Innovative Data Tools that Support Capital and Facilities Planning

Julianna M. Carney
Planning and Facilities Management

Scaling Down the Data Warehouse

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• Bachelors in Mechanical Engineering, Illinois Tech
• Master of Mechanical and Aerospace Engineering, Illinois Tech
• NASA Engineer
• Energy modeling and HVAC design (Revit and AutoCAD)
• Project Management – Chicago Public Schools and Georgetown University
• MBA, Strategy from Georgetown University
• Program Management, business development, data science and analytics
Learning Outcomes

1. Explain the data you need to drive strategic decision making in capital and facilities planning.
2. Summarize how to build a planning and facilities data warehouse.
3. Describe tools available to collect and use data in the capital and facilities planning process.
4. Review current processes and opportunities for automating your data collection processes.
Founded in 1789 and is the Nation’s Oldest Catholic and Jesuit University

SPACE:
• 104 Acres
• 50 Buildings
• 5.4 Million Gross Square Feet
• $3 Billion Real Estate Portfolio

PEOPLE:
• 7,400 Undergraduate Students
• 11,700 Graduate Students
• 4,200 Faculty and Staff
1. Data & Tools

2. Data Maturity Levels in Capital Planning
   - Case study: Level 1 - 3
   - Case study: Level 4

3. Strategy and Analytics (what’s next)
Riggs Library, Healy Hall
Its construction had been supervised by architect Paul Pelz, whose firm also designed Healy Hall and the Library of Congress.
Shared characteristics of innovative leaders

“They emphasize strategic decision-making and cultivate a data-enabled culture. Innovative leaders promote decision-making based on evidence, which can increase the tolerance for strategic risk and small failures. Cultivating positive attitudes toward the collection and use of data enables a culture on campus that elevates informed decision-making at all levels across the campus.”
What Data Science Can Do

81% of executives believe that data should drive decision-making, but only 3% of them have a mature organizational data strategy.

- Empowers management to make better decisions
- Increases operational efficiency and investment from staff
- Increases accountability and validates decisions

Data Society 2018
Data is information that should be seen as an opportunity to working smarter and better, building efficiency, and reducing costs
Data is information that should be seen as an opportunity to working smarter and better, building efficiency, and reducing costs

Open source tools are available that enable sharing of data, analytics, and predictions using large amounts of data
<table>
<thead>
<tr>
<th>Data Tools</th>
<th>PRICE: $$$</th>
<th>FREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business analytics and spreadsheet computation</td>
<td><img src="image" alt="Excel" /></td>
<td><img src="image" alt="Google Docs" /> <img src="image" alt="OpenOffice" /></td>
</tr>
<tr>
<td>Mathematical and scientific computation</td>
<td><img src="image" alt="MATLAB" /></td>
<td><img src="image" alt="Python" /> <img src="image" alt="SciPy" /> <img src="image" alt="matplotlib" /></td>
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<tr>
<td>Statistical modeling and analysis</td>
<td><img src="image" alt="IBM SPSS" /> <img src="image" alt="Stata" /> <img src="image" alt="R" /></td>
<td><img src="image" alt="IBM" /> <img src="image" alt="MySQL" /> <img src="image" alt="PostgreSQL" /></td>
</tr>
<tr>
<td>Databases</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Needs of Capital Planning

**Where invest?**
- Facilities
  - Deferred Maintenance
  - Capital Improvement
  - New Construction

**How much should we invest?**
- Debt
  - Annual Investments
  - Life Cycle

**What can we afford?**
- Health and Life Safety
- MEP
- Envelope
- Programs
- Athletics
- Student Life
- Regulatory Requirements
- Research
- Teaching
- Services
- Campus Aesthetics

**Why invest?**

**What is the timing of investment?**
GOALS

Ability to plan appropriately
Use capital resources responsibly
Development of long-term CIP
Building efficiency across the enterprise

- Enabling automated data acquisition
- Growing data warehouse
- Building transparency and collaboration
- Improving decision making based on objective information
- Directing allocation of resources and long term capital planning
## Data Maturity in Capital Planning

