarded, and undergraduate enrollment. This differs from a typical table in that rather than representing the data for each department across a single row, the department name is repeated for each data point. For each department name and variable pair the column is sorted in descending order. The first columns are sorted by library expenditures on resources related to the work of the department. Across the table, the next pairs are sorted by research grant awards in dollars, graduate enrollment, PhDs awarded, and undergraduate enrollment. With the columns ordered in this way it is impossible to read across rows as one would normally with a table. Instead we added JavaScript to the table that highlights in gray all the values for a single department when one passes the cursor over a department. One can also make the highlighting “stick” by clicking on a value; this appears in pale red. This interactive table facilitates exploration of a multivariate data

set. The highlighted rows reveal the rank of a department across five different categories. Note that the difference in value between one row and the next is variable, and that many of the values at the end of each column are zero.

dept name	total exp	grant dollars	grad enroll	phd awarded	undergrad enroll
Chemical & Biomolecular Engineering	\$1,737,863.36	Physics	Electrical & Computer Engineering	28	Business Management
Chemistry	\$1,645,984.48	Marine, Earth and Atmospheric Sciences	Electrical & Computer Engineering	28	Biological Sciences
Mathematics, Science & Technology Education	\$1,262,365.07	Mathematics, Science & Technology Education	Business Management	34	Mathematics & Aerospace Engineering
Physics	\$1,244,153.67	Crop Science	Communication	37	Mathematics, Science & Technology Education
Biomolecular Engineering	\$1,160,891.42	Mathematics	Educational Leadership & Policy Studies	38	Electrical & Computer Engineering
Sat Science	\$1,133,864.75	Statistics	Electrical & Computer Engineering	38	Communication
Genetics	\$1,037,634.45	Chemistry	Adult & Higher Education	254	Psychology
Materials Science & Engineering	\$1,011,691.77	Materials Science & Engineering	Mathematics & Aerospace Engineering	14	Animal Science
Electrical & Computer Engineering	\$975,936.64	Statistics	Physics	10	Public, Recreation & Tourism Management
Psychology	\$975,936.64	Statistics	Public & International Affairs	10	Public & International Affairs
Textile Engineering, Chemistry & Science	\$955,985.36	Chemical & Biomolecular Engineering	Statistics	154	Statistics
Psychology	\$955,985.36	Chemical & Biomolecular Engineering	English	152	Textile & Apparel Technology & Management
Industrial & Systems Engineering	\$947,271.09	Wood & Paper Science	Chemistry	102	Accounting
Marine & Structural Biotechnology	\$944,848.32	Environmental & Molecular Toxicology	Industrial & Systems Engineering	117	Sociology and Anthropology HISS
Business Management	\$944,848.32	Forestry & Environmental Resources	Psychology	117	Marine & Structural Biotechnology
Plant Biology	\$944,848.32	Forestry & Environmental Resources	Mathematics, Science & Technology Education	7	English
Public & International Affairs	\$944,848.32	Environmental & Molecular Toxicology	Educational Leadership & Policy Studies	6	Mathematics, Science & Technology Education
Mathematics & Aerospace Engineering	\$944,848.32	Textile Engineering, Chemistry & Science	Statistics	6	Chemical & Biomolecular Engineering
History	\$944,848.32	Nuclear Engineering	Genetics	6	Forestry & Environmental Resources
Biological & Agricultural Engineering	\$944,848.32	Genetics	Forestry & Environmental Resources	5	Agricultural & Resource Economics
Agricultural & Resource Economics	\$944,848.32	Animal Science	Marine, Earth and Atmospheric Sciences	5	History
Sociology and Anthropology HISS	\$944,848.32	Marine & Structural Biotechnology	Nuclear Engineering	5	Chemistry
Nuclear Engineering	\$944,848.32	Social Work	Plant Biology	5	Biomolecular Engineering
Mathematics	\$944,848.32	Statistics	Entomology	4	Crop Science
Biological Sciences	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Marine, Earth and Atmospheric Sciences
Educational Leadership & Policy Studies	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Textile Engineering, Chemistry & Science
Crop Science	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Biological & Agricultural Engineering
Adult & Higher Education	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Foreign Languages & Literatures
Curriculum and Instruction	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Monterology
Social Work	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Food, Bioprocessing and Nutrition Sciences
Foreign Languages & Literatures	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Food, Bioprocessing and Nutrition Sciences
Plant Biology	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Agricultural & Resource Economics
Forestry & Environmental Resources	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Agricultural & Resource Economics
Public Science	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Marine, Earth and Atmospheric Sciences	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Communication	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Philosophy & Religion	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Monterology	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Genetics	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Agricultural & Resource Economics	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Food, Bioprocessing and Nutrition Sciences	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Management, Innovation & Entrepreneurship	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Accounting	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Textile & Apparel Technology & Management	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Art & Design	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Architecture	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Landscape Architecture	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Graphic Design	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Industrial Design	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Public, Recreation & Tourism Management	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs
Wood & Paper Science	\$944,848.32	Statistics	Environmental & Molecular Toxicology	4	Public & International Affairs