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Strategic Initiative</th>
<th>Architecture and Tools</th>
<th>Data</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Developed Planning Database</td>
<td>Google Cloud</td>
<td>Project information</td>
<td>Enterprise Automation</td>
</tr>
<tr>
<td>1</td>
<td>No consistent information match with architecture, no enterprise tools, no data management or governance</td>
<td>Developed and implemented the Project Initiation form</td>
<td>Google Forms</td>
<td>Funding</td>
<td>Planning Metrics and developed KPIs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automated approval process</td>
<td>Google Apps Script</td>
<td>Budget</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automated data capture in the cloud</td>
<td>JavaScript</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Presence of Agile, the cloud, data warehouse</td>
<td>Developed Planning dashboards</td>
<td>Google Cloud</td>
<td>Facilities Data</td>
<td>Capital Projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Developed beta application for quick implementation in Planning using cloud platform</td>
<td>Appsheet</td>
<td>HPDM Data</td>
<td>Annual Metrics and Statistics</td>
</tr>
<tr>
<td>3</td>
<td>Presence of data standards and data specialists, data quality information</td>
<td>Developed, implemented, and trained Project Managers and Contract Managers in PFM App</td>
<td>Enterprise tool PFM App</td>
<td>Project Tracking</td>
<td>Bi-weekly PM updates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Consistent data capture</td>
<td>SQL</td>
<td>Schedule</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Predictive analytics, data retention, starting to integrate Artificial Intelligence in your initiative</td>
<td>Earned Value Management</td>
<td>Excel/Google Sheets</td>
<td>Cost Variance</td>
<td>Monthly performance tracking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Predictive Analytics (Budget and schedule)</td>
<td>GMS</td>
<td>Schedule Variance</td>
<td>Lessons Learned</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Predictive Analytics HPDM</td>
<td>Python ML</td>
<td>Cost Performance Index</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change Order Process</td>
<td></td>
<td>Variance at Completion</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Data is now an asset of your financial assets, on the top of mind of executives, mature organizational management program</td>
<td></td>
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</tbody>
</table>
### Case Study 1

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Approach</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Outdated system</td>
<td>• One system for all users</td>
<td>• Localized information</td>
</tr>
<tr>
<td>• Localized</td>
<td>• “touching” a project</td>
<td>• Real-time reporting</td>
</tr>
<tr>
<td>• Outdated information</td>
<td>• Using the same data starting from</td>
<td>• Mobile friendly</td>
</tr>
<tr>
<td>• Disparate information</td>
<td>Project Initiation</td>
<td>• Sharing of information</td>
</tr>
<tr>
<td>• No collaboration or sharing</td>
<td>• Accessible online and remotely</td>
<td>• Collaboration</td>
</tr>
<tr>
<td>• Schedule challenges</td>
<td>• Up to date live information and</td>
<td>• Continuously improving</td>
</tr>
<tr>
<td></td>
<td>documents</td>
<td></td>
</tr>
</tbody>
</table>

**AppSheet**

**Level 1**

- Localized information

**Level 2**

- Real-time reporting

**Level 3**

- Mobile friendly

**Level 4**

- Sharing of information
- Collaboration
- Continuously improving
Georgetown Project Initiation

Your username (jmc386@georgetown.edu) will be recorded when you submit this form. Not you?
Sign out

* Required

GEORGETOWN PROJECT INITIATION (GPI)

This form should be used as a project request for infrastructure, space (relocation, new or renovation), furniture, and signage. If you have any questions please contact:
CAMPUS & STRATEGIC PLANNING

Data Features

- Budget information
- Funding accounting codes
- Location
- Building
- Campus
- Program
- Square Feet
- Dates
- Schedule
- Subjective information
Georgetown Project Initiation

User wants to initiate a project

User fills out Georgetown Project Initiation (GPI) form

Ready to submit?

Email to Organization Approval Authority with PDF of form responses and link to Approval Form

Facilities
Main Campus
Medical Center
University Services
Law Center

Approved GPI form

Yes
Project moved to C&SP database and email to University Planner

No
Notification email sent to User: Project Remains in request database

Yes

After 5 days Email reminder to User to complete form

The form is saved for the User to edit later and remains on hold until form is submitted

C&SP will reach out to stakeholders to begin strategic review and needs assessment

User may contact Chief Business Officer for further information

Level 1 Level 2 Level 3 Level 4

Level 1
Level 2
Level 3
Level 4

Georgetown University
Project Application

• One system for all users “touching” a project
• Using the same data starting from Project Initiation
• Accessible online and remotely
• Up to date live information and documents
• Mobile friendly
• Real-time reporting
• Continuously improving
Project Application Features

- Projects by Planner
- Projects by PM
- Comments by Date

- PM Edits and Updates
- Planner Edits and Updates
- Contract Managers Edits and Updates

- Projects by Building
- Projects by Campus

- Level 1
- Level 2
- Level 3
- Level 4

- • Square Feet
- • Year Built
- • Floor Plans
- • FCI

- • Location
- • Square Feet
- • Lease Dates

Level 1: Projects by Planner
Level 2: Projects by PM
Level 3: Comments by Date
Level 4: PM Edits and Updates
Project Application Screenshots
Case Study 2

**Challenge**

- Prioritize about $500 Million in deferred maintenance needs
- Extract insights from over 3000 lines of condition assessment data
- Create an actionable plan

**Approach**

- Leveraged data science to produce manageable list of priority projects
- Added new data features to existing data
- Developed model in Python using unsupervised machine learning

**Results**

- Produced actionable sized projects for scoring and ranking
- Applied framework for distribution and planning

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Developing Projects from condition assessment surveys

3000 lines of aggregate data → Data set enhancements → Python → 200 projects logically grouped

Build new features
- NAV
- System Life (Source: BOMA Life Expectancy)
- Mission
- Utilization

- Model selection
  - Agglomerative (hierarchical) clustering
- Develop clusters

Level 1
Level 2
Level 3
Level 4
Hierarchical Clustering Dendrogram

Python Model Output
Future opportunities

By leveraging the efficiencies created through disciplined resource management, with data/analytics as foundation for decision-making, we can generate cost savings to reinvest into facilities.
Institutional Long-term Planning

Academic Planning
- Academic excellence
- Research
- Interdisciplinary
- Global

Financial Planning
- Innovative partnerships
- Growth
- Sustainability

Capital Planning
- Deferred Maintenance
- Programs
- DC Area
- Community

Data culture – Data Decision Support – Data Insights and Opportunities
Scaling Down the Data Warehouse
David DeBoer
Interim Director, Office of Assessment and Decision Support

- Bachelors in Sociology and Arabic
- Masters in Computer Science
- 11 years experience at Georgetown University
  - Registrar’s Office for 6
  - OADS for 5
- Data management, business intelligence, predictive modeling, data visualization

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Outline

• Needs of Academic Planning
• Data Warehousing Background
• Proposal for a Scaled Down Data Model
• Project Scope/Metrics Platform
• Demo
• Next Steps
• Questions
Needs of Academic Planning

What faculty to hire?
Faculty
- Teaching
- Research
- Service

What is the balance?
- Courses
  - Students
  - New Admits
  - Continuing
- Curriculum
  - Majors
  - Applicants
  - Financial Aid
  - Tuition
  - Graduates
  - Fulfilled Curriculum
Needs of Capital Planning

Faculty office space?

New Lab Space?

What classrooms?

Where will students live?

How do we pay for it?
Ideally, capital, financial, and academic planning would be in sync.

The data needed for these tasks are generally disparate and unrelated.