In the screenshot above the Computer Science department is highlighted in red and Civil, Construction and Environmental Engineering is highlighted in gray. Both departments are relatively high across all categories, which is expected. Nothing in particular stands out, except perhaps that both departments are near the top in graduate enrollment and PhDs awarded and not quite as high in library expenditures.

dept name	total exp	grant dollars	grad enroll	phd awarded	undergrad enroll
Chemical & Biomolecular Engineering	\$1,707,368.58	Physics	\$7,313,100.00	Electrical & Computer Engineering	146
Chemistry	\$1,340,364.40	Marine, Earth and Atmospheric Sciences	\$5,913,000.00	Statistics	22
Mathematical, Science & Technology Education	\$1,202,663.57	Mechanical & Aerospace Engineering	\$5,480,300.00	Civil Construction & Environmental Engineering	10
Physics	\$1,244,103.67	Crop Science	\$5,150,070.00	Curriculum and Instruction	307
Biological Engineering	\$1,190,981.42	Materials	\$5,040,000.00	Educational Leadership & Policy Studies	202
Social Science	\$1,116,846.75	Genetics	\$4,880,000.00	Civil Construction & Environmental Engineering	247
Marine, Earth and Atmospheric Sciences	\$1,011,695.77	Chemistry	\$4,250,400.00	Adul & Higher Education	254
Civil Construction & Environmental Engineering	\$979,604.00	Materials Science & Engineering	\$4,190,070.00	Mathematics	179
Electrical & Computer Engineering	\$941,775.94	Plant Pathology	\$4,040,070.00	Public & International Affairs	105
Statistics	\$888,966.88	Civil Construction & Environmental Engineering	\$4,024,000.00	Statistics	154
Textile Engineering, Chemistry & Science	\$882,646.03	Biological & Agricultural Engineering	\$3,871,300.00	English	122
Psychology	\$860,495.35	Chemical & Biomolecular Engineering	\$3,864,100.00	Chemistry	122
Industrial & Systems Engineering	\$797,071.39	Wood & Paper Science	\$3,807,300.00	Industrial & Systems Engineering	121
Molecular & Structural Biochemistry	\$776,408.02	Environmental & Molecular Toxicology	\$3,774,070.00	Psychology	117
Business Management	\$754,538.00	Forestry & Environmental Resources	\$3,740,000.00	Forestry & Environmental Resources	110
Plant Biology	\$751,981.40	Ecology	\$3,680,000.00	Physics	110
Public & International Affairs	\$750,611.15	Mathematical, Science & Technology Education	\$3,400,407.00	Chemical & Biomolecular Engineering	109
Mechanical & Aerospace Engineering	\$668,861.68	Textile Engineering, Chemistry & Science	\$3,264,000.00	Economics	104
History	\$664,795.39	Nuclear Engineering	\$3,070,000.00	Mathematical, Science & Technology Education	104
Biological & Agricultural Engineering	\$660,491.48	Genetics	\$3,040,000.00	Marine, Earth and Atmospheric Sciences	96
Agricultural & Resource Economics	\$657,042.02	Animal Science	\$2,857,407.00	Accounting	96
Sociology and Anthropology HADES	\$657,042.02	Molecular & Structural Biochemistry	\$2,850,000.00	Nuclear Engineering	96
Nuclear Engineering	\$646,547.02	Social Work	\$1,869,204.00	Biomedical Engineering	75
Mathematics	\$640,221.42	Public Science	\$1,819,600.00	Agricultural & Extension Education	74
Biological Sciences	\$640,221.42	Horticultural Science	\$1,805,400.00	Environmental & Molecular Toxicology	74