A data warehouse can be a solution to merging data across domains.
Data Warehousing Background

• Some goals of a data warehouse
  – All data in one place
  – Data is transformed into meaningful information
  – Agreed upon definitions for data
  – Looking at data across time
  – Dimensional data models that link across domains
Data Warehousing Background

• Can we scale back the goals to make this easier?
  – All data in one place *All Data?*
  – Data is transformed into meaningful information *Sounds good*
  – Agreed upon definitions for data *prerequisite for the previous one*
  – Looking at data across time *What about when systems and processes change?*
  – Dimensional data models that link across domains *What does this even mean? Is a dimensional data model necessary?*
The Data Model as an interface
Traditional Data Warehouse

Complexity

Translate

Interact

BI Tool

Analyst

Decision Maker

Analyst

Analyst

Analyst

Analyst
The Scaled Down Data Model

• Observations
  – The data an analyst needs is different from what decision makers need:
    • E.g. You need detailed data to create a logistic regression model for predicting graduate student enrollment, but the Dean just wants to see expected enrollment by program
  – A robust, detailed data model serves the needs of analysts, not decision makers
  – Simplifying the data model allows for
    • Less overhead in terms of data management and adding new data
    • Interesting options for presentation
    • Opportunities around metadata and documentation
    • Easier training for users
The Data Model as an interface
Scaled Down Data Warehouse

<table>
<thead>
<tr>
<th>Unit</th>
<th>Course Credits</th>
<th>Undergraduate Credits</th>
<th>SATS</th>
<th>Student Course</th>
<th>Female Student Count</th>
<th>Faculty Count</th>
<th>Faculty Comp</th>
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<tbody>
<tr>
<td>English</td>
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</tbody>
</table>
The Data Model -- Columns

• By simplifying the structure of the data, developers can focus on defining and creating the most useful columns possible.
• There will be many columns for all of the different data needs.

<table>
<thead>
<tr>
<th>Unit Type</th>
<th>Data Set Type</th>
<th>Data Set Name</th>
<th>Column Code</th>
<th>Column Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>Faculty</td>
<td>DepartmentFacultyRecruitment</td>
<td>StaffCount</td>
<td>Staff headcount ◦</td>
</tr>
<tr>
<td>Department</td>
<td>Faculty</td>
<td>DepartmentFacultyRecruitment</td>
<td>StaffFTE</td>
<td>Staff FTE ◦</td>
</tr>
<tr>
<td>Department</td>
<td>Faculty</td>
<td>DepartmentFacultyRecruitment</td>
<td>TenureLineFaculty</td>
<td>Tenure line faculty headcount ◦</td>
</tr>
</tbody>
</table>
The Data Model and Planning

- The data model provides a framework for integrating data needed for Capital Planning and Academic Planning
- It can also be a repository for the output from the work of data scientists
The Data Model and Planning: Use Case

- We are considering changes in academic offerings that could impact how on-campus housing is managed.
- The current plan for dormitory renovations assumes a steady state.
The Data Model and Planning: Use Case Current Plan

- Upperclassmen
- Renovations
- Underclassmen
The Data Model and Planning: Use Case New Plan

- Upperclassmen
- Renovations
- Underclassmen
The Data Model and Planning: Use Case No Plan

Upperclassmen

Renovations

Underclassmen
Project Goals

- Work with stakeholders to identify important (very specific) data needs for decision makers
- Fully define data metrics that meet these needs
- Use a platform to store, present, and document shared data
- Move toward using state of the art data visualization technology (D3)

- Note: We assume that the data already exists. If not, you will need to collect it
Project Goals

• Work with stakeholders to identify important (very specific) data needs for decision makers
• Fully define data metrics that meet these needs
  • Use a platform to store, present, and document shared data
  • Move toward using state of the art data visualization technology (D3)
• Gap we are trying to fill
  • Note: We assume that the data already exists. If not, you will need to collect it
Scope: What the application does do

- Allows us to create and share standardized, agreed upon metrics
- Allows for robust use of metadata for documentation
- Simplifies comparisons across units
- Simplifies comparisons across domains
Scope: What it does not do

- Statistical Calculations (those would have to be done when the data model is being populated)
- Data mining of detailed data
- Drill-Through to detail
Demo
Lessons Learned

Agile processes

Get buy in – at all levels

Feedback and continuous evolution
Questions?