Educational Leadership & Policy Studies	\$640,221.42	Social Science	\$1,800,000.00	Public, Recreation & Tourism Management	72
Statistics	\$635,841.12	Food, Bioprocessing and Nutrition Sciences	\$1,790,000.00	History	70
Crop Science	\$600,000.00	Industrial & Systems Engineering	\$1,677,000.00	Material Science & Engineering	70
Adul & Higher Education	\$588,965.11	Curriculum and Instruction	\$1,460,000.00	Mathematics	68
Curriculum and Instruction	\$588,965.11	Plant Biology	\$1,460,000.00	Crop Science	68
Social Work	\$580,300.00	Public, Recreation & Tourism Management	\$1,400,000.00	Public, Recreation & Tourism Management	63
Foreign Languages & Literatures	\$567,042.02	Industrial Architecture	\$1,310,000.00	Economics	63
English	\$549,619.58	Textile & Apparel Technology & Management	\$1,276,207.00	Nuclear Engineering	57
Plant Pathology	\$540,491.67	Agricultural & Resource Economics	\$1,100,000.00	Agricultural & Resource Economics	55
Forestry & Environmental Resources	\$537,000.00	Psychology	\$1,079,070.00	Landscape Architecture	54
Physics Science	\$540,422.59	Electrical & Computer Engineering	\$996,400.00	Sociology and Anthropology HADES	50
Industrial Science	\$541,116.01	Microbiology	\$972,700.00	Animal Science	48
Marine, Earth and Atmospheric Sciences	\$538,616.02	Economics	\$945,100.00	Biological & Agricultural Engineering	48
Communication	\$530,266.00	Accounting	\$945,400.00	Horticultural Science	48
Philosophy & Religion	\$529,465.66	Sociology and Anthropology HADES	\$920,407.00	Textile & Apparel Technology & Management	47
Microbiology	\$526,475.09	Business Management	\$918,100.00	Ecology	47
Economics	\$520,205.15	Philosophy & Religion	\$918,100.00	Plant Pathology	37
Geography	\$507,144.40	English	\$910,000.00	Architecture	37
Agricultural & Extension Education	\$506,266.45	History	\$910,000.00	Statistics	36
Environmental & Molecular Toxicology	\$500,277.30	Agricultural & Extension Education	\$910,000.00	Molecular & Structural Biochemistry	36
Food, Bioprocessing and Nutrition Sciences	\$494,700.00	Architectural	\$900,000.00	Foreign Languages & Literatures	36
Music	\$510,254.09	Foreign Languages & Literatures	\$900,000.00	Environmental & Molecular Toxicology	36
Animal Science	\$507,204.00	Management, Innovation & Entrepreneurship	\$85,000.00	Industrial Design	30
Management, Innovation & Entrepreneurship	\$500,000.00	Adul & Higher Education	\$80,700.00	Plant Biology	31
Accounting	\$501,208.40	Art & Design	\$80.00	Wood & Paper Science	30
Textile & Apparel Technology & Management	\$495,201.17	Biological Sciences	\$80.00	Textile Engineering, Chemistry & Science	27
Art & Design	\$495,175.09	Communication	\$80.00	Social Science	26
Architecture	\$477,000.10	Educational Leadership & Policy Studies	\$80.00	Public Science	25
Landscape Architecture	\$477,000.10	Graphic Design	\$80.00	Art & Design	24
Graphic Design	\$477,000.10	Landscape Architecture	\$80.00	Graphic Design	14
Industrial Design	\$460,200.00	Public, Recreation & Tourism Management	\$80.00	Management, Innovation & Entrepreneurship	14
Public, Recreation & Tourism Management	\$460,200.00	Music	\$80.00	Textile & Apparel Technology & Management	14
Wood & Paper Science	\$460,200.00	Public & International Affairs	\$80.00	Textile Engineering, Chemistry & Science	14
				Wood & Paper Science	14

In the next screenshot, Computer Science is still highlighted in red, but now Genetics is highlighted in gray. In this case the gray highlighted rows reveal that Genetics, while well supported by the resources the library has purchased, has fewer research grant awards, lower graduate enrollment, PhDs awarded, and undergraduate enrollment. This view of the data provides a means to make general comparisons across departments relatively quickly. Identifying departments where the library's financial support for purchasing resources seems out of line with the basic demographics of the department might prompt a closer look at the fund code assignment and allocations. This could be as simple as looking at a list of the fund codes that were mapped to the department to identify why the library's support appears the way it does. If the funding level seems too high it could be explained by a very general and generous fund code having been mapped to the department. In such cases the disparity between the department's profile and the funding level would be easily explained by closer examination.

To get a broader view of the mapping we created between departments and fund codes, we generated a tree map. Tree maps provide a way to display hierarchical data as nested rectangles. The size of each rectangle represents the value of the data. We have found tree maps useful for explaining and examining the mapping between fund codes and departments. The tree map below shows a simplified mapping between fund codes and colleges.

To test whether there is a relationship between the library's expenditures on resources in different subject areas and various departmental measures we ran statistical tests of correlation between total expenditure (the total amount in each fund code mapped to a given department) and each of the departmental data elements. The table below reveals that the strongest positive correlation is between total expenditure and PhD awarded. Other variables show some level of positive correlation, although undergraduate enrollment shows the least positive correlation.

Variable	by Variable	Correlation	Count	Signif. Prob.
totalexpenditure	facultycount	0.2403	119	0.0085*
totalexpenditure	graduateenrollment	0.3306	119	0.0002*
totalexpenditure	undergradenrollment	0.1609	119	0.0805
totalexpenditure	phdawarded	0.4579	119	<.0001*
totalexpenditure	grantsincome	0.3576	119	<.0001*

Other Considerations

The broad purpose of this project is to help collection managers evaluate and think about how library purchasing power is distributed across different subject areas. We have shown that there is some correlation between departmental measures such as PhDs awarded, graduate enrollment, and research grants income. We have not explicitly set out to provide greater support to departments that match these profiles; it has just worked out to be the case, probably because departments with high levels of graduate enrollment and grant income are likely to be known strengths of the institution, which we do intentionally provide with high levels of support.

The use of data to examine the relationship between our spending on resources and the departments the library serves can help test our assumptions about the strengths of the university. Additionally, various methods of visualizing and exploring the data can help reveal instances where we might be overlooking the strength of a particular department and may not be meeting its need for library provided resources.

A limitation of this project is that simple measures across a few characteristics of academic departments cannot tell us everything we need know about differences in research and teaching needs across departments. The measures we employ do not account for differences in the way that departments make use of library materials. Some collecting areas may be important because they are historical strengths of our collection, even if they do not provide immediate support to particular departments. Also, the future utility of present collection activities is not taken into account. It is important to keep in mind that the human-created mapping between departments and fund codes significantly affects the results.

Future Plans

So far we have collected complete data for two academic years. We plan to maintain and update the database as each academic year's data become available. Additionally, the querying and data visualization tools will be refined as we learn more about how collection managers want to use the data. We are also working on a more sophisticated mapping scheme that will provide more nuanced and customizable mappings between fund codes and departments. Ultimately we would like to see this as part of the collection managers' toolkit as they make decisions about resource allocations across different subject areas